Enriched Diborane
Material Safety Data Sheet

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name
Enriched Diborane

UN-Number
UN1911

Recommended Use
Electronics.

Synonyms
Boroethane, boron hydride, diboron hexahydride

Supplier Address*
Linde Gas North America LLC - Linde Merchant Production Inc. - Linde LLC
575 Mountain Ave.
Murray Hill, NJ 07974
Phone: 908-464-8100
www.lindeus.com

Linde Gas Puerto Rico, Inc.
Las Palmas Village
Road No. 869, Street No. 7
Catano, Puerto Rico 00962
Phone: 787-641-7445
www.pr.lindegas.com

Linde Canada Limited
5860 Chedworth Way
Mississauga, Ontario L5R 0A2
Phone: 905-501-1700
www.lindecanada.com

* May include subsidiaries or affiliate companies/divisions.
For additional product information contact your local customer service.

Chemical Emergency Phone Number
Chemtrec: 1-800-424-9300 for US/ 703-527-3887 outside US

2. HAZARDS IDENTIFICATION

DANGER!

Emergency Overview
Flammable gas
Fatal if inhaled
Irritating to eyes, respiratory system and skin
May cause central nervous system depression
Contents under pressure
Keep at temperatures below 52°C / 125°F

Appearance Colorless
Physical State Gas.
Odor Repulsive, Sweet

Potential Health Effects

Principle Routes of Exposure
Eye contact. Skin contact. Inhalation.
**Acute Toxicity**

**Inhalation**
Fatal if inhaled. Irritating to respiratory system. May cause central nervous system depression with nausea, headache, dizziness, vomiting, and incoordination. Odor will not provide sufficient warning of exposure. Potentially dangerous amounts may be inhaled before odor is detected.

**Eyes**
Irritating to eyes. Contact of longer duration and concentration can cause serious injury to the eyes, possibly blindness, due to formation of boric acid.

**Skin**
Irritating to skin.

**Skin Absorption Hazard**
No known hazard by skin absorption.

**Ingestion**
Not an expected route of exposure.

**Chronic Effects**
No known effect based on information supplied

**Main Symptoms**
Symptoms of overexposure may be headache, dizziness, tiredness, nausea and vomiting.

**Aggravated Medical Conditions**

**Environmental Hazard**
See Section 12 for additional Ecological Information.

### 3. COMPOSITION/ INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>CAS-No</th>
<th>Volume %</th>
<th>Chemical Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enriched Diborane (11)B2H6</td>
<td>12068-64-3</td>
<td>&gt;99</td>
<td>(11)B₂H₆</td>
</tr>
</tbody>
</table>

**Additional information:** Composition listed covers broad ranges rather than exact percentages for specific products.

### 4. FIRST AID MEASURES

**General Advice**
Immediate medical attention is required. Show this safety data sheet to the doctor in attendance.

**Eye Contact**
Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Call a physician immediately.

**Skin Contact**
Wash off immediately with soap and plenty of water removing all contaminated clothes and shoes. Call a physician immediately.

**Inhalation**
PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF INHALATION OVEREXPOSURE. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS. Conscious inhalation victims should be assisted to an uncontaminated area and inhale fresh air. If breathing is difficult, administer oxygen. Unconscious persons should be moved to an uncontaminated area and, as necessary, given artificial resuscitation and supplemental oxygen. Treatment should be symptomatic and supportive.

**Ingestion**
Not an expected route of exposure. Do NOT induce vomiting. Call a physician or Poison Control Center immediately. Never give anything by mouth to an unconscious person. Drink plenty of water.

**Notes to Physician**
Treat symptomatically.

**Protection of First-aiders**
Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.
5. FIRE-FIGHTING MEASURES

Flammable Properties
Extremely flammable.

Suitable Extinguishing Media
It may be safer to allow the fire to burn itself out. Use water spray to knock down vapors and cool fire-exposed containers. DO NOT EXTINGUISH A LEAKING GAS FIRE UNLESS LEAK CAN BE STOPPED.

