

Occupational Health Guideline for Epichlorohydrin*

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_3H_5OCl
- Synonyms: 1-Chloro-2,3-epoxypropane; 2-chloropropylene oxide; gamma-chloropropylene oxide
- Appearance and odor: Colorless liquid with an irritating chloroform-like odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for epichlorohydrin is 5 parts of epichlorohydrin per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 19 milligrams of epichlorohydrin per cubic meter of air (mg/m^3). NIOSH has recommended that the permissible exposure limit be reduced to 2 mg/m^3 (0.5 ppm) averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 19 mg/m^3 averaged over a 15-minute period. The NIOSH Criteria Document for Epichlorohydrin should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**
Epichlorohydrin 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:** Epichlorohydrin may cause irritation of the eyes, respiratory tract, and skin. Nausea and vomiting may also occur. Coughing, difficult breathing, and a blue coloration of the skin may be

present. Liquid epichlorohydrin may produce blistering and deep-seated pain on contact with the skin. The liquid is highly irritating to the eyes. Breathing difficulty may occur several hours after exposure. A person may become sensitized to this chemical so that even very small amounts cannot be tolerated.

2. **Long-term Exposure:** Repeated or prolonged skin contact with epichlorohydrin may cause skin burns. Repeated or prolonged contact with this chemical might also cause liver, lung, and kidney injury. Anti-fertility effects, including persistent sterility, have been induced in animals exposed to epichlorohydrin.

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 epichlorohydrin.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to epichlorohydrin 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 eyes, hematopoietic and respiratory systems, liver, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders.

—14" x 17" chest roentgenogram: Epichlorohydrin may cause human lung damage. Surveillance of the lungs is indicated.

—Pulmonary function testing of FVC and FEV (1 sec): Epichlorohydrin is a severe pulmonary irritant in animals.

—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.

—Eye disease: Epichlorohydrin is a severe eye irritant and may cause tissue damage. Those with pre-

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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existing eye problems may be at increased risk from exposure.

—Liver function tests: Epichlorohydrin may cause liver damage. A profile of liver function should be obtained by utilizing a medically acceptable array of biochemical tests.

—Skin disease: Epichlorohydrin is a defatting agent and can cause dermatitis on prolonged exposure. It can also cause burning, itching, blisters, skin erosion, redness, and residual erythema which may occur from a few minutes to several hours after exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Medical warning: Employees should be informed that large doses of epichlorohydrin have caused anti-fertility effects in animals; however, no effects have been found on potency.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis, except that an x-ray is necessary only when indicated by the results of pulmonary function testing.

• Summary of toxicology

Epichlorohydrin vapor is a potent eye and respiratory irritant. The LC50 for rats was 500 ppm for 4 hours; the animals showed gradual development of cyanosis followed by muscular relaxation of the extremities, but not narcosis. Rats exposed repeatedly to 120 ppm for 6-hour periods showed lung, liver, and kidney injury; some respiratory distress was observed at 56 ppm, while 9 ppm produced no effects. The liquid is markedly irritating when instilled in the eye and intensely irritating to the depilated skin of laboratory animals, leading to widespread necrosis. Subcutaneous injection of epichlorohydrin in animals has been reported to cause sarcoma at the site of injection. In man, contact of the liquid with the skin at first produces a slight transient burning sensation which may be followed several hours later by blistering and pain in the region of contact; it is also highly irritating to the eyes. An occasional case of sensitization with resulting intolerance to very small quantities of the substance has been reported. At 25 ppm the odor is recognized by the majority of persons; one report indicated eye and nose irritation only at levels exceeding 100 ppm while another stated that 40 ppm at the site of a spill caused immediate eye, nose, and throat irritation. The earliest symptoms of intoxication may be referable to the gastrointestinal tract (nausea, vomiting, abdominal discomfort) or pain in the region of the liver; labored breathing, cough, and cyanosis may be evident; the onset of chemical pneumonitis may occur several hours after exposure.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 92.5
2. Boiling point (760 mm Hg): 115 C (239 F)
3. Specific gravity (water = 1): 1.18
4. Vapor density (air = 1 at boiling point of epichloro-

hydrin): 3.19

5. Melting point: -58 C (-72 F)

6. Vapor pressure at 20 C (68 F): 13 mm Hg

7. Solubility in water, g/100 g water at 20 C (68 F): 6.4

8. Evaporation rate (butyl acetate = 1): 1.35

• Reactivity

1. Conditions contributing to instability: Temperatures above 325 C (617 F) will cause epichlorohydrin to polymerize.

2. Incompatibilities: Contact with strong acids, caustics, zinc, aluminum, chlorides of iron and aluminum and strong oxidizers may cause fires and explosions.

3. Hazardous decomposition products: Toxic gases and vapors (such as phosgene, hydrogen chloride, and carbon monoxide) may be released in a fire involving epichlorohydrin.

