OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR CARBON TETRABROMIDE

INTRODUCTION

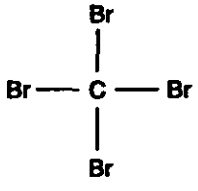
This guideline summarizes pertinent information about carbon tetrabromide for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

SUBSTANCE IDENTIFICATION

- **Formula**

  CBr_4

- **Structure**



- **Synonyms**

  Carbon bromide, tetrabromomethane, methane tetrabromide

- **Identifiers**

  1. CAS No.: 558-13-4
  2. RTECS No.: FG4725000
  3. DOT UN: 2516 53
  4. DOT label: St. Andrew's Cross

- **Appearance and odor**

  Carbon tetrabromide is a nonflammable, colorless to yellow-brown, crystalline solid.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

  1. Molecular weight: 331.65
  2. Boiling point (760 mm Hg): 189.5°C (373.1°F)
  3. Specific gravity (water = 1): 3.42
  4. Vapor density (air = 1 at boiling point of carbon tetrabromide): 11.4
  5. Melting point: 90.1°C (194.2°F)
  6. Vapor pressure at 96.3°C (205°F): 40 mm Hg
  7. Solubility: Insoluble in water; soluble in alcohol, ether, chloroform, and other organic solvents
  8. Evaporation rate: Data not available

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Education and Information Division

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

Reactivity

1. Conditions contributing to instability: None reported

2. Incompatibilities: Contact of carbon tetrabromide with lithium or hexylcyclohexyldilead may cause an explosion.

3. Hazardous decomposition products: Toxic gases (such as bromine) may be released in a fire involving carbon tetrabromide.

4. Special precautions: None

Flammability

The National Fire Protection Association has not assigned a flammability rating to carbon tetrabromide; this substance is not combustible.

1. Flash point: Not applicable

2. Autoignition temperature: Not applicable

3. Flammable limits in air: Not applicable

4. Extinguishant: Use dry chemical, carbon dioxide, water spray, or regular foam.

Fires involving carbon tetrabromide should be fought upwind from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Emergency personnel should stay out of low areas and ventilate closed spaces before entering. Dikes should be used to contain fire-control water for later disposal. Firefighters should wear a full set of protective clothing and self-contained breathing apparatus when fighting fires involving carbon tetrabromide. Structural firefighters' protective clothing may provide limited protection against fires involving carbon tetrabromide.

EXPOSURE LIMITS

- **OSHA PEL**

The Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure limit (PEL) for carbon tetrabromide [29 CFR 1910.1000, Table Z-1].

- **NIOSH REL**

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) of 0.1 ppm (1.4 mg/m^3) as a TWA for up to a 10-hr workday and a 40-hr workweek and 0.3 ppm (4 mg/m^3) as a STEL. A STEL is a 15-min TWA exposure that should not be exceeded at any time during the workday [NIOSH 1992a].

- **ACGIH TLV**

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned carbon tetrabromide a threshold limit value (TLV) of 0.1 ppm (1.4 mg/m^3) as a TWA for a normal 8-hr workday and a 40-hr workweek and a STEL of 0.3 ppm (4.1 mg/m^3) for periods not to exceed 15 min [ACGIH 1993].

- **Rationale for limits**

The NIOSH limits are based on the risk of eye, skin, lung, and liver irritation, and hepatotoxic effects associated with exposure to carbon tetrabromide.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Exposure to carbon tetrabromide can occur through inhalation, eye or skin contact, and ingestion.

- **Summary of toxicology**

1. *Effects on Animals:* In animals, carbon tetrabromide is a severe irritant of the eyes and respiratory tract as well as a liver and kidney toxicant. Undiluted carbon tetrabromide applied to the eyes of rabbits caused severe irritation and permanent corneal damage. However, when the material was promptly washed from the eyes, pain and irritation were noted but the corneal damage was reversible. Exposure of rats to carbon tetrabromide fume at 10 mg/m^3 for 4 hr daily caused irritation of the eyes and respiratory tract [Clayton and Clayton 1981]. Contact with the skin of rabbits caused relatively slight irritation, but when the material was confined tightly to the skin, it caused hyperemia and a moderate degree of swelling [Clayton and Clayton 1981]. The subcutaneous LD_{50} in mice is 298 mg/kg [NIOSH 1992b] and the rat oral

LD_{50} is 1,800 mg/kg [Clayton and Clayton 1981]. Rats exposed to 10 to 1,000 mg/m^3 (0.07 to 74 ppm) for 4 hr/day during a 4-month period exhibited metabolic changes in the liver [Clayton and Clayton 1981]. Rats repeatedly exposed to 100 mg/m^3 or to 300 to 500 mg/m^3 (depending on the analytical method) for 7 hr/day, 5 days/week during a 6-month period showed no effects, but exposure to higher (not further specified) concentrations caused poor growth; fatty and degenerative changes of the liver appeared at autopsy [Clayton and Clayton 1981].