Unsuitable Extinguishing Media
Do not use halogenated extinguishing agents or foam. Diborane reacts with these materials and will form shock sensitive and thermally sensitive materials.

Hazardous Combustion Products
Boron compounds.

Explosion Data

Sensitivity to Mechanical Impact
Due to the presence of Diborane, this mixture may become shock and thermally sensitive in the presence of impurities such as oxygen, water, halogenated hydrocarbons and other materials, when Diborane level is at its highest.

Sensitivity to Static Discharge
Yes.

Specific Hazards Arising from the Chemical
May form explosive mixtures with air. Vapors from liquefied gas are initially heavier than air and spread along ground. Vapors may travel to source of ignition and flash back. Continue to cool fire exposed cylinders until flames are extinguished. Cylinders may rupture under extreme heat. Damaged cylinders should be handled only by specialists.

Protective Equipment and Precautions for Firefighters
If possible, stop the flow of gas. Do not extinguish the fire until supply is shut off as otherwise an explosive-ignition may occur. If the fire is extinguished and the flow of gas continues, use increased ventilation to prevent build-up of explosive atmosphere. Ventilation fans must be explosion proof. Use non-sparking tools to close container valves.

For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible withdraw from area and let fire burn.

Use water spray to cool surrounding containers. Be cautious of a Boiling Liquid Evaporating Vapor Explosion, BLEVE, if flame is impinging on surrounding containers.

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Additional chemical protective clothing may be required to protect from toxic decomposition products.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions
ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. All equipment used when handling the product must be grounded. Take precautionary measures against static discharges. Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe.

Environmental Precautions
Beware of vapors accumulating to form explosive concentrations. Vapors can accumulate in low areas. Prevent entry into waterways, sewers, basements or confined areas.

Methods for Containment
Stop the flow of gas or remove cylinder to outdoor location if this can be done without risk. If leak is in container or container valve, contact the appropriate emergency telephone number in Section 1 or call your closest Linde location.

Methods for Cleaning Up
Return cylinder to Linde or an authorized distributor.
7. HANDLING AND STORAGE

Handling

Handle this gas mixture only in sealed and purged systems. All areas where this gas mixture is used should be monitored with very sensitive gas detection instruments. Detection of concentrations below 50% of the PEL (0.1 ppm) should trigger immediate response and corrective action. Detection of higher levels should initiate an alarm calling for the evacuation of all personnel with exposure potential.

Do not breathe gas. Remove all sources of ignition. Use only in ventilated areas. Ground and bond all lines and equipment associated with product system. All equipment should be non-sparking and explosion proof. "NO SMOKING" signs should be posted in storage and use areas.

Diborane is noncorrosive and may be used with all materials of construction except aluminum.

Never attempt to lift a cylinder by its valve protection cap. Protect cylinders from physical damage; do not drag, roll, slide or drop. When moving cylinders, even for short distance, use a cart designed to transport cylinders. Use equipment rated for cylinder pressure. Use backflow preventive device in piping.

Use an adjustable strap wrench to remove over-tight or rusted caps. Close valve after each use and when empty. Never insert an object (e.g. wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage valve, causing leak to occur. If user experiences any difficulty operating cylinder valve discontinue use and contact supplier.

Never put cylinders into trunks of cars or unventilated areas of passenger vehicles. Never attempt to refill a compressed gas cylinder without the owner's written consent. Never strike an arc on a compressed gas cylinder or make a cylinder a part of an electrical circuit.