4. Special precautions: Epichlorohydrin will attack some forms of plastics, rubber, and coatings.

• Flammability

1. Flash point: 37.8 C (100 F) (closed cup)

2. Autoignition temperature: 415.6 C (780 F)

3. Flammable limits in air, % by volume: Lower: 3.8; Upper: 21.0

4. Extinguishant: Dry chemical, alcohol foam, carbon dioxide

• Warning properties

The AIHA *Hygienic Guide* states that 5 ppm of epichlorohydrin, the permissible exposure limit, cannot be detected by odor. At 16 ppm, four humans "detected the presence of epichlorohydrin, but only two could identify it;" at 64 ppm, all four could recognize the odor. In another investigation, half of a group of people detected 10-12 ppm, and within 5 minutes all of the subjects detected 25 ppm. According to the *Hygienic Guide*, "the threshold for nose and eye irritation is reported to be greater than 100 ppm." Since the warning properties of epichlorohydrin do not become evident until concentrations are several times the permissible exposure limit, epichlorohydrin is treated as a material with poor warning properties.

Epichlorohydrin is an eye irritant. The NIOSH Criteria Document cites data indicating that exposure to 20 ppm for one hour causes temporary burning of the eye and nasal passages.

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 epichlorohydrin. 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.

• **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 epichlorohydrin may be used. An analytical method for epichlorohydrin 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 any possibility of skin contact with liquid epichlorohydrin.

• Clothing contaminated with liquid epichlorohydrin should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of epichlorohydrin from the clothing. If the

clothing is to be laundered or otherwise cleaned to remove the epichlorohydrin, the person performing the operation should be informed of epichlorohydrin's hazardous properties.

• Where there is any possibility of exposure of an employee's body to liquid epichlorohydrin, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

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

• Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of liquid epichlorohydrin contacting the eyes.

• Where there is any possibility that employees' eyes may be exposed to liquid epichlorohydrin, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

• Skin that becomes contaminated with liquid epichlorohydrin should be immediately washed or showered with soap or mild detergent and water to remove any epichlorohydrin.

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

• Employees who handle liquid epichlorohydrin should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Use as intermediate in manufacture of DGEBA resins, epoxy novolac resins, phenoxy resins, and wet-strength resins for paper	Process enclosure; local exhaust ventilation; personal protective equipment
Use in manufacture of glycerol and glycidol derivatives for use as plasticizer, stabilizer solvent, intermediate, dyestuff surfactants, pharmaceuticals, and intermediates for further synthesis	Process enclosure; local exhaust ventilation; personal protective equipment

Operation

Use as stabilizer in manufacture of chlorinated rubber and chlorinated insecticides

Use in coating fibers and textile surface coatings

Controls

Process enclosure; local exhaust ventilation; personal protective equipment

Process enclosure; local exhaust 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 epichlorohydrin gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If epichlorohydrin gets on the skin, immediately flush the contaminated skin using soap or mild detergent and water. If epichlorohydrin soaks through the clothing, remove the clothing immediately and flush 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 epichlorohydrin, 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 epichlorohydrin 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 epichlorohydrin 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. Epichlorohydrin 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 epichlorohydrin vapors are permitted.

• Waste disposal method:

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

REFERENCES

- American Conference of Governmental Industrial Hygienists: "Epichlorohydrin," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
- American Industrial Hygiene Association: "Epichlorohydrin," *Hygienic Guide Series*, Detroit, Michigan, 1961.
- Christensen, H. E., and Luginbyhl, T. L. (eds.): *NIOSH Toxic Substances List*, 1974 Edition, HEW Publication No. 74-134, 1974.
- Dow Chemical Company: *Material Safety Data Sheet - Epichlorohydrin*, Midland, Michigan, 1971.
- Grant, W. M.: *Toxicology of the Eye* (2nd ed.), C. C. Thomas, Springfield, Illinois, 1974.
- National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare: *Criteria for a Recommended Standard . . . Occupational Exposure to Epichlorohydrin*, HEW Publication No. (NIOSH) 76-206, GPO No. 017-033-00197-9, U.S. Government Printing Office, Washington, D.C., 1976.
- Patty, F. A. (ed.): *Toxicology*, Vol. II of *Industrial Hygiene and Toxicology* (2nd ed. rev.), Interscience, New York, 1963.
- Sax, N. I.: *Dangerous Properties of Industrial Materials* (3rd ed.), Van Nostrand Reinhold, New York, 1968.
- Van Duuren, B. L., et al.: "Carcinogenicity of Haloethers. II. Structure-Activity Relationships of Analogs of Bis (Chloromethyl) Ether," *Journal of National Cancer Institute*, 48:1431-1439, 1972.

* 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 11, 1976, and Volume 18, 1978.

RESPIRATORY PROTECTION FOR EPICHLOROHYDRIN

Condition	Minimum Respiratory Protection* Required Above 5 ppm
Vapor Concentration	
50 ppm or less	Any supplied-air respirator.** Any self-contained breathing apparatus.**
250 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 250 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 and acid gases. Any escape self-contained breathing apparatus.

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

**If eye irritation occurs, full-facepiece respiratory protective equipment should be used.

***Use of supplied-air suits may be necessary to prevent skin contact while providing respiratory protection from airborne concentrations of epichlorohydrin; however, this equipment should be selected, used, and maintained under the immediate supervision of trained personnel. Where supplied-air suits are used above a concentration of 250 ppm, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.