

In an emergency, call CHEMTREC at 800-424-9300 or 703-527-3887.

Section 1: Chemical Product and Company Identification

Material Name: Flammable diborane mixtures:
0.4% to 1.5% in argon, 0.54% to 1.5% in helium, or
0.8% to 1.5% in hydrogen or nitrogen.

Chemical Formula of principal gas: B₂H₆.

Synonyms of principal gas: Boroethane, boron hydride, diboron hexahydride.

Manufacturer: Voltaix, LLC.: Post Office Box 5357, North Branch, New Jersey 08876-5357, USA
Voice:: 908-231-9060 or 800-VOLTAIX, Facsimile: 908-231-9063

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Section 2: Composition/Information on Ingredients

Component	CAS Registry Number	Molar (volume) concentration	Exposure Guidelines
Diborane	19287-45-7	0.4% to 1.5%	0.1 ppm TLV-TWA (ACGIH)
Argon	7440-37-1	balance	Simple asphyxiant
Helium	7440-59-7	balance	Simple asphyxiant
Hydrogen	1333-74-0	balance	Simple asphyxiant
Nitrogen	7727-37-9	balance	Simple asphyxiant

Section 3: Hazards Identification

Emergency Overview

These diborane mixtures are colorless gases with a repulsive odor. As exposure deadens the sense of smell, do not use smell to determine diborane concentration. These mixtures are flammable gases that may be pyrophoric (autoigniting in air). They may form mixtures with air that do not autoignite, but are flammable or explosive. Their immediate health hazards are that they are poison gases and may cause thermal burns. Diborane is reactive with water, oxidizers and halogens.

NFPA 704 Rating (determined by Voltaix): Health 1 Fire 4 Reactivity 1 Special none

Note: Section 3 is continued on Page 2.

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Section 3: Hazards Identification (Continued)**Potential Health Effects**

Routes of Exposure: At low concentrations, the primary route is inhalation. At high concentrations, diborane may autoignite, creating a thermal burn risk, but reducing the toxic hazard.

Lengths of Exposure: Diborane has been found in animal studies to be toxic in acute (4 hour) and subacute (6 hours/day for several months) tests.

Severity of Effect: Depends on concentration and duration.

Target Organs: Lungs. Some neurological effects have also been reported.

Type of Effect: Respiratory irritation and impairment, pulmonary edema.

Signs and Symptoms of Exposure: Diaphragmatic pain, shortness of breath, headache, vertigo, chills and nausea.

Medical Conditions that may be Aggravated by Exposure: None identified.

Reported Carcinogenic and Reproductive Effects: Although NTP has not reported genetic or long-term toxicology and carcinogenesis effects studies, diborane was negative in the *Salmonella* assay.

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Section 4: First Aid Measures

Inhalation

This is the primary route of exposure.

- 1) Remove the affected person from the gas source or contaminated area. Note: Personal Protective Equipment (PPE), including positive pressure, self contained breathing apparatus, may be required to assure the safety of the rescuer.
- 2) If the affected person is not breathing spontaneously, administer rescue breathing.
- 3) If the affected person does not have a pulse, administer CPR.
- 4) If medical oxygen and appropriately trained personnel are available, administer 100% oxygen to the affected person.
- 5) Summon an emergency ambulance. If an ambulance is not available, contact a physician, hospital, or poison control center for instruction.
- 6) Keep the affected person warm, comfortable, and at rest while awaiting professional medical care. *Monitor the breathing and pulse continuously.* Administer rescue breathing or CPR if necessary.

Skin Contact

Flush with a copious stream of water while removing contaminated clothing. Continue flushing until the professional medical assistance arrives, but for no less than fifteen minutes. Treat thermal burns by assuring that affected area is cool by flushing with cool water, then apply dry sterile dressings. If the patient is burned on the face, neck, head, or chest, assume that the airway may also have been burned and obtain professional medical assistance immediately.

Eye Contact

Flush continuously with clean water until the professional medical assistance arrives, but for no less than thirty minutes. Continuation of flushing until patient is transferred to an ophthalmologist or emergency physician is recommended.

