1. PRODUCT AND COMPANY IDENTIFICATION

Product Name: ARSINE
Product Code(s): G-9
UN-No: UN2188
Recommended Use: Compressed gas.
Synonyms: Arsine Hydride; Arsenic Trihydride; Hydrogen Arsenide
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
Fatal if inhaled.
May cause adverse effects on the bone marrow and blood-forming system
This product contains one or more substances which are classified by IARC as carcinogenic to humans (Group I), probably carcinogenic to humans (Group 2A) or possibly carcinogenic to humans (Group 2B)
May adversely affect liver and kidney.
Contents under pressure
Keep at temperatures below 52°C / 125°F

<table>
<thead>
<tr>
<th>Appearance</th>
<th>Colorless</th>
<th>Physical State</th>
<th>Gas.</th>
<th>Odor</th>
<th>Garlic</th>
</tr>
</thead>
</table>

**Potential Health Effects**

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

**Acute Toxicity**

**Inhalation**
Fatal if inhaled. Early effects are commonly characterized by drowsiness, giddiness, headache, thirst and abdominal pain with vomiting. Arsine may discolor urine to red or a darkened color, and the skin to a bronze or jaundiced color.

**Eyes**
High concentrations may cause eye damage, however, systemic poisoning will occur first. Contact with rapidly expanding gas near the point of release may cause frostbite.

**Skin**
May cause irritation. Contact with rapidly expanding gas near the point of release may cause frostbite.

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

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

**Chronic Effects**
Prolonged or repeated exposure increases the risk. Possible risks of irreversible effects. Contains a known or suspected reproductive toxin. May cause adverse liver and kidney effects. May cause adverse effects on the bone marrow and blood-forming system.

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

**Aggravated Medical Conditions**

**Environmental Hazard**
Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. 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>Arsine</td>
<td>7784-42-1</td>
<td>&gt;99</td>
<td>AsH₃</td>
</tr>
</tbody>
</table>

4. FIRST AID MEASURES

**General Advice**
Immediate medical attention is required. Show this safety data sheet to the doctor in attendance.
Eye Contact
In case of contact with substance, immediately flush eyes with running water for at least 30 minutes. Keep eye wide open while rinsing. Call a physician immediately.

Skin Contact
Immediate medical attention is required. Wash off immediately with soap and plenty of water for at least 30 minutes while removing all contaminated clothing and shoes.

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
Arsine is a powerful hemolytic agent. The principle clinical manifestation of arsine toxicity is acute intravascular hemolysis and consequent renal failure. Bronze skin pigmentation may be confused with jaundice. In all cases of exposure, T-wave elevation of serial EKGs has been found. Survivors followed for as long as 18 months showed evidence that arsine was the causal agent of myocardial degeneration and cardiac failure. Management of intoxication is dependent on treatment of the hemolytic episode and its consequences. Dimercaptol does not appear to alter the course of hemolysis, however, it may be useful in the treatment of arsenic neuropathy that appears to follow some cases of arsine poisoning. Severe hemolytic anemia may require transfusion of red cells. Alkalinization of the urine with small doses of oral sodium bicarbonate has been recommended by some clinicians in the management of hemoglobinurea. The advice of a nephrologist should be sought quickly.

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. Containers may explode when heated.

Suitable Extinguishing Media
Water spray. DO NOT EXTINGUISH A LEAKING GAS FIRE UNLESS LEAK CAN BE STOPPED.

Unsuitable Extinguishing Media
Do not use halogenated extinguishing agents or foam.

Hazardous Combustion Products
Arsenic compounds including arsenic trioxide.

Explosion Data
Sensitivity to Mechanical Impact
None

Sensitivity to Static Discharge
Yes

Specific Hazards Arising from the Chemical
Low ignition energy. 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.