Storage

Protect from physical damage. Cylinders should be stored upright with valve protection cap in place and firmly secured to prevent falling. Store in cool, dry, well-ventilated area of non-combustible construction away from heavily trafficked areas and emergency exits. Keep at temperatures below 52°C / 125°F. Full and empty cylinders should be segregated. Use a "first in-first out" inventory system to prevent full cylinders from being stored for excessive periods of time. Always store and handle compressed gas cylinders in accordance with Compressed Gas Association, pamphlet CGA-P1, Safe Handling of Compressed Gases in Containers.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Guidelines

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>ACGIH TLV</th>
<th>OSHA PEL</th>
<th>NIOSH IDLH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enriched Diborane (11)B2H6 12068-64-3</td>
<td>TWA: 0.1 ppm (Diborane)</td>
<td>TWA: 0.1 ppm (Diborane)</td>
<td>(Diborane) IDLH: 15 ppm TWA: 0.1 mg/ m³: 0.1 ppm</td>
</tr>
</tbody>
</table>

ACGIH TLV: American Conference of Governmental Industrial Hygienists - Threshold Limit Value. OSHA PEL: Occupational Safety and Health Administration - Permissible Exposure Limits. NIOSH IDLH: Immediately Dangerous to Life or Health.

Other Exposure Guidelines

Vacated limits revoked by the Court of Appeals decision in AFL-CIO v. OSHA, 965 F.2d 962 (11th Cir., 1992).

Engineering Measures

Showers. Eyewash stations. Ventilation systems. Exhaust gas should be vented to a gas treatment system.

Ventilation

Use ventilation adequate to keep exposures below recommended exposure limits.

Personal Protective Equipment

Eye/ Face Protection

Tightly fitting safety goggles.
Skin and Body Protection
Appropriate protective and chemical resistant gloves, clothing and splash protection, or fully encapsulating vapor protective clothing to prevent exposure. For materials of construction consult protective clothing manufacturer’s specifications.

Respiratory Protection

General Use
NIOSH/ MSHA certified respiratory protection should be worn. Positive-pressure supplied air respirators are required or work in fume hood/ gas cabinet with exhaust gas vented to a treatment system. Respiratory protection must be provided in accordance with current local regulations.

Emergency Use
Use positive pressure air line respirator or self-contained breathing apparatus for exposure over exposure limits or emergency use. For exposures above IDLH, an additional escape bottle is required.

Hygiene Measures
Do not eat, drink or smoke when using this product. Remove and wash contaminated clothing before re-use. Provide regular cleaning of equipment, work area and clothing. Keep away from food, drink and animal feeding stuffs. Avoid contact with skin, eyes and clothing.

9. PHYSICAL AND CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Colorless</td>
</tr>
<tr>
<td>Odor Threshold</td>
<td>2.5 ppm</td>
</tr>
<tr>
<td>Flash Point</td>
<td>No information available</td>
</tr>
<tr>
<td>Decomposition Temperature</td>
<td>No information available</td>
</tr>
<tr>
<td>Freezing Point</td>
<td>No information available</td>
</tr>
<tr>
<td>Water Solubility</td>
<td>No information available</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>40 PSIA @ -78°C</td>
</tr>
<tr>
<td>VOC Content (%)</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Odor</td>
<td>Repulsive, Sweet.</td>
</tr>
<tr>
<td>Physical State</td>
<td>Gas</td>
</tr>
<tr>
<td>Autoignition Temperature</td>
<td>36 °C / 100 °F</td>
</tr>
<tr>
<td>Boiling Point/ Boiling Range</td>
<td>-93 °C</td>
</tr>
<tr>
<td>Molecular Weight</td>
<td>28.06</td>
</tr>
<tr>
<td>Evaporation Rate</td>
<td>No information available</td>
</tr>
<tr>
<td>Vapor Density</td>
<td>1.2475 g/L @ 0°C</td>
</tr>
<tr>
<td>Flammability Limits in Air</td>
<td></td>
</tr>
<tr>
<td>Upper</td>
<td>98%</td>
</tr>
<tr>
<td>Lower</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

10. STABILITY AND REACTIVITY

Stability
Unstable at elevated temperatures. Diborane mixture storage time should be minimized.

Incompatible Products

Conditions to Avoid
Exposure to air or moisture over prolonged periods. Keep away from open flames, hot surfaces and sources of ignition.

Hazardous Decomposition Products
Hydrogen, higher boranes at room temperature.

Hazardous Polymerization
Diborane will polymerize to form liquid pentaborane. No information was available for reaction rate.