Ingestion

Ingestion is not an observed route of exposure to gaseous hazardous materials.

Chronic Effects

None is known to Voltaix.

Note to Physicians:

The reaction product of diborane and moist air or water is boron oxide. Therefore, skin and eye burns should be irrigated to the extent the physician feels necessary to remove the boron oxide to an acceptable degree. Thereafter, treatment for burns is as usual.

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Section 5: Fire Fighting Measures

Flammability and Explosivity

Flash Point: Not applicable, these materials are gases.

Flammability Limits in Air: 0.8% to 98% (NFPA) for diborane, 4% to 75% for hydrogen, the other diluents are nonflammable gases.

Autoignition Temperature: Approximately 40 to 50 °C (100 to 125 °F) for pure diborane. These diborane mixtures may autoignite in moist air.

Flammability Classification (per 29 CFR 1910.1200): Flammable gas.

Known or Anticipated Hazardous Products of Combustion: Boron oxide.

Properties that may Initiate or Intensify Fire: Heating cylinder to the point of initiating polymerization of the diborane or activating the pressure relief device.

Reactions that Release Flammable Gases: Thermal decomposition or reaction with water releases hydrogen.

Extinguishing Media

None.

Fire Fighting Instructions

The only safe way to extinguish a flammable gas fire is to stop the flow of gas. If the flow cannot be stopped, allow the entire contents of the cylinder to burn. Cool the cylinder and surroundings with water from a suitable distance. Extinguishing the fire without stopping the flow of gas may permit the formation of ignitable or explosive mixtures with air. These mixtures may propagate to a source of ignition.

Excessive pressure may develop in gas cylinders exposed to fire, which may result in explosion, regardless of the cylinder's content. Cylinders with pressure relief devices (PRD's) may release their contents through such devices if the cylinder is exposed to fire. Cylinders without PRD's have no provision for controlled release and are therefore more likely to explode if exposed to fire.

Positive pressure, self contained breathing apparatus is required for all fire fighting involving hazardous materials. Full structural fire fighting (bunker) gear is the *minimum* acceptable attire. The need for proximity, entry, and flashover protection and special protective clothing should be determined for each incident by a competent fire fighting safety professional.

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Section 6: Accidental Release Measures

Containment

As these materials are gases at atmospheric conditions, the only means of containment is the enclosure of the space into which the materials are released. Such containment is described in Section 7.

Clean Up

Clean up consists of passing the entire gas volume of the enclosure through appropriate exhaust gas treatment equipment (EGTE). Purge the enclosure with a non-reactive gas, such as nitrogen, through the EGTE until an acceptably low level of contamination remains. Equipment contaminated by these materials must then be cleaned or decommissioned appropriately.

Evacuation

If the release is not contained in an appropriate device or system, all personnel not appropriately protected (see Section 8) must evacuate the contaminated spaces. Consider evacuation of additional areas, as a precaution against the spread of the release or subsequent explosion or fire.

Special Instructions

Some releases of these diborane mixtures into air will autoignite, producing boron oxide, a white powder that may be suspended in the air if produced in this manner. As most leaks will not autoignite, consider the possible formation of ignitable or explosive mixtures with air.

Section 7: Handling and Storage

Handling

Handle these materials only in sealed, purged systems. The design of handling systems for hazardous materials is beyond the scope of this MSDS, and should be performed by a competent, experienced professional. Consider the use of doubly-contained piping; diaphragm or bellows sealed, soft seat valves; backflow prevention devices; flash arrestors; and flow monitoring or limiting devices. Gas cabinets, with appropriate exhaust treatment, are recommended, as is automatic monitoring of the secondary enclosures and work areas for release.

Handle sealed gas cylinders in accordance with CGA P-1, *Safe Handling of Compressed Gases in Containers*.

Some material may have accumulated behind the outlet plug. Face the outlet away from you and wear appropriate protective equipment when removing the plug to connect the cylinder to your system.

Never introduce any substance into a gas cylinder. If you believe your cylinder may have been contaminated, notify Voltaix immediately. Provide as much information as possible on the nature and quantity of contamination.