Vapors from liquefied gas are initially heavier than air and spread along ground. Vapors may accumulate in confined areas (basement, tanks, hopper/tank cars, etc.). Vapors may travel to source of ignition and flash back. 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. 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 spreading of vapors through sewers, ventilation systems and 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

Do not breathe gas. To avoid ignition of vapors by static electricity discharge, all metal parts of the equipment must be grounded. 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.

Aluminum, carbon steel, stainless steel, Monel®, and Hastelloy C® are preferred materials for handling arsine. Brass should be avoided. Kel-F® and Teflon® are preferred gasket materials; Viton® and Nylon® are acceptable.

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.
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>Arsine</td>
<td>TWA: 0.005 ppm</td>
<td>TWA: 0.2 mg/m³</td>
<td>Ceiling: 0.002 mg/m³ 15 min</td>
</tr>
</tbody>
</table>

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. Explosion proof 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
If exposure limits are exceeded or irritation is experienced, NIOSH/MSHA approved respiratory protection should be worn. Positive-pressure supplied air respirators may be required for high airborne contaminant concentrations. 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
When using, do not eat, drink or smoke. Provide regular cleaning of equipment, work area and clothing. Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product. Keep away from food, drink and animal feeding stuffs.
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>0.5 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>-116.9°C / -178.4°F</td>
</tr>
<tr>
<td>Water Solubility</td>
<td>Slightly soluble</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>218 PSIA @ 70°F</td>
</tr>
<tr>
<td>VOC Content (%)</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Odor</td>
<td>Garlic.</td>
</tr>
<tr>
<td>Physical State</td>
<td>Gas</td>
</tr>
<tr>
<td>Autoignition Temperature</td>
<td>No information available.</td>
</tr>
<tr>
<td>Boiling Point/Range</td>
<td>-62.48°C / -80.46°F</td>
</tr>
<tr>
<td>Molecular Weight</td>
<td>77.94</td>
</tr>
<tr>
<td>Evaporation Rate</td>
<td>No information available</td>
</tr>
<tr>
<td>Vapor Density</td>
<td>2.67 (air = 1)</td>
</tr>
<tr>
<td>Odor Threshold</td>
<td>0.5* ppm</td>
</tr>
<tr>
<td>Flammability Limits in Air</td>
<td>Upper 78%  Lower 5.1%</td>
</tr>
</tbody>
</table>

**Note:** The odor threshold of arsine is 10-fold greater than the OSHA permissible exposure limit. Odor is not an adequate indicator of arsine’s presence and does not provide reliable warning of hazardous concentrations.

10. STABILITY AND REACTIVITY

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability</td>
<td>Stable under recommended storage conditions.</td>
</tr>
<tr>
<td>Conditions to Avoid</td>
<td>Ignitions sources - heat, sparks and open flames. Extremes of temperature and direct sunlight.</td>
</tr>
<tr>
<td>Hazardous Decomposition Products</td>
<td>Hydrogen gas. Arsenic and arsenic trioxide at above 450 °F.</td>
</tr>
<tr>
<td>Hazardous Polymerization</td>
<td>Hazardous polymerization does not occur.</td>
</tr>
</tbody>
</table>

11. TOXICOLOGICAL INFORMATION

**Acute Toxicity**

- LD50 Oral: No information available.
- LD50 Dermal: No information available.
- LC50 Inhalation: Per CGA P-20:LC50: 20 ppm / 1 hr (Mouse) (time adjusted)

**Inhalation**

Arsine is a powerful reducing agent and has a strong affinity for the hemoglobin in the blood. The hemolysis of the red blood cells causes renal failure. The destruction of red blood cells causes the primary manifestation of hemolysis. Renal function impairment and possible complete shutdown is the most serious manifestation of arsine poisoning. Permanent injury, especially to the central nervous system or fatal consequences are also well recognized.

**Repeated Dose Toxicity**

- No information available.

