

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR DECABORANE

INTRODUCTION

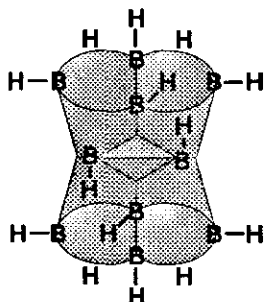
This guideline summarizes pertinent information about decaborane for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

SUBSTANCE IDENTIFICATION

• Formula



• Structure



• Synonyms

Decaboron tetradecahydride, boron hydride

• Identifiers

1. CAS No.: 17702-41-9
2. RTECS No.: HD1400000
3. DOT UN: 1868 34
4. DOT label: Flammable solid, poison

• Appearance and odor

Decaborane is a colorless to white crystalline solid with a bitter, chocolate-like odor. The median odor threshold for decaborane is 0.06 part per million (ppm) parts of air.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 122.3
2. Boiling point (760 mm Hg): 213°C (416°F)
3. Specific gravity (water = 1): 0.94 at 25°C (77°F)
4. Vapor density (air = 1 at boiling point of decaborane): 4.2
5. Melting point: 99.7°C (211°F)
6. Vapor pressure at 25°C (77°F): 0.05 mm Hg
7. Solubility: Slightly soluble in cold water; soluble in

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service
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National Institute for Occupational Safety and Health
Education and Information Division

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benzene, hexane, toluene, alcohol, and ether; very soluble in carbon disulfide

8. Evaporation rate: Data not available

Reactivity

1. Conditions contributing to instability: Heat, sparks, and open flame
2. Incompatibilities: Contact of decaborane with oxidizers, oxygenated solvents, or dimethyl sulfoxide causes fires or explosions. In contact with carbon tetrachloride, ethers, or halocarbons, decaborane forms impact-sensitive mixtures.
3. Hazardous decomposition products: Toxic fumes (such as boron oxides) may be released in a fire involving decaborane.
4. Special precautions: None reported

Flammability

The National Fire Protection Association has assigned a flammability rating of 2 (moderate fire hazard) to decaborane.

1. Flash point: 80°C (176°F) (closed cup)
2. Autoignition temperature: Data not available
3. Flammable limits in air: Data not available
4. Extinguishant: Use dry chemical, waterspray, or regular foam to fight fires involving decaborane.

Fires involving decaborane should be fought upwind from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Emergency personnel should stay out of low areas and ventilate closed spaces before entering. Containers of decaborane may explode in the heat of the fire and should be moved from the fire area if it is possible to do so safely. If this is not possible, cool containers from the sides with water until well after the fire is out. Stay away from the ends of containers. Dikes should be used to contain fire-control water for later disposal. Firefighters should wear a full set of protective clothing and self-contained breathing apparatus when fighting fires involving decaborane. Structural firefighters' protective

clothing may provide limited protection against fires involving decaborane.

EXPOSURE LIMITS

• OSHA PEL

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for decaborane is 0.05 ppm (0.3 mg/m³) as an 8-hr time-weighted average (TWA) concentration. The OSHA PEL also bears a "Skin" notation, which indicates that the cutaneous route of exposure (including mucous membranes and eyes) contributes to overall exposure [29 CFR 1910.1000, Table Z-1].

• NIOSH REL

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) of 0.05 ppm (0.3 mg/m³) as a TWA for up to a 10-hr workday and a 40-hr workweek and a STEL of 0.15 (0.9 mg/m³). A STEL is the maximum 15-min concentration to which workers may be exposed during any 15-min period of the working day. The NIOSH REL and STEL also bear a "Skin" notation [NIOSH 1992].

• ACGIH TLV

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned decaborane a threshold limit value (TLV) of 0.05 ppm as a TWA for a normal 8-hr workday and a 40-hr workweek and a short-term exposure limit (STEL) of 0.15 ppm for periods not to exceed 15 minutes. The ACGIH also assigns decaborane a "Skin" notation [ACGIH 1993].

• Rationale for limits

The OSHA, NIOSH, and ACGIH limits are based on the risk of neuropathic, hepatic, and nephrotoxic effects associated with exposure to decaborane [54 Fed. Reg. 2409; NIOSH 1992; ACGIH 1991].