Storage

Store cylinders in accordance with CGA P-1, *Safe Handling of Compressed Gases in Containers*, local building and fire codes and other relevant regulations. Materials should be segregated, by the hazards they comprise, for storage.

Protect the cylinders from direct sunlight, precipitation, mechanical damage, and temperatures above 55 °C (130 °F).

Ship and store cylinders with the outlet plug and valve protective cap in place.

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Section 8: Exposure Control/Personal Protection

Engineering Controls

Local exhaust is required. Secondary containment, with appropriate exhaust gas treatment, is strongly encouraged and is required in some jurisdictions.

Monitor the work area and the secondary containment continuously for release of the material. Automatic alerting of personnel and automatic shutdown of flow are appropriate in most applications and are required in some jurisdictions.

Purge all primary containment systems with a nonreactive gas, such as nitrogen, before introducing diborane.

Personal Protective Equipment (PPE)

Respiratory Protection: Positive pressure, full face, air supplied breathing apparatus should be used for work within the secondary containment equipment if a leak is suspected or the primary containment is to be opened, e.g., for a cylinder change. Air supplied breathing apparatus is required for response to demonstrated or suspected releases from the primary containment.

Eye/Face Protection: When using respiratory protection as described above, use a face mask that provides splash and impact protection for the face and eyes. For handling sealed cylinders, wear safety glasses.

Skin Protection: Wear appropriate gloves when handling sealed cylinders. Use gloves and other skin protection, as assigned by a competent safety professional, when working within the secondary enclosure with the primary enclosure compromised, e.g., cylinder changing, to protect both from exposure to the material and from fire that may result from its release to the air.

Other Protection: Wear appropriate protective footwear when moving cylinders.

Exposure Guidelines for diborane (The diluents are simple asphyxiants.)

TLV-TWA: 0.1 ppm (ACGIH).

PEL-TWA: 0.1 ppm (0.1 mg/m³) (OSHA).

TWA (10 hour): 0.1 ppm (NIOSH).

IDLH: 15 ppm (NIOSH).

Section 9: Physical and Chemical Properties

Notes: 1) "N/A" means not applicable.

2) Unless otherwise specified, properties are reported at 0 °C (32 °F) and 1 atmosphere (1.0 bar, 14.7 psia).

Property	Diborane	Argon	Helium	Hydrogen	Nitrogen
Appearance	colorless	colorless	colorless	colorless	colorless
Odor	repulsive	none	none	none	none
Physical State	gas	gas	gas	gas	gas
pH	not applicable	N/A	N/A	N/A	N/A
Vapor Pressure	2.8 bar (40 psia) at -78 °C (-108 °F)	N/A	N/A	N/A	N/A
Vapor Density	1.2475 g/L at 0 °C (32 °F)	1.78 g/L	0.18 g/L	0.082 g/L	1.146 g/L
Boiling Point	-92.8 °C (-135.1 °F)	-122.4 °C (-188 °F)	-268.9 °C (-458 °F)	-252.9 °C (-423 °F)	-195.8 °C (-320 °F)
Melting Point	-164.9 °C (-264.8 °F)	N/A	N/A	N/A	N/A
Solubility in Water (v/v)	not applicable, as diborane reacts with water	0.0337	0.0086	0.0182	0.0149
Specific Gravity (liquid)	0.341 at -33 °C (-27.4 °F)	N/A	N/A	N/A	N/A
Molecular wt.	27.668	39.95	4	2.02	28.01

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Section 10: Stability and Reactivity

Chemical Stability: Diborane polymerizes spontaneously at room temperature, producing higher boranes and hydrogen. At these concentrations, the polymerization does not present a safety concern. The diluents are stable materials.

Conditions to Avoid: Sources of ignition, exposure to air.

Incompatibility with Other Materials: Oxidizers, halogens, water.

Hazardous Decomposition, Reaction and Oxidation (other than burning) Products: Boron oxide, higher boranes, hydrogen.

Hazardous Polymerization: Occurs at room and elevated temperatures, producing higher boranes and hydrogen.