**Chronic Toxicity**

**Carcinogenicity**

The table below indicates whether each agency has listed any ingredient 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

Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

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
Arsine
Hazard Class
2.3
Subsidiary Class
2.1
UN-No
UN2188
Special Provisions
This material is toxic by inhalation in Hazard Zone A.
Additional Description:
"Toxic-Inhalation Hazard Zone A". If net weight of product is greater than or equal to 100 lbs., the shipping description must also contain the letters "RQ".
Additional Marking Requirements:
"Inhalation Hazard". If net weight of product is greater than or equal to 100 lbs., the container must also be marked with the letters "RQ".
Emergency Response Guide Number
119

TDG
Proper Shipping Name: Arsine
Hazard Class: 2.3
Subsidiary Class: (2.1)
UN-No: UN2188
Description: UN2188,ARSINE,2.3(2.1),Marine Pollutant

MEX
Proper Shipping Name: Arsine
Hazard Class: 2.3
Subsidiary Class: 2.1
UN-No: UN2188
Description: UN2188 Arsine,2.3

IATA
UN-No: UN2188
Proper Shipping Name: Arsine
Hazard Class: 2.3
Subsidiary Class: 2.1
ERG Code: 10P
Description: UN2188,Arsine,2.3(2.1)

IMDG/IMO
Proper Shipping Name: Arsine
Hazard Class: 2.3
Subsidiary Class: 2.1
UN-No: UN2188
EmS No.: F-D, S-U
Description: UN2188, Arsine,2.3(2.1),Marine Pollutant

ADR
Proper Shipping Name: Arsine
Hazard Class: 2.3
UN-No: UN2188
Classification Code: 2TF
Description: UN2188 Arsine,2.3,

15. REGULATORY INFORMATION

International Inventories

<table>
<thead>
<tr>
<th>Inventory</th>
<th>Complies</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSCA</td>
<td>Complies</td>
</tr>
<tr>
<td>DSL</td>
<td>Complies</td>
</tr>
<tr>
<td>EINECS/ELINCS</td>
<td>Complies</td>
</tr>
</tbody>
</table>

Legend
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/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 contains a chemical or chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372:

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>CAS-No</th>
<th>SARA 313 - Threshold Values %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsine</td>
<td>7784-42-1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

SARA 311/312 Hazard Categories

Acute Health Hazard: Yes
Chronic Health Hazard: Yes
Fire Hazard: Yes
Sudden Release of Pressure Hazard: Yes
Reactive Hazard: No

Clean Water Act
This product contains the following substances which are regulated pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42):

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>CWA - Reportable Quantities</th>
<th>CWA - Toxic Pollutants</th>
<th>CWA - Priority Pollutants</th>
<th>CWA - Hazardous Substances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsine</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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>Arsine</td>
<td>1000 lbs</td>
<td></td>
<td>100 lb</td>
</tr>
</tbody>
</table>

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)
This product contains the following substances which are listed hazardous air pollutants (HAPS) under Section 112 of the Clean Air Act:

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>CAS-No</th>
<th>HAPS data</th>
<th>VOC Chemicals</th>
<th>Class 1 Ozone Depleters</th>
<th>Class 2 Ozone Depleters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsine</td>
<td>7784-42-1</td>
<td>Present (including Arsine and any unique chemical substance that contains Arsenic as part of its infrastructure)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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>Arsine</td>
<td>100 lb</td>
<td>100 lb</td>
<td>100 lb TPQ</td>
</tr>
</tbody>
</table>

U.S. State Regulations

California Proposition 65
This product contains the following 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>Arsine</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

International Regulations

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Carcinogen Status</th>
<th>Exposure Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsine</td>
<td>A1</td>
<td>Mexico: TWA= 0.05 ppm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mexico: TWA= 0.2 mg/m³</td>
</tr>
</tbody>
</table>

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
B1 Flammable gas
D1A Very toxic materials
D2A Very toxic materials

Legend
NPRI - National Pollutant Release Inventory

16. OTHER INFORMATION

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

Issuing Date
17-Mar-2010

Revision Date
10-Sep-2010

Revision Number
1

Revision Note
(M)SDS sections updated. 1.
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