HEALTH HAZARD INFORMATION

• Routes of exposure

Exposure to decaborane can occur through inhalation, ingestion, eye and skin contact, and absorption through the skin.

• **Summary of toxicology**

1. *Effects on Animals:* Decaborane is toxic to the central nervous system, liver, cardiovascular system, and kidneys of experimental animals. It is toxic by all routes of exposure, and cumulative effects have been reported in rats, rabbits, and dogs [Clayton and Clayton 1981; Parmeggiani 1983]. Corneal opacities developed in mice and rats following a 4-hr exposure to a 26-ppm concentration of decaborane [Hathaway et al. 1991]. The dermal LD₅₀ is 71 mg/kg in rabbits and 740 mg/kg in rats [NIOSH 1993]. The 4-hr LC₅₀ is 46 ppm in rats and 12 ppm in mice [NIOSH 1993]. The oral LD₅₀ is 64 mg/kg in rats and 41 mg/kg in mice [NIOSH 1993]. The manifestations of acute decaborane-induced central nervous system toxicity in rodents include hyperexcitability, restlessness, coarse head movements, generalized weakness, rigid hindquarters, absent eye reflexes, convulsive seizures, depressed breathing, and narcosis [Parmeggiani 1983; Hathaway et al. 1991]. Repeated low-dose oral exposure (3 mg/kg) to decaborane did not cause marked central nervous system effects in any test species but did cause liver and kidney damage [Hathaway et al. 1991]. Cardiovascular toxicity is manifested in dogs as slow heart rate, initial moderate elevation in blood pressure, and a final drop in blood pressure after lethal doses of decaborane are administered by any route [Hathaway et al. 1991; Parmeggiani 1983].

2. *Effects on Humans:* Decaborane causes central nervous system effects in humans. Exposure causes headaches, dizziness, drowsiness, and nausea, and severe exposure is expected to cause general weakness, incoordination, hyperexcitability, narcosis, fatigue, muscle spasms, tremors, convulsions, and unconsciousness [Hathaway et al. 1991]. The onset of symptoms may be delayed for up to 2 days. Recovery from muscle spasms may occur in 24 hours, but lightheadedness and fatigue may be present for up to 3 days [Hathaway et al. 1991].

• **Signs and symptoms of exposure**

1. *Acute exposure:* The signs and symptoms of acute exposure to decaborane may include headache, dizziness, drowsiness, nausea, lightheadedness, fatigue, and incoordination. Based on effects seen in animals, exposure may cause redness and irritation of the eyes and eyelids, tremor, localized muscle spasm, and convulsions.

2. *Chronic exposure:* The signs and symptoms of chronic exposure to decaborane may include headaches, fatigue, drowsiness, inability to concentrate, and lack of coordination. Based on effects seen in animals, chronic exposure may lead to jaundice, enlarged and tender liver, and blood, pus, or protein in the urine.

• **Emergency Procedures**

<p style="text-align: center;">WARNING!</p> <p style="text-align: center;">Exposed victims may die!</p> <p style="text-align: center;">Transport immediately to emergency medical facility!</p>

Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. *Immediately* initiate the following emergency procedures, continuing them as appropriate en route to the emergency medical facility:

1. *Eye exposure:* Tissue destruction and blindness may result! *Immediately but gently* flush the eyes with large amounts of water for at least 15 min, occasionally lifting the upper and lower eyelids.

2. *Skin exposure:* Severe burns, skin corrosion, and absorption of lethal amounts may result! *Immediately* remove all contaminated clothing! *Immediately, continuously, and gently* wash skin for at least 15 min. Use soap and water if skin is intact; use only water if skin is not intact.

3. *Inhalation exposure:* If particulates, mists, or vapors of decaborane are inhaled, move the victim to fresh air *immediately*. Have the victim blow his or her nose or use a soft tissue to remove particulates or residues from the nostrils.

If the victim is not breathing, clean any chemical contamination from victim's lips and perform cardiopulmonary resuscitation (CPR); if breathing is difficult, give oxygen.

4. *Ingestion exposure:* Take the following steps if decaborane or any material containing it is ingested:

—Do *not* induce vomiting.

—Have the victim rinse the contaminated mouth cavity several times with a fluid such as water.

—Immediately after rinsing, have the victim drink one cup (8 oz) of fluid and *no more*.