Section 11: Toxicological Information for diborane (The diluents are simple asphyxiants.)

Acute Data (by route): Exposure by inhalation: LC₅₀, 4-hour, albino rat 40 ppm or 80 ppm, decreasing with age. The primary effect is the production of pulmonary edema. Reaction with air or water may produce irritation or thermal burns to skin, eyes and mucous membranes.

Chronic and Subchronic Data: Most of the rats and both of the dogs exposed at 5 ppm for six hours per day for several months died. One of two dogs and none of ten guinea pigs similarly exposed at 1 to 2 ppm died. This material is listed in the *Registry of Toxic Effects of Chemical Substances* (RTECS), but no information on its carcinogenicity is available.

Special Studies: None known to Voltaix

Section 12: Ecological Information

Ecotoxicity: None known to Voltaix

Environmental Fate: None known to Voltaix.

Section 13: Disposal Considerations

Classification under RCRA, 40 CFR 261: Not listed.

US EPA waste number and descriptions: D001 (ignitability) and D003 (reactivity).

Special Instructions and Limitations: Treat process and other exhaust streams appropriately before release to the atmosphere.

Notice: This information is derived from Voltaix's interpretation of the US federal laws, regulations and policies concerning the material, as shipped by Voltaix, at the time this MSDS was prepared. Federal controls are subject to change and state and local controls may also apply. Proper waste disposal is the responsibility of the owner of the waste. The user is encouraged to consult with appropriate experts in developing a disposal plan.

Section 14: Transport Information

Basic Description: Compressed Gas, Flammable, n.o.s. (Diborane, x% in *diluent*), Division 2.1 (Flammable Gas), UN 1954.

Note: Substitute the mixture concentration for x%, and the proper shipping name of the diluent for *diluent*.

Additional Information for shipment by water: IMDG Page Number 2124.

Additional Information for shipment by air: Transportation by air is not permitted.

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Section 15: Regulatory Information

TSCA Status: The component materials are listed in the index of chemical substances.

CERCLA Reportable Quantity (40CFR302.4): This material is not listed. The Reportable Quantity (RQ) for "Unlisted Hazardous Wastes Characteristic of Ignitability" (D001) or "Unlisted Hazardous Wastes Characteristic of Reactivity" (D003) of 45.4 kg (100 lbs.) therefore applies.

SARA Title III Status (Section 302 (40CFR355), Section 311/312, Section 313 (40CFR372)): 40CFR355 lists diborane as an Extremely Hazardous Substance with a Threshold Planning Quantity (TPQ) of 45.4 kg (100 lbs.) and a Reportable Quantity (RQ) of 454 g (1 lb.). Diborane is not listed in 40CFR372.

Note: State and local requirements may be more stringent.

Section 16: Other Information

References

Book of SEMI Standards, Facilities Standards and Safety Guidelines. Mountain View, CA: Semiconductor Equipment and Materials International, 1993.

Borak, Jonathan, M.D., Michael Callan and William Abbott, *Hazardous Materials Exposure: Emergency Response and Patient Care.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1991.

Documentation of TLV's and BEI's. Cincinnati, Ohio: American Conference of Government Industrial Hygienists, 1992.

Effects of Exposure to Toxic Gases: First Aid and Treatment. Lyndhurst, NJ: Matheson Gas Products, 1977.

Fire Protection Guide on Hazardous Materials. Quincy, MA: National Fire Protection Association, 1991.

Safe Handling of Compressed Gases in Containers (Pamphlet P-1). Arlington, VA: Compressed Gas Association, Inc., 1991.

Derivation of this information

The information in this MSDS was obtained by estimating or calculating the characteristics of mixtures based on the characteristics and concentrations of their components. Mixtures of a range of compositions and any of several diluents have similar characteristics. A single MSDS is therefore provided for them as a group.

Revision Indication

Revise to reflect company name change

Disclaimer

Voltaix cannot guarantee that these are the only hazards that exist. Users are solely responsible for the safe storage, handling, use and disposal of these materials, and for compliance with the applicable laws, regulations and accepted practices.

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