

# Occupational Health Guideline for Carbon Disulfide

## 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: CS<sub>2</sub>
- Synonyms: Carbon bisulfide
- Appearance and odor: Colorless to faintly yellow liquid with a strong, disagreeable or sweetish odor.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for carbon disulfide is 20 parts of carbon disulfide per million parts of air (ppm) averaged over an eight-hour work shift, with a ceiling level of 30 ppm, and an acceptable peak of 100 ppm for 30 minutes in an eight-hour work shift. NIOSH has recommended that the permissible exposure limit be reduced to 1 ppm averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling of 10 ppm averaged over a 15-minute period. The NIOSH Criteria Document for Carbon Disulfide should be consulted for more detailed information.

## HEALTH HAZARD INFORMATION

### • Routes of exposure

Carbon disulfide 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 enter the body through the skin.

### • Effects of overexposure

**1. Short-term Exposure:** Inhalation of carbon disulfide vapor may cause headache, nausea, drop in blood pressure, dizziness, unconsciousness, and death. Liquid carbon disulfide and high concentrations of the vapor may cause irritation of the skin, eyes, and nose. If the

liquid is trapped under clothing, it may cause a burn. Swallowing carbon disulfide may cause loss of consciousness and convulsions. If small amounts are swallowed, vomiting, diarrhea, and headache may occur.

**2. Long-term Exposure:** Prolonged or repeated exposure to carbon disulfide may damage the nervous system and cause muscle weakness, numbness, feelings of pins and needles, unsteady walking, and difficulty in swallowing. Palsy, speech difficulty, and muscle spasticity may also occur. In addition, memory loss, headache, difficulty in sleeping, nervousness, fatigue, irritability, depression, suicidal tendencies, and psychosis may occur. Eye damage may occur with such symptoms as blind spots, narrowing of vision, and decreased ability to see in the dark. Increased arteriosclerosis may occur which may cause or increase damage to the heart and other organs. High blood pressure, kidney damage, liver damage, and stomach problems may occur. Repeated or prolonged exposure of the skin to carbon disulfide may cause a skin rash.

**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 disulfide.

### • Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to carbon disulfide 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 the central and peripheral nervous systems, eyes, cardiovascular system, kidneys, and liver should be stressed. The skin should be examined for evidence of chronic disorders.

—Urinalysis: Since kidney damage has been observed in humans exposed to carbon disulfide, a urinalysis

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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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should be obtained to include, at a minimum, specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

—Liver function tests: Since liver damage has been observed in humans exposed to carbon disulfide, a profile of liver function should be obtained by using a medically acceptable array of biochemical tests.

—An electrocardiogram: Carbon disulfide has caused arrhythmias and electrocardiographic changes in humans. Periodic surveillance is indicated.

—Ophthalmic examination: Carbon disulfide has caused ocular changes in humans. An ophthalmic examination should be performed, including visual acuity.

—Medical warning: Workers should be informed of potential undesirable effects of exposure to carbon disulfide on reproduction (such as spermatic deficiencies, menstrual disorders, and spontaneous abortions).

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

#### • Summary of toxicology

Carbon disulfide vapor causes narcosis at high concentrations; repeated exposure to low concentrations causes damage to the central and peripheral nervous systems and may accelerate the development of or worsen coronary heart disease. Exposure of humans to 1150 ppm causes serious symptoms, and 4800 ppm for 30 minutes may be fatal. Carbon disulfide intoxication can involve all parts of the central and peripheral nervous systems, including damage to the cranial nerves and development of polyneuritis with paresthesias and muscle weakness in the extremities, unsteady gait, and dysphagia. In extreme cases of intoxication, a Parkinson-like syndrome may result, characterized by speech disturbances, muscle spasticity, tremor, memory loss, mental depression, and marked psychic symptoms; permanent disability is likely. Reproductive disorders occur, such as aspermia, menstrual irregularities, and spontaneous abortion. Psychosis and suicide are established risks of overexposure to carbon disulfide. Other reported effects of exposure to carbon disulfide are ocular changes (retinal degeneration, corneal opacities, disturbances of color vision, corneal anesthesia, diminished pupillary reflexes, microscopic aneurysms in the retina), gastrointestinal disturbances (chronic gastritis and achlorhydria), renal impairment (albuminuria, microhematuria, elevated blood urea nitrogen, diastolic hypertension), and liver damage. Effects commonly caused by repeated exposure to carbon disulfide vapor are exemplified by a group of workers with a time-weighted average (TWA) exposure of 11.2 ppm (range 0.9 to 127 ppm) who complained of headaches and dizziness; in other workers with a TWA of 186 ppm (range 23 to 378 ppm) complaints also included sleep disturbances, fatigue, nervousness, anorexia, and weight loss; the end-of-day exposure coefficient of the iodine azide test on urine was a good indicator of workers who were or had been symptomatic. Overexposure to

carbon disulfide has long been regarded as potentially atherogenic for cerebral, renal, and coronary arteries; recent epidemiologic studies of viscose rayon workers have confirmed a 2.5- to 5-fold increase in risk of death from coronary heart disease as compared with the experience of unexposed workers. Other cardiovascular effects observed in workers repeatedly exposed to carbon disulfide are bradycardia, tachycardia, arrhythmias, and electrocardiographic changes consistent with both nonspecific and ischemic wave changes. Splashes of the liquid in the eyes cause immediate and severe irritation; dermatitis and vesiculation may result from skin contact with the vapor or the liquid. Although ingestion is unlikely to occur, it may cause coma and convulsions.

## CHEMICAL AND PHYSICAL PROPERTIES

### • Physical data

1. Molecular weight: 76.1
2. Boiling point (760 mm Hg): 46.3 C (115 F)
3. Specific gravity (water = 1): 1.27
4. Vapor density (air = 1 at boiling point of carbon disulfide): 2.6
5. Melting point: -111.5 C (-169 F)
6. Vapor pressure at 20 C (68 F): 300 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.2
8. Evaporation rate (butyl acetate = 1): 22.6

### • Reactivity

1. Conditions contributing to instability: Containers may burst when heated.

2. Incompatibilities: Contact with strong oxidizers, and chemically active metals (such as sodium, potassium, and zinc), azides, and organic amines may cause fires and explosions.

3. Hazardous decomposition products: Toxic gases and vapors (such as sulfur dioxide and carbon monoxide) may be released in a fire involving carbon disulfide.

4. Special precautions: Liquid carbon disulfide will attack some forms of plastics, rubber, and coatings.

### • Flammability

1. Flash point: -30 C (-22 F) (closed cup)
2. Autoignition temperature: 90 C (194 F)
3. Flammable limits in air, % by volume: Lower: 1.3; Upper: 50
4. Extinguishant: Dry chemical, carbon dioxide for small fires

### • Warning properties

1. Odor Threshold: The *Handbook of Organic Industrial Solvents* states that at less than 1 ppm, carbon disulfide has a disagreeable odor. Summer gives an odor threshold of 7.7 ppm, and May gives 0.0011 ppm and 0.0081 ppm. The *AIHA Hygienic Guide* gives an odor threshold of 1.2 ppm.

2. Eye Irritation Level: Carbon disulfide is not known to be an eye irritant.

3. Evaluation of Warning Properties: Since the odor threshold of carbon disulfide is below the permissible

exposure limit, it is treated as a material with good 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 disulfide. Each measurement 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.

### • Peak Above Ceiling Evaluation

Measurements to determine employee peak exposure should be taken during periods of maximum expected airborne concentration of carbon disulfide. 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 carbon disulfide vapors using an adsorption tube with subsequent desorption with benzene and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure carbon disulfide may be used. An analytical method for carbon disulfide 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 skin contact with liquid carbon disulfide, where skin contact may occur.

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

• Any clothing which becomes wet with liquid carbon disulfide should be removed immediately and not reworn until the carbon disulfide is removed from the clothing.

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

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

## SANITATION

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

## COMMON OPERATIONS AND CONTROLS

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

## Operation

## Controls

Use in manufacture of viscose rayon during xanthation of cellulose and spinning and cutting operations; use as a xanthating agent in manufacture of cellophane; use during manufacture of pesticides

Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment

Use as a fumigant and spray application on grains, and space fumigation of agricultural premises

General dilution ventilation; temperature control; personal protective equipment

Use in synthesis of carbon tetrachloride

Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment

Use in synthesis of intermediates and manufacture of dyes, pharmaceuticals, rubber chemicals, pesticides, and flotation agents

Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment

Liberation during destructive distillation of coal in manufacture of coal gas and coal tar

Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment

Use as a solvent in dry spinning of polyvinyl chloride; as a solvent in oil wells; use in manufacture of optical glass

Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment

Use during rubber manufacture in cold curing operations; during extraction processing of oils, fats, resins, and waxes; use in manufacture of matches

Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment

## 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 liquid carbon disulfide 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 liquid carbon disulfide gets on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If liquid carbon disulfide soaks through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention promptly.

### • Breathing

If a person breathes in large amounts of carbon disulfide, 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 liquid carbon disulfide has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

### • 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 disulfide is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. Carbon disulfide should not be allowed to enter a confined space, such as

a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of carbon disulfide vapors are permitted.

- Waste disposal method:

Carbon disulfide may be disposed of by atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

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## RESPIRATORY PROTECTION FOR CARBON DISULFIDE

Condition	Minimum Respiratory Protection* Required Above 20 ppm
Vapor Concentration	
200 ppm or less	Any chemical cartridge respirator with an organic vapor cartridge(s). Any supplied-air respirator. Any self-contained breathing apparatus.
500 ppm or less	Any chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s). A gas mask with a chin-style or a front- or back-mounted organic vapor canister. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece. A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 500 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.