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

LD50 Oral: No information available.

LD50 Dermal: No information available.

LC50 Inhalation: Per CGA P-20: 80 ppm; time adjusted; (Diborane)
Repeated Dose Toxicity
No information available.

Chronic Toxicity
Chronic Toxicity
None known.

Carcinogenicity
Contains no ingredient listed as a carcinogen.

Irritation
No information available.

Sensitization
No information available.

Reproductive Toxicity
No information available.

Developmental Toxicity
No information available.

Synergistic Materials
None known.

Target Organ Effects

12. ECOLOGICAL INFORMATION

Ecotoxicity
The environmental impact of this product has not been fully investigated.

Ozone depletion potential; ODP; (R-11 = 1): Does not contain ozone depleting chemical (40 CFR Part 82).

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods
Do not attempt to dispose of residual waste or unused quantities. Return in the shipping container PROPERLY LABELED WITH ANY VALVE OUTLET PLUGS OR CAPS SECURED AND VALVE PROTECTION CAP IN PLACE to Linde for proper disposal.

Contaminated Packaging
Do not re-use empty containers.

14. TRANSPORT INFORMATION

DOT
Proper shipping name
Diborane
Hazard Class
2.3
Subsidiary Class
2.1
UN-Number
UN1911
Description
UN1911,Diborane,2.3,(2.1)
Additional Description:
"Inhalation Hazard" Packing Requirements 173.304 "Toxic-Inhalation Hazard Zone A".
Emergency Response Guide Number
119
### TDG

<table>
<thead>
<tr>
<th>Proper Shipping Name</th>
<th>Diborane, compressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard Class</td>
<td>2.3</td>
</tr>
<tr>
<td>Subsidiary Class</td>
<td>(2.1)</td>
</tr>
<tr>
<td>UN-Number</td>
<td>UN1911</td>
</tr>
<tr>
<td>Description</td>
<td>UN1911, DIBORANE, COMPRESSED, 2.3(2.1)</td>
</tr>
</tbody>
</table>

### MEX

<table>
<thead>
<tr>
<th>Proper Shipping Name</th>
<th>Diborane, compressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard Class</td>
<td>2.3</td>
</tr>
<tr>
<td>Subsidiary Class</td>
<td>2.1</td>
</tr>
<tr>
<td>UN-Number</td>
<td>UN1911</td>
</tr>
<tr>
<td>Description</td>
<td>UN1911 Diborane, compressed, 2.3(2.1)</td>
</tr>
</tbody>
</table>

### IATA

<table>
<thead>
<tr>
<th>UN-Number</th>
<th>UN1911</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proper Shipping Name</td>
<td>Diborane</td>
</tr>
<tr>
<td>Hazard Class</td>
<td>2.3</td>
</tr>
<tr>
<td>Subsidiary Class</td>
<td>2.1</td>
</tr>
<tr>
<td>ERG Code</td>
<td>10P</td>
</tr>
<tr>
<td>Description</td>
<td>UN1911, Diborane, 2.3(2.1)</td>
</tr>
</tbody>
</table>

### IMDG/IMO

<table>
<thead>
<tr>
<th>Proper Shipping Name</th>
<th>Diborane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard Class</td>
<td>2.3</td>
</tr>
<tr>
<td>Subsidiary Class</td>
<td>2.1</td>
</tr>
<tr>
<td>UN-Number</td>
<td>UN1911</td>
</tr>
<tr>
<td>EmS No.</td>
<td>F-D, S-U</td>
</tr>
<tr>
<td>Description</td>
<td>UN1911, Diborane, 2.3(2.1)</td>
</tr>
</tbody>
</table>

### ADR

<table>
<thead>
<tr>
<th>Proper Shipping Name</th>
<th>Diborane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard Class</td>
<td>2.3</td>
</tr>
<tr>
<td>UN-Number</td>
<td>UN1911</td>
</tr>
<tr>
<td>Classification Code</td>
<td>2TF</td>
</tr>
<tr>
<td>Description</td>
<td>UN1911 Diborane, 2.3(2.1),</td>
</tr>
<tr>
<td>ADR/ RID-Labels</td>
<td>2.1</td>
</tr>
</tbody>
</table>