—Do *not* permit the victim to drink milk or carbonated beverages!

—Do *not* permit the victim to drink any fluid if more than 60 min have passed since initial ingestion.

NOTE: These instructions must be followed exactly. Drinking a carbonated beverage or more than one cup of fluid could create enough pressure to perforate already damaged stomach tissue. The tissue-coating action of milk may impede medical assessment of tissue damage. Ingestion of any fluid more than 60 min after initial exposure could further weaken damaged tissue and result in perforation.

5. *Rescue:* Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the material safety data sheet required by OSHA's hazard communication standard [29 CFR 1910.1200]). All workers should be familiar with emergency procedures, the location and proper use of emergency equipment, and methods of protecting themselves during rescue operations.

EXPOSURE SOURCES AND CONTROL METHODS

The following operations may involve decaborane and lead to worker exposures to this substance:

—Use as a reducing agent in chemical synthesis and as an olefin polymerization catalyst

—Use as a vulcanizing agent in rubber manufacture and as an anti-corrosive coating for metals

—Manufacture of high-energy fuel, rocket propellants, plastics, and polymers

—Use as a stabilizer, rayon delustrant, mothproofing agent, dye-stripping agent, fluxing agent, and oxygen scavenger

The following methods are effective in controlling worker exposures to decaborane, depending on the feasibility of implementation:

—Process enclosure

—Local exhaust ventilation

—General dilution ventilation

—Personal protective equipment

Good sources of information on control methods are as follows:

1. ACGIH [1992]. *Industrial ventilation—a manual of recommended practice*. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

2. Burton DJ [1986]. *Industrial ventilation—a self study companion*. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

3. Alden JL, Kane JM [1982]. *Design of industrial ventilation systems*. New York, NY: Industrial Press, Inc.

4. Wadden RA, Scheff PA [1987]. *Engineering design for control of workplace hazards*. New York, NY: McGraw-Hill.

5. Plog BA [1988]. *Fundamentals of industrial hygiene*. Chicago, IL: National Safety Council.

MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical monitoring program is intended to supplement, not replace, such measures. To place workers effectively and to detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.

• Preplacement medical evaluation

Before a worker is placed in a job with a potential for exposure to decaborane, a licensed health care profes-

sional should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the central nervous system, liver, kidneys, eyes, and skin.

A preplacement medical evaluation is recommended to detect and assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to decaborane at or below the prescribed exposure limit. The health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with diseases of the central nervous system, liver, kidneys, eyes, or skin.

- **Periodic medical examinations and biological monitoring**

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to decaborane exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of decaborane on the central nervous system, liver, kidneys, eyes, or skin. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. Borate concentrations can be measured in the serum of exposed individuals, and some sources state that serum borate concentrations greater than 20 mg/liter indicate excessive exposure. However, no biological monitoring test acceptable for routine use has yet been developed for decaborane because serum borate levels do not correlate well with airborne concentrations.

- **Medical examinations recommended at the time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of placement should be repeated at the time of job transfer or termination to determine the worker's medical status at the end of his or her employment. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

WORKPLACE MONITORING AND MEASUREMENT

Determination of a worker's exposure to airborne decaborane is made using a mixed cellulose ester filter (MCEF) (0.8 micron). Samples are collected at a maximum flow rate of 2.0 liters/min until a maximum air volume of 480 liters is collected. Analysis is conducted by inductively coupled plasma/atomic emission spectrometry. The limit of detection for this procedure is not known. Analysis is performed for total boron and then back-calculated for decaborane. This method is described in the OSHA Laboratory In-House File [OSHA 1991].

PERSONAL HYGIENE

If decaborane contacts the skin, workers should flush the affected areas immediately with 3 percent aqueous ammonia hydroxide, followed by washing with soap and water.

Clothing contaminated with decaborane should be removed immediately, and provisions should be made for the safe removal of the chemical from the clothing. Persons laundering the clothes should be informed of the hazardous properties of decaborane, particularly its potential to cause burns of the skin.

A worker who handles decaborane should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, applying cosmetics, or using toilet facilities.

Workers should not eat, drink, use tobacco products, or apply cosmetics in areas where decaborane or a solution containing decaborane is handled, processed, or stored.

