Occupational Health Guideline for Carbon Tetrachloride*

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: CCl_4
- Synonyms: Tetrachloromethane
- Appearance and odor: Colorless liquid with an ether-like odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for carbon tetrachloride is 10 parts of carbon tetrachloride per million parts of air (ppm) averaged over an eight-hour work shift, with an acceptable ceiling concentration of 25 ppm and a maximum allowable peak of 200 ppm for up to 5 minutes in any four-hour period. NIOSH has recommended that the permissible exposure limit be reduced to a ceiling level of 2 ppm averaged over a one-hour period, and that carbon tetrachloride be regulated as an occupational carcinogen. The NIOSH Criteria Document for Carbon Tetrachloride should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Carbon tetrachloride can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may be absorbed through the skin.

- **Effects of overexposure**

1. Short-term Exposure: Exposure to carbon tetrachloride may cause drowsiness, dizziness, incoordination, and unconsciousness. Delayed effects from short-term overexposure include damage to the heart, liver, and kidneys. Symptoms of liver damage include yellow jaundice and dark urine. Eye contact with liquid carbon tetrachloride causes burning and intense irritation.

2. Long-term Exposure: Prolonged or repeated exposure may cause liver and kidney damage. Repeated or prolonged contact of the liquid with the skin may cause skin irritation.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to carbon tetrachloride.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to carbon tetrachloride at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of liver and kidneys should be stressed. The skin and eyes should be examined for evidence of chronic disorders.

—Liver function tests: Carbon tetrachloride causes liver damage. A profile of liver function should be obtained using a medically acceptable array of biochemical tests.

—Urinalysis: Since kidney damage has also been observed from exposure, a urinalysis should be obtained to include at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.

- **Summary of toxicology**

Carbon tetrachloride vapor is a narcotic and causes severe damage to the liver and kidneys. In animals the primary damage from intoxication is to the liver, but in humans the majority of fatalities have been the result of renal injury with secondary cardiac failure. In humans, liver damage occurs more often after ingestion of the

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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liquid than after inhalation of the vapor. Human fatalities from acute renal damage have occurred after exposure for @1/2 to 1 hour to concentrations of 1000 to 2000 ppm. Cardiac arrhythmias have been reported. Exposure to high concentrations results in symptoms of central nervous system depression, including dizziness, vertigo, incoordination, and mental confusion; abdominal pain, nausea, vomiting, and diarrhea are frequent. Polycythemia followed by anemia and hemodilution may occur. Within a few days, jaundice may appear and liver injury progress to toxic necrosis. At the same time, acute nephritis occurs, and albumin, red and white blood cells, and casts appear in the urine; there may be oliguria, anuria, and increased nitrogen retention resulting in the development of uremia. There are several reports of adverse effects in workmen who were repeatedly exposed to concentrations between 25 and 30 ppm; nausea, vomiting, dizziness, drowsiness, and headache were frequently noted. The effects of carbon tetrachloride in humans who are addicted to alcohol are more severe than usual. No adverse symptoms resulted from repeated exposure to 10 ppm. The liquid splashed in the eye causes pain and minimal injury to the conjunctiva. Prolonged or repeated skin contact with the liquid may result in skin irritation. It can be absorbed through the intact skin of animals and humans in toxic amounts. Hepatomas have been reported in several animal species and in man.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**
  1. Molecular weight: 153.8
  2. Boiling point (760 mm Hg): 76.8 C (170 F)
  3. Specific gravity (water = 1): 1.59
  4. Vapor density (air = 1 at boiling point of carbon tetrachloride): 5.3
  5. Melting point: −23 C (-9 F)
  6. Vapor pressure at 20 C (68 F): 91 mm Hg
  7. Solubility in water, g/100 g water at 20 C (68 F): 0.08
  8. Evaporation rate (butyl acetate = 1): 12.8
- **Reactivity**
  1. Conditions contributing to instability: None
  2. Incompatibilities: Carbon tetrachloride reacts with chemically active metals such as sodium, potassium, and magnesium.
  3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, chlorine, phosgene, and carbon monoxide) may be released when carbon tetrachloride decomposes.
  4. Special precautions: Liquid carbon tetrachloride will attack some forms of plastics, rubber, and coatings.
- **Flammability**
  1. Not combustible
- **Warning properties**
  1. Odor Threshold: Carbon tetrachloride has an odor threshold of approximately 50 ppm, according to the *Hygienic Guide*.
  2. Eye Irritation Level: Grant states that carbon tetrachloride is slightly irritating to the eyes, but does not mention the concentrations at which irritation occurs. In addition, carbon tetrachloride is "strongly suspected of causing retrobulbar neuritis, optic neuritis, and optic atrophy."
  3. Evaluation of Warning Properties: Since the odor threshold of carbon tetrachloride is well above the permissible exposure, and since no quantitative data are available relating its warning properties to air concentrations, carbon tetrachloride is considered as a substance with poor warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **Eight-Hour Exposure Evaluation**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Ceiling Evaluation**

