



# MATERIAL SAFETY DATA SHEET

Prepared to U.S. OSHA, CMA, ANSI, Canadian WHMIS Standards and EC Standards

## SECTION 1. PRODUCT IDENTIFICATION

**PRODUCT NAME:** 0-0.1% PHOSPHINE, 0-0.2% DIBROMOMETHANE IN ARGON, KRYPTON, or XENON**PRODUCT USE:** Various**MANUFACTURER:****ADDRESS:** SPECTRA GASES, INC.  
3434 Route 22 West  
Branchburg, NJ 08876, U.S.A.**PHONE:** 908/252-9300**FAX:** 908/252-0811**WEB SITE:** [www.spectra-gases.com](http://www.spectra-gases.com)**SPECTRA GASES EMERGENCY CONTACT:** 800/932-0624 8:30 am - 7:00 pm (EST)**24 HOUR EMERGENCY CONTACT, CHEMTREC:** 800/424-9300, 703/527-3887

## SECTION 2. COMPOSITION and INFORMATION ON INGREDIENTS

**EU LABELING/CLASSIFICATION:** This gas mixture meets the definition of hazardous as defined by the European Community Council Directives.**EU Classification:** Xn [Harmful]**EU Risk Phrases:** R: 20 [Harmful by Inhalation]

Chemical Name	Chemical Synonyms	Chemical Formula	CAS #	EINECS #	% Composition	EU Classification For Components
Phosphine	Hydrogen phosphide; Phosphane; Phosphoretted hydrogen; Phosphorous hydride; Phosphorous trihydride	H <sub>3</sub> P	7803-51-2	232-260-8	0-0.1%	HAZARD CLASSIFICATION: F+ [Extremely Flammable]; T+ [Very Toxic]; N [Dangerous for the Environment] RISK PHRASES: R: 12; R: 17; R: 26; R: 34; R: 50
Dibromomethane	Dibromomethane; Methylene Bromide; Methylene dibromide	CH <sub>2</sub> Br <sub>2</sub>	74-95-3	200-824-2	0-0.2%	HAZARD CLASSIFICATION: Xn [Harmful] RISK PHRASES: R: 20; R: 52/53
Argon	Not Applicable	Ar	7440-37-1	231-147-0	0-99%	HAZARD CLASSIFICATION: Not applicable RISK PHRASES: Not Applicable
Krypton	Not Applicable	Kr	7439-09-9	231-098-5	0-99%	HAZARD CLASSIFICATION: Not applicable RISK PHRASES: Not Applicable
Xenon	Not Applicable	Xn	7440-63-3	231-172-7	0-99%	HAZARD CLASSIFICATION: Not applicable RISK PHRASES: Not Applicable

## SECTION 3. HAZARD IDENTIFICATION

**EMERGENCY OVERVIEW: Product Description:** This gas is colorless, non-flammable gas mixture shipped under pressure. It may have a fishy odor or be odorless (depending on composition). **Health Hazards:** This gas mixture may cause *adverse health effects* due to the presence of Phosphine and Dibromomethane, which can reach exposure limits at the percentage in this mixture. Releases of this gas product should be responded to with caution. Pure phosphine is highly toxic, however, because this mixture contains a dilute concentration of phosphine (<0.1%), the risk of exposure is significantly reduced. In addition, releases of this gas can cause asphyxiation, by displacement of oxygen. **Flammability Hazards:** This gas is not flammable. However, if involved in a fire, this gas mixture can decompose to produce toxic gases (e.g., phosphorous oxides.) **Reactivity Hazards:** This gas is not reactive. **Environmental Hazards:** Release of this product to the environment may cause harm to contaminated plants and animals. **Emergency Response Considerations:** Emergency responders must wear the proper personal protective equipment suitable for the situation to which they are responding. **WARNING** - If rescue personnel need to enter an area suspected of having toxic levels of phosphine or dibromomethane or a low level of Oxygen, they should be equipped with Self-Contained Breathing Apparatus (SCBA).