2. *Effects on Humans:* Carbon tetrabromide is a severe irritant of the eyes, nose, throat, and lungs; it is also a liver toxicant. The vapor of carbon tetrabromide causes pronounced eye irritation and lacrimation even at low concentrations [Clayton and Clayton 1981]. Exposure to high concentrations (not further specified) of carbon tetrabromide vapors can irritate the upper respiratory tract, cause CNS depression, and injure the lungs, liver, and kidneys [ACGIH 1991].

- **Signs and symptoms of exposure**

1. *Acute exposure:* Acute exposure to carbon tetrabromide can induce corneal damage, profuse tearing and burning of the eyes; ocular, skin, and upper respiratory tract irritation; and CNS depression.

2. *Chronic exposure:* Liver damage is the primary response to chronic exposure to carbon tetrabromide at very low concentrations [Clayton and Clayton 1981]. Chronic exposure to low concentrations of carbon tetrabromide can also induce contact irritation.

- **Emergency procedures**

> **WARNING!**
>
> **Seek immediate medical attention for severely affected victims or for victims with signs and symptoms of toxicity or irritaiton!**

Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. Initiate the following emergency procedures:

1. *Eye exposure:* Irritation may result from exposure to concentrated solutions, vapors, mists, or aerosols of carbon tetrabromide. ***Immediately and thoroughly*** flush the eyes with large amounts of water, occasionally lifting the upper and lower eyelids.

2. *Skin exposure:* Irritation may result. ***Immediately*** remove contaminated clothing and ***thoroughly*** wash contaminated skin with soap and water.

3. *Inhalation exposure:* Move the victim to fresh air ***immediately.***

   If the victim is not breathing, clean any chemical contamination from the victim's lips and perform cardiopulmonary resuscitation (CPR); if breathing is difficult, give oxygen.

4. *Ingestion exposure:* Take the following steps if carbon tetrabromide or any material containing it is ingested:

   —Have the victim rinse the contaminated mouth cavity several times with a fluid such as water.

   —Have the victim drink a glass (8 oz) of fluid such as water.

   —Induce vomiting by giving syrup of ipecac as directed on the package. If ipecac is unavailable, have the victim touch the back of the throat with a finger until productive vomiting ceases.

   —Do ***not*** force an unconscious or convulsing person to drink fluid or to vomit.

5. *Rescue:* Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the material safety data sheet required by OSHA's hazard communication standard [29 CFR 1910.1200]). All workers should be familiar with emergency procedures and the location and proper use of emergency equipment.

EXPOSURE SOURCES AND CONTROL METHODS

Workers may be exposed to carbon tetrabromide during its use as an intermediate in the manufacture of other chemicals.

The following methods are effective in controlling worker exposures to carbon tetrabromide, depending on the feasibility of implementation:

—Process enclosure

—Local exhaust ventilation

—General dilution ventilation

—Personal protective equipment

Good sources of information about control methods are as follows:

1. ACGIH [1992]. Industrial ventilation—a manual of recommended practice. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

2. Burton DJ [1986]. Industrial ventilation—a self study companion. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

3. Alden JL, Kane JM [1982]. Design of industrial ventilation systems. New York, NY: Industrial Press, Inc.

4. Wadden RA, Scheff PA [1987]. Engineering design for control of workplace hazards. New York, NY: McGraw-Hill.

5. Plog BA [1988]. Fundamentals of industrial hygiene. Chicago, IL: National Safety Council.

MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical monitoring program is intended to supplement, not replace, such measures. To place workers effectively and to detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.

- **Preplacement medical evaluation**

Before a worker is placed in a job with a potential for exposure to carbon tetrabromide, a licensed health care professional should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, and liver.

A preplacement medical evaluation is recommended to detect and assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to carbon tetrabromide at or below the prescribed exposure limit. The licensed health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with diseases of the eyes, skin, or liver.

- **Periodic medical examinations and biological monitoring**

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to carbon tetrabromide exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of carbon tetrabromide on the eyes, skin, and liver. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. No biological monitoring test acceptable for routine use has yet been developed for carbon tetrabromide.