### 15. REGULATORY INFORMATION

**International Inventories**

- **TSCA**: Complies
- **DSL**: Does not Comply
- **EINECS/ELINCS**: Does not Comply

**NOTE:** Under TSCA Low Volume Exemption: Product must be used as specified in MSDS.
Legend

- **TSCA** - United States Toxic Substances Control Act Section 8(b) Inventory
- **DSPL/NDSL** - Canadian Domestic Substances List/Non-Domestic Substances List
- **EINECS/ELINCS** - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances

**U.S. Federal Regulations**

**SARA 313**
Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

**SARA 311/312 Hazard Categories**

<table>
<thead>
<tr>
<th>Category</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Health Hazard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic Health Hazard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire Hazard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sudden Release of Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactive Hazard</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Clean Water Act**
This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

**Risk and Process Safety Management Programs**
This material, as supplied, contains one or more regulated substances with specified thresholds under 40 CFR Part 68 or regulated as a highly hazardous chemical pursuant to the 29 CFR Part 1910.110 with specified thresholds:

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>U.S. - CAA (Clean Air Act) - Accidental Release Prevention - Toxic Substances</th>
<th>U.S. - CAA (Clean Air Act) - Accidental Release Prevention - Flammable Substances</th>
<th>U.S. - OSHA - Process Safety Management - Highly Hazardous Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enriched Diborane (11)B2H6</td>
<td>2500 lbs (Diborane)</td>
<td></td>
<td>100 lbs (Diborane)</td>
</tr>
</tbody>
</table>

**Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs)** (see 40 CFR 61)
This product does not contain any substances regulated as hazardous air pollutants (HAPS) under Section 112 of the Clean Air Act Amendments of 1990.

**CERCLA/SARA**
This material, as supplied, contains one or more substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355):

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Hazardous Substances RQs</th>
<th>Extremely Hazardous Substances RQs</th>
<th>TPQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enriched Diborane (11)B2H6</td>
<td>100 lbs (Diborane)</td>
<td>100 lbs (Diborane)</td>
<td></td>
</tr>
</tbody>
</table>

**U.S. State Regulations**

**California Proposition 65**
This product does not contain any Proposition 65 chemicals.

**U.S. State Right-to-Know Regulations**

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Massachusetts</th>
<th>New Jersey</th>
<th>Pennsylvania</th>
<th>Illinois</th>
<th>Rhode Island</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diborane</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
International Regulations

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS Hazard Class
A  Compressed gases
B6  Reactive flammable material
D1A  Very toxic materials

Prepared By
Product Stewardship
23 British American Blvd.
Latham, NY 12110
1-800-572-6501

Issuing Date
10-Jan-2012

Revision Date
12-Mar-2013

Revision Number
2

Revision Note
(M)SDS sections updated: 14.

NFPA
Health Hazard 4
Flammability 4
Stability 3

HMIS
Health Hazard 4
Flammability 4
Physical Hazard 3

Physical and Chemical Hazards W
Personal Protection -

Note: Ratings were assigned in accordance with Compressed Gas Association (CGA) guidelines as published in CGA Pamphlet P-19-2009, CGA Recommended Hazard Ratings for Compressed Gases, 3rd Edition.

General Disclaimer
For terms and conditions, including limitation of liability, please refer to the purchase agreement in effect between Linde LLC, Linde Merchant Production, Inc. or Linde Gas North America LLC (or any of their affiliates and subsidiaries) and the purchaser.

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES
Although reasonable care has been taken in the preparation of this document, we extend no warranties and make no representations as to the accuracy or completeness of the information contained herein, and assume no responsibility regarding the suitability of this information for the user's intended purposes or for the consequences of its use. Each individual should make a determination as to the suitability of the information for their particular purpose(s).

End of Safety Data Sheet