**HMIS RATINGS:** HEALTH HAZARD: = 2; FLAMMABILITY HAZARD: = 0; PHYSICAL HAZARD: = 0

**SECTION 3. HAZARD IDENTIFICATION (Continued)**

**ROUTES OF ENTRY, SYMPTOMS OF ACUTE EXPOSURE: WARNING** - If rescue personnel need to enter an area in which a release of this gas mixture has occurred, they should be equipped with Self-Contained Breathing Apparatus (SCBA). High concentration of this gas will create an oxygen-deficient atmosphere, creating the risk of asphyxiation. Acute overexposure to this gas may cause the following health effects:

**SKIN CONTACT:** Skin contact with this gas may cause irritation. If skin contact is prolonged, severe irritation or damage to the skin may result due to presence of Phosphine and formation of phosphoric acid. The Dibromomethane and Phosphine components of this gas mixture can be absorbed via intact skin, possibly causing toxic effect by this route of exposure as described under "Inhalation".

**EYE CONTACT:** Eye contact with this gas may cause irritation. If eye contact is prolonged, severe irritation or damage to the eyes may result due to presence of Phosphine and formation of phosphoric acid. Release of a high-pressure gas may result in airborne objects.

**INGESTION:** Ingestion of this gas is not a likely route of industrial exposure.

**INHALATION:** Acute over-exposures to this gas mixture can be dangerous due to presence of Phosphine present. Non-lethal exposures may result in the following symptoms can include lachrymation (watery eyes), substernal chest pain, chest tightness, shortness of breath, a slight cough, and cyanosis. Such exposures can cause gastrointestinal tract irritation and central nervous system effects. Abdominal symptoms include nausea, vomiting, severe epigastric pain, and diarrhea. Neurologic symptoms include vertigo, headache, restlessness, involuntary tremors, lack of muscular coordination, double vision, drowsiness, and a decreased sensation in the extremities. Death can occur in humans after exposure as low as 8 ppm of Phosphine for 1-2 hours.

In addition, high concentrations of this gas mixture can cause an oxygen-deficient environment. Individuals breathing such an atmosphere may experience symptoms which include headaches, ringing in ears, dizziness, drowsiness, unconsciousness, nausea, vomiting, and depression of all the senses. The skin of a victim may have a blue color. Under some circumstances of over-exposure, death may occur, due to the displacement of oxygen. The following effects associated with various levels of oxygen are as follows:

**CONCENTRATION**

**of OXYGEN**

**EXPOSURE SYMPTOM**

20.9% Oxygen:

Normal oxygen concentration in air.

15-19% Oxygen:

Decreased ability to perform tasks. May impair coordination and may induce early symptoms in persons with heart, lung, or circulatory problems.

12-15% Oxygen:

Breathing increases, especially in exertion. Pulse up. Impaired coordination, perception, and judgment.

10-12% Oxygen:

Breathing further increases in rate and depth, poor coordination and judgment, lips slightly blue.

8-10% Oxygen:

Mental failure, fainting, unconsciousness, ashen face, blueness of lips, nausea (upset stomach), and vomiting.

6-8% Oxygen:

8 minutes, may be fatal in 50-100% of cases; 6 minutes, may be fatal in 25 to 50% of cases; 4-5 minutes, recovery with treatment.

4-6% Oxygen:

Coma in 40 seconds, followed by convulsion, breathing failure, death.

**WARNING: Exposure to atmospheres containing 8-10% or less oxygen will bring about unconsciousness without warning and so quickly that individuals cannot help or protect themselves. Lack of sufficient oxygen may cause serious injury or death.**

**OTHER HEALTH EFFECTS:** Contact with rapidly expanding gases (which are released from under high pressure) may cause frostbite. Symptoms of frostbite include change in skin color to white or grayish-yellow. The pain caused by frostbite can quickly subside, masking the injury. In addition, