

# Occupational Health Guideline for Tetrahydrofuran

## 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:  $C_4H_8O$
- Synonyms: Diethylene oxide; tetramethylene oxide; THF
- Appearance and odor: Colorless liquid with an ether-like odor.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for tetrahydrofuran is 200 parts of tetrahydrofuran per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 590 milligrams of tetrahydrofuran per cubic meter of air ( $mg/m^3$ ).

## HEALTH HAZARD INFORMATION

### • Routes of exposure

Tetrahydrofuran can affect the body if it is inhaled, is swallowed, or comes in contact with the eyes or skin.

### • Effects of overexposure

1. *Short-term Exposure:* Overexposure to tetrahydrofuran may cause irritation of the eyes and nose, nausea, dizziness, and headache.

2. *Long-term Exposure:* Prolonged or repeated exposure to tetrahydrofuran may cause drying of the skin.

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 tetrahydrofuran.

### • Recommended medical surveillance

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

1. *Initial Medical Screening:* Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from tetrahydrofuran exposure.

—Skin disease: Tetrahydrofuran can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Liver disease: Although tetrahydrofuran is not known as a liver toxin in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.

—Kidney disease: Although tetrahydrofuran is not known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.

—Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of tetrahydrofuran might cause exacerbation of symptoms due to its irritant properties.

2. *Periodic Medical Examination:* Any employee developing the above-listed conditions should be referred for further medical examination.

### • Summary of toxicology

Tetrahydrofuran is an anesthetic agent and a mild upper respiratory tract irritant. Exposure of animals to vapor above 3000 ppm for 8 hours daily for 20 days produced irritation of the upper respiratory tract. Some injury to the liver and kidneys was observed, which was possibly due to impurities, since other studies have not confirmed this finding. Concentrations above 25,000 ppm produced anesthesia, with a small margin of safety between anesthesia and death. Severe headaches were

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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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noted among technicians performing this experiment. Daily 6-hour exposures of dogs for 3 to 4 weeks at 200 ppm produced only a slight change in pulse pressure, but no other signs were noted, even when continued for a total of 9 weeks followed by an additional 3 weeks' exposure at nearly 400 ppm. This substance was irritating to the skin of rabbits when applied in aqueous solutions exceeding 20% concentration, although it has not been observed to be a significant skin irritant or sensitizer in industrial practice. No chronic systemic effects have been reported in humans, although nausea, dizziness, and headaches are said to occur with overexposure and are readily reversible in fresh air.

## CHEMICAL AND PHYSICAL PROPERTIES

### • Physical data

1. Molecular weight: 72
2. Boiling point (760 mm Hg): 66 C (151 F)
3. Specific gravity (water = 1): 0.9
4. Vapor density (air = 1 at boiling point of tetrahydrofuran): 2.5
5. Melting point: -108 C (-163 F)
6. Vapor pressure at 20 C (68 F): 145 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Miscible in all proportions
8. Evaporation rate (butyl acetate = 1): 14.5

### • Reactivity

1. Conditions contributing to instability: Heat and sunlight
2. Incompatibilities: Contact with strong oxidizing agents may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving tetrahydrofuran.
4. Special precautions: Tetrahydrofuran will attack some forms of plastics, rubber, and coatings. Storage in the presence of air and light causes the formation of explosive peroxides that remain dissolved in tetrahydrofuran. Containers may explode when their caps or stoppers are removed.

### • Flammability

1. Flash point: -14.5 C (6 F) (closed cup)
2. Autoignition temperature: 321 C (610 F)
3. Flammable limits in air, % by volume: Lower: 2; Upper: 11.8
4. Extinguishant: Dry chemical, alcohol foam, carbon dioxide

### • Warning properties

1. Odor Threshold: May and Summer both report an odor threshold for tetrahydrofuran of 30 ppm.
2. Eye Irritation Level: Sax reports that tetrahydrofuran is an eye irritant, and Stecher, Browning, and the ILO indicate that it is a mucous membrane irritant, but the concentrations which produce irritation are not given. The *Handbook of Organic Industrial Solvents* reports that tetrahydrofuran "may cause irritation to mucuous membranes at concentrations higher than the threshold limit," but no quantitative information is

available concerning the threshold of eye irritation.

3. Other Information: "The TLV of 200 ppm is recommended to protect against irritative effects and has a wide margin of safety for narcotic and systemic effects," according to the *Documentation of TLV's*.

4. Evaluation of Warning Properties: Since the odor threshold of tetrahydrofuran is well below the permissible exposure limit, it is treated as a material with good warning properties.

## MONITORING AND MEASUREMENT PROCEDURES

### • General

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).

### • Method

Sampling and analyses may be performed by collection of tetrahydrofuran 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 tetrahydrofuran may be used. An analytical method for tetrahydrofuran is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

## 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 tetrahydrofuran.
- Clothing wet with liquid tetrahydrofuran should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of tetrahydrofuran from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the tetrahydrofuran, the person performing the operation should be informed of tetrahydrofuran's hazardous properties.
- Any clothing which becomes wet with liquid tetrahydrofuran should be removed immediately and not reworn until the tetrahydrofuran is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where liquid tetrahydrofuran may contact the eyes.

## SANITATION

- Skin that becomes wet with liquid tetrahydrofuran should be promptly washed or showered to remove any tetrahydrofuran.

## COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Use as a solvent in preparation of printing inks, adhesives, lacquers, and other coatings	General dilution ventilation; personal protective equipment
Use as a Grignard reagent in synthesis of motor fuels, vitamins, hormones, pharmaceuticals, synthetic perfumes, organometallic compounds and insecticides	General dilution ventilation; process enclosure; personal protective equipment
Use as an intermediate in the preparation of various chemicals, including adipic acid, butadiene, polytetramethylene, and acrylic acid	Process enclosure; general dilution ventilation; 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 tetrahydrofuran 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 tetrahydrofuran gets on the skin, promptly wash the contaminated skin with water. If tetrahydrofuran soaks through the clothing, remove the clothing immediately and flush the skin with water. If irritation persists after washing, get medical attention.

### • Breathing

If a person breathes in large amounts of tetrahydrofuran, 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 tetrahydrofuran 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 tetrahydrofuran 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 collected, dissolved in alcohol of greater molecular weight than butyl alcohol, and atomized in a suitable combustion chamber. Tetrahydrofuran should

not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

- Waste disposal method:

Tetrahydrofuran may be disposed of by dissolving in alcohol of greater molecular weight than butyl alcohol, and atomizing in a suitable combustion chamber.

## REFERENCES

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## RESPIRATORY PROTECTION FOR TETRAHYDROFURAN

Condition	Minimum Respiratory Protection* Required Above 200 ppm
Vapor Concentration	
1000 ppm or less	A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s).
5000 ppm or less	A gas mask with a chin-style organic vapor canister.
10,000 ppm or less	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.
20,000 ppm or less	A powered air-purifying respirator with a full facepiece and organic vapor cartridge(s). A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 20,000 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.