Material Safety Data Sheet for:

Flammable Trimethylboron (TMB) Mixtures

(0.54% to 13.9% in argon, helium, hydrogen or nitrogen)

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

Section 1: Chemical Product and Company Identification

Material Name: Flammable Trimethylboron Mixtures (0.54% to 13.9% in argon, helium, hydrogen or nitrogen)

Principal Gas Chemical Formula: $B(CH_3)_3$

Principal Gas Synonyms: Trimethyl borane, trimethyl borine, TMB

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

Section 2: Composition/Information on Ingredients

Component	CAS Registry Number	Concentration	Exposure Guidelines
Trimethylboron (TMB)	593-90-8	0.54% to 13.9%	7 ppm TWA (See Section 11)
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

DANGER! WATER REACTIVE, PYROPHORIC.

These trimethylboron mixtures are colorless gases with a repulsive, suffocating odor. Its immediate health hazards are that it may cause thermal burns and depending on trimethylboron concentration, it may be poisonous. It is a flammable gas that is usually pyrophoric (autoigniting in air). It may form mixtures with air that do not autoignite, but are flammable or explosive. These mixtures are violently reactive with water, oxidizers and halogens. Depending on trimethylboron concentration, contents of cylinder may be combination of gas and liquefied gas.

NFPA 704 Rating (NFPA 49-1991): Health 1 Fire 4 Reactivity 3 Special ~~W~~

Potential Health Effects

Routes of Exposure:

The primary route of exposure at low concentrations is inhalation. At higher concentrations, the material ignites spontaneously in air, creating a thermal burn risk, but reducing the toxic inhalation hazard.

Lengths of Exposure:

Voltaix is aware of no data on exposures of humans or test animals to Trimethylboron at any concentration or for any duration.

Severity of Effect:

Unknown. Severity depends on concentration and duration

Target Organs:

None identified.

Type of Effect:
No effect identified.

Signs and Symptoms of Exposure:
Suspected to cause headache and nausea.

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

Reported Carcinogenic and Reproductive Effects:
None known to Voltaix.

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. Assume the patient has also been exposed by inhalation and obtain professional medical assistance immediately. 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 trimethylboron 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.

Section 5: Fire Fighting Measures

Flammability and Explosivity

Flash Point:
Not applicable, this material is a gas.

Flammability Limits in Air (% by volume):

	Lower	Upper
Trimethylboron	~0.5%	Not established
Hydrogen	4%	75%

The other diluents are nonflammable.

Autoignition Temperature:
Less than 54 °C (130 °F), this material is pyrophoric.

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 activating the pressure relief device, contact with air or water

Reactions that Release Flammable Gases:
The reaction of trimethylboron and water produces methane.

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.

Section 6: Accidental Release Measures

Containment

This material is a gas at atmospheric conditions. The only means of containment is the enclosure of the space into which the material is 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 this material 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

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

Section 7: Handling and Storage

Handling

Handle this material 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.

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 trimethylboron mixtures.

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 from exposure to the material. For response to demonstrated or suspected releases from the primary containment, the need for whole-body exposure protection should be determined by a competent safety professional.

Other Protection:

Wear appropriate protective footwear when moving cylinders. Select per OSHA 29CFR1901.132 and 1910.133.

Exposure Guidelines

Voltaix recommends a time weighted average workplace limit of 7 ppm for trimethylboron. (See Section 11.) The diluents are all simple asphyxiants.

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	Trimethylboron	Argon	Helium	Hydrogen	Nitrogen
Appearance	Colorless	colorless	colorless	colorless	colorless
Odor	Repulsive, suffocating	none	none	none	none
Physical state	gas	gas	gas	gas	gas
pH	N/A	N/A	N/A	N/A	N/A
Vapor Pressure	4.1 bar (45 psia) at 21°C (70 °F)	N/A	N/A	N/A	N/A
Vapor Density	2.3 g/L at 21 °C (70 °F)	1.78 g/L	0.18 g/L	0.082 g/L	1.146 g/L
Boiling point (at 1 atm)	-20.2 °C (-4.4 °F)	-122.4 °C (-188 °F)	-268.9 °C (-458 °F)	-252.9 °C (-423 °F)	-195.8 °C (-320 °F)
Melting point	-161.5 °C (-258.7 °F)	N/A	N/A	N/A	N/A
Solubility in water (v/v)	N/A, as TMB reacts with water	0.0337	0.0086	0.0182	0.0149
Specific gravity of liquid (water = 1)	0.625 at -100 °C (-148°F)	N/A	N/A	N/A	N/A
Molecular weight	55.92	39.95	4	2.02	28.01

Section 10: Stability and Reactivity

Chemical Stability:

Trimethylboron is stable at room temperature and atmospheric pressure.

Conditions to Avoid:

Sources of ignition, exposure to air or water.

Incompatibility with Other Materials:

Oxidizers, halogens, water.

Hazardous Decomposition, Reaction and Oxidation (other than burning) Products:

Boron oxide, methane.

Hazardous Polymerization:

Has not been observed.

Section 11: Toxicological Information

Acute Data (by route):

Exposure by inhalation may cause headache or nausea. Reaction with air or water may produce irritation or thermal burns to skin, eyes and mucous membranes.

Chronic and Subchronic Data:

None available. Trimethylboron is not listed in the Registry of Toxic Effects of Chemical Substances (RTECS); no information on its carcinogenicity is available.

Special Studies:

None known to Voltaix. No exposure guidelines for this material are available. For trimethylboron, the Time Weighted Average (TWA) of 7 ppm recommended by Voltaix is based on the limit for boron oxide of 10 mg/m3 and the assumption that trimethylboron will be completely converted to oxides upon contact with the air.

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:

This material, depending on concentration, meets the criteria for an "acute hazardous waste".

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:

The information above 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. (Trimethylboron *x%* in *diluent*), Division 2.1 (Flammable Gas), UN 1954.

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

Additional Information for shipment by water:

IMDG Page Number 2124

Additional Information for shipment by air:

Air transportation is not permitted.

Section 15: Regulatory Information

TSCA Status:

This material is supplied under a "Low Volume Exemption" (40 CFR 723) of the Toxic Substances Control Act. As such, its use is restricted to use as a doping material in semiconductor materials, a synthesis reagent or use as a reactor fuel additive/surface treatment.

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)):

No Threshold Planning Quantity (TPQ) or Reportable Quantity (RQ) is listed for this substance. The default federal MSDS submission and inventory requirement filing threshold of 4,540 kg (10,000 lbs.) therefore applies..

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. Cincinatti, 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

Revised to reflect company name change (21 July 2006)

Revised percent threshold for MSDS and format (21 January 2010)

Disclaimer

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