- **Medical examinations recommended at the time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's

health status should be compared with those expected for a suitable reference population. Because occupational exposure to carbon tetrabromide may cause diseases with prolonged latent periods, the need for medical monitoring may extend well beyond the termination of employment.

WORKPLACE MONITORING AND MEASUREMENT

A worker's exposure to airborne carbon tetrabromide is determined by using an XAD-4 tube (80/40-mg sections, 15/50 mesh). Samples are collected at a maximum flow rate of 0.2 liter/min until a maximum air volume of 10 liters (TWA) or 3 liters (STEL) is collected. The sample is then treated with toluene to extract the carbon tetrabromide. Analysis is conducted by gas chromatography using an electron capture detector. This method is included in the OSHA Laboratory In-House Methods File [OSHA 1991].

PERSONAL HYGIENE

If carbon tetrabromide contacts the skin, workers should immediately wash the affected areas with soap and water.

Clothing contaminated with carbon tetrabromide should be removed immediately, and provisions should be made for safely removing this chemical from these articles. Persons laundering contaminated clothing should be informed of the hazardous properties of carbon tetrabromide, particularly its potential to cause burns of the eyes and skin.

A worker who handles carbon tetrabromide should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, using toilet facilities, or applying cosmetics.

Workers should not eat, drink, use tobacco products, or apply cosmetics in areas where carbon tetrabromide or a solution containing carbon tetrabromide is handled, processed, or stored.

STORAGE

Carbon tetrabromide should be stored in a cool, dry, well-ventilated area in tightly sealed containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. Containers of carbon tetrabromide should be protected from physical damage and should be stored separately from strong oxidizers, lithium, hexylcyclohexyldilead, heat, sparks, and open flame. Because containers that formerly contained carbon tetrabromide may still hold product residues, they should be handled appropriately.

SPILLS

In the event of a spill involving carbon tetrabromide, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup is complete. The following steps should be undertaken following a spill:

1. Do not touch the spilled material.
2. Notify safety personnel.
3. Use a clean shovel and gently place the spilled material into a clean, dry container creating as little dust as possible; cover and remove the container from the spill area.

SPECIAL REQUIREMENTS

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and hazardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

- **Emergency planning requirements**

  Carbon tetrabromide is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) [42 USC 11022].

- **Reportable quantity requirements for hazardous releases**

  Employers are not required by the emergency release notification provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [42 CFR 355.40] to notify the National Response Center of an accidental release of carbon tetrabromide; there is no reportable quantity for this substance.

- **Community right-to-know requirements**

  Employers are not required by Section 313 of SARA to submit a Toxic Chemical Release Inventory Form (Form R) to EPA reporting the amount of carbon tetrabromide emitted or released from their facility annually.

- **Hazardous waste management requirements**

EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24. Although carbon tetrabromide is not specifically listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) [40 USC 6901 et seq.], EPA requires employers to treat waste as hazardous if it exhibits any of the characteristics discussed above.

Providing detailed information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (800) 424-9346 or at (202) 382-3000 in Washington, D.C. In addition, relevant State and local authorities should be contacted for information about their requirements for waste removal and disposal.

RESPIRATORY PROTECTION

- **Conditions for respirator use**

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of carbon tetrabromide exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers should use only respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

- **Respiratory protection program**

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's respiratory protection standard [29 CFR 1910.134]. Such a program must include respirator selection, an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, respirator fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information about the selection and use of respirators and about the medical screening of respirator users, consult the *NIOSH Respirator Decision Logic* [NIOSH 1987b] and the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987a].

PERSONAL PROTECTIVE EQUIPMENT

Protective clothing (gloves, gauntlets, aprons, coveralls, and other clothing, as appropriate) should be worn to prevent any skin contact with carbon tetrabromide. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use. A Viton/neoprene laminate has been tested against carbon tetrabromide and has demonstrated good resistance. A laminate of butyl rubber and neoprene has demonstrated poor resistance to permeation by carbon tetrabromide.

If carbon tetrabromide is dissolved in an organic solvent, the permeation properties of both the solvent and the mixture must be considered when selecting personal protective equipment and clothing.

Safety glasses, goggles, or face shields should be worn during operations in which carbon tetrabromide might contact the eyes (e.g., through dust particles or splashes of solution). Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with carbon tetrabromide. Contact lenses should not be worn if the potential exists for carbon tetrabromide exposure.

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