

Occupational Health Guideline for Diborane

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: B_2H_6
- Synonyms: Boroethane
- Appearance and odor: Colorless gas with a repulsive, sweet odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for diborane is 0.1 part of diborane per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 0.1 milligram of diborane per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

- Routes of exposure
Diborane can affect the body if it is inhaled or if it comes in contact with the eyes or skin.
- Effects of overexposure
 1. *Short-term Exposure:* Diborane may cause tightness in the chest, cough, inability to take a deep breath, and chest pain. Severe breathing difficulties may occur. These difficulties may be delayed in onset. High concentrations of diborane may irritate the eyes.
 2. *Long-term Exposure:* Prolonged exposure to low concentrations of diborane may cause headache, lightheadedness, fatigue, muscular weakness, and tremors. It has caused liver and kidney damage in animals.
 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 diborane.

- Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to diborane 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 lungs, nervous system, liver, and kidneys should be stressed.

—14" x 17" chest roentgenogram: Diborane causes human lung damage. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Diborane is a respiratory irritant. Persons with impaired pulmonary function may be at increased risk from exposure. Periodic surveillance is indicated.

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, or when signs and symptoms of respiratory disease occur.

- Summary of toxicology

Diborane gas is a pulmonary irritant. The LC50 for rats was 50 ppm for 4 hours; in other animal experiments, acute exposure caused pulmonary edema and hemorrhage and temporary damage to the liver and kidneys. In humans, overexposure results in a sensation of tightness in the chest leading to precordial pain, shortness of breath, nonproductive cough, and sometimes nausea. Prolonged exposure to low concentrations causes headache, light-headedness, vertigo, chills and, less frequently, fever; fatigue or weakness occurs and may persist for several hours; tremor or muscular fasciculations occur infrequently and are usually localized and of short duration. Diborane gas has not been found to have significant effects upon contact with skin or mucous

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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membranes, although high concentrations may cause eye irritation.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 27.7
2. Boiling point (760 mm Hg): -92 C (-134 F)
3. Specific gravity (water = 1): 0.47 (liquid)
4. Vapor density (air = 1 at boiling point of diborane): 0.96
5. Melting point: -165 C (-265 F)
6. Vapor pressure at 20 C (68 F): Greater than 1 atmosphere
7. Solubility in water, g/100 g water at 20 C (68 F): Reacts rapidly to form hydrogen gas

8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity

1. Conditions contributing to instability: Temperatures above -18 C (0 F). Containers are usually stored in "dry ice." Ignites spontaneously in moist air at room temperature.

2. Incompatibilities: Contact with air or halogenated compounds will cause fires and explosions. Contact with aluminum, lithium, and other active metals forms hydrides which may ignite spontaneously. Diborane reacts with many oxidized surfaces as a strong reducing agent.

3. Hazardous decomposition products: Toxic gases and vapors (such as boron oxide smoke) may be released in a fire involving diborane.

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

• Flammability

1. Flash point: Data not available
2. Autoignition temperature: $38-52\text{ C}$ ($100-125\text{ F}$)
3. Flammable limits in air, % by volume: Lower: 0.8; Upper: 98

4. Extinguishant: Stop flow of gas, or let fire burn.

• Warning properties

1. Odor Threshold: According to the AIHA *Hygienic Guide*, the nauseating odor of diborane is "not a reliable warning of toxic exposure." No quantitative information is available concerning the threshold of odor, however.

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

3. Evaluation of Warning Properties: Since there is no quantitative information relating warning properties to air concentrations of diborane, it is treated as a material with poor 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

At the time of publication of this guideline, no measurement method for diborane had been published by NIOSH.

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.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Use as a reducing agent in the synthesis of organic chemical intermediates; use as a component or additive for high-energy fuels; use as a catalyst in olefin polymerization	Process enclosure; personal protective equipment
Use in electronics industry to improve crystal growth or to impart electrical properties in pure crystals	Process enclosure; 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 strong concentrations of diborane gas get 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.

• Breathing

If a person breathes in large amounts of diborane, 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.

• 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.

LEAK PROCEDURES

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

• If diborane is leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of leak.
3. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair the leak or allow the cylinder to empty.

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RESPIRATORY PROTECTION FOR DIBORANE

Condition	Minimum Respiratory Protection* Required Above 0.1 ppm
Gas Concentration	
1 ppm or less	Any supplied-air respirator. Any self-contained breathing apparatus.
5 ppm or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
40 ppm or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 40 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 diborane. Any escape self-contained breathing apparatus.

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