STORAGE

Decaborane should be stored in a cool, dry, well-ventilated area in tightly sealed, weather-proof containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. Outside or detached storage is preferred; inside storage should be in a standard flammable liquids storage room. Containers of decaborane should be protected from physical damage and should be stored separately from oxidizers, oxygenated solvents, dimethyl sulfoxide, heat, sparks, and open flame. Only nonsparking tools may be used to handle decaborane. To prevent static sparks, containers should be grounded and bonded for transfers. Because containers that formerly contained decaborane may still hold product residues, they should be handled appropriately.

SPILLS AND LEAKS

In the event of a spill or leak involving decaborane, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup has been completed. The following steps should be undertaken following a spill or leak:

1. Do not touch the spilled material.
2. Notify safety personnel.
3. Remove all sources of heat and ignition.
4. Ventilate potentially explosive atmospheres.
5. For small dry spills, use a clean shovel and gently place the material into a clean, dry container, creating as little dust as possible; cover and remove the container from the spill area.
6. For large liquid spills, build dikes far ahead of the spill to contain the decaborane for later reclamation or disposal.

SPECIAL REQUIREMENTS

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and hazardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

• Emergency planning requirements

Employers owning or operating a facility at which there are 10,000 lb or more of decaborane must comply with EPA's emergency planning requirements. (If decaborane is in the form of a finely divided powder or is handled in solution or in molten form, the employer must comply with these requirements if 500 lb or more of decaborane are present at the facility.)

• Reportable quantity requirements for hazardous releases

A hazardous substance release is defined by EPA as any spilling, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment (including the abandonment or discarding of containers) of hazardous substances. In the event of a release that is above the reportable quantity for that chemical, employers are required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR 355.40] to notify the proper Federal, State, and local authorities.

The reportable quantity for decaborane is 1 lb. If an amount equal to or greater than this quantity is released within a 24-hour period in a manner that will expose persons outside the facility, employers are required to do the following:

—Notify the National Response Center *immediately* at (800) 424-8802 or at (202) 426-2675 in Washington, D.C. [40 CFR 302.6].

—Notify the emergency response commission of any State likely to be affected by the release [40 CFR 355.40].

—Notify the community emergency coordinator of the local emergency planning committee (or relevant local emergency response personnel) of any area likely to be affected by the release [40 CFR 355.40].

• Community right-to-know requirements

Employers are not required by Section 313 of the Superfund Amendments and Reauthorization Act (SARA) [42 USC 11022] to submit a Toxic Chemical Release Inventory form (Form R) to EPA reporting the amount of decaborane emitted or released from their facility annually.

- **Hazardous waste management requirements**

EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity, as defined in 40 CFR 261.21-261.24. Although decaborane is not specifically listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) [40 USC 6901 et seq.], the EPA requires employers to treat any waste as hazardous if it exhibits any of the characteristics discussed above.

Providing detailed information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (800) 424-9346 or at (202) 382-3000 in Washington, D.C. In addition, relevant State and local authorities should be contacted for information about their requirements for waste removal and disposal.

RESPIRATORY PROTECTION

- **Conditions for respirator use**

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of decaborane exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers should use only respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

- **Respiratory protection program**

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's respiratory protection standard [29 CFR 1901.134]. Such a program must include respirator selection, an evaluation of the worker's ability to

perform the work while wearing a respirator, the regular training of personnel, respirator fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information about the selection and use of respirators and about the medical screening of respirator users, consult the *NIOSH Respirator Decision Logic* [NIOSH 1987b] and the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987a].

PERSONAL PROTECTIVE EQUIPMENT

Protective clothing (gloves, boots, aprons, and gauntlets, as appropriate) should be worn to prevent any skin contact with decaborane. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use. No reports have been published on the resistance of various protective clothing materials to decaborane permeation. If permeability data are not readily available, protective clothing manufacturers should be requested to provide information on the best chemical protective clothing for workers to wear when they are exposed to decaborane.

If decaborane is dissolved in water or an organic solvent, the permeation properties of both the solvent and the mixture must be considered when selecting personal protective equipment and clothing.

Safety glasses, goggles, or face shields should be worn during operations in which decaborane might contact the eyes. Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with decaborane. Contact lenses should not be worn if the potential exists for decaborane exposure.

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