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of carbon tetrachloride. Each measurement to determine short-duration ceiling levels should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure. Each measurement to determine a one-hour ceiling should consist of a one-hour sample or a series of consecutive samples totalling one hour.

- **Peak Above Ceiling Evaluation**

Measurements to determine employee peak exposure should be taken during periods of maximum expected airborne concentration of carbon tetrachloride. Each measurement should consist of a 30-minute sample or a series of consecutive samples totalling 30 minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- **Method**

Sampling and analyses may be performed by collection of vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure carbon tetrachloride may be used. An analytical method for carbon tetrachloride is in the

NIOSH Manual of Analytical Methods, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid carbon tetrachloride.

• Clothing wet with liquid carbon tetrachloride should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of carbon tetrachloride from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the carbon tetrachloride, the person performing the operation should be informed of carbon tetrachloride's hazardous properties.

• Non-impervious clothing which becomes contaminated with liquid carbon tetrachloride should be removed promptly and not reworn until the carbon tetrachloride is removed from the clothing.

• Employees should be provided with and required to use splash-proof safety goggles where liquid carbon tetrachloride may contact the eyes.

SANITATION

• Skin that becomes wet with liquid carbon tetrachloride should be promptly washed or showered with soap or mild detergent and water to remove any carbon tetrachloride.

• Eating and smoking should not be permitted in areas where carbon tetrachloride is handled, processed, or stored.

• Employees who handle liquid carbon tetrachloride should wash their hands thoroughly with soap or mild detergent and water before eating or smoking.

• Areas in which exposure to carbon tetrachloride can occur should be identified by signs or other appropriate means, and access to these areas should be limited to authorized persons.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to carbon tetrachloride may occur and control methods which may be effective in each case:

Operation	Controls
Use in manufacture of fluorocarbons for aerosols, refrigerants, and fire extinguishants	Material substitution; process enclosure; local exhaust ventilation; personal protective equipment
Use as an agricultural grain fumigant and pesticide	Material substitution; personal protective equipment
Use in polymer technology as reaction medium, catalyst, chain transfer agent, and solvent for resins; in organic synthesis for chlorination of organic compounds in soap perfumery and insecticide industries	Process enclosure; local exhaust ventilation
Use as an industrial solvent for rubber cements, cable and semiconductor manufacture, separation of xylene isomers as components to reduce flammability	Material substitution; process enclosure; local exhaust ventilation; personal protective equipment
Use as a laboratory solvent	Material substitution; personal protective equipment
Use in metal recovery and catalyst regeneration	Process enclsoure; local exhaust ventilation

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If carbon tetrachloride gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present

after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

• **Skin Exposure**

If carbon tetrachloride gets on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If carbon tetrachloride soaks through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• **Breathing**

If a person breathes in large amounts of carbon tetrachloride, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Swallowing**

When carbon tetrachloride has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If carbon tetrachloride is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. Collect for reclamation or absorb in vermiculite, dry sand, earth, or a similar material.

• Waste disposal method:

Carbon tetrachloride may be disposed of by absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.

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* SPECIAL NOTE

The International Agency for Research on Cancer (IARC) has evaluated the data on this chemical and has concluded that it causes cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 1, 1972.

RESPIRATORY PROTECTION FOR CARBON TETRACHLORIDE

Condition	Minimum Respiratory Protection* Required Above 10 ppm
Vapor Concentration	
100 ppm or less	Any supplied-air respirator. Any self-contained breathing apparatus.
300 ppm or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
Greater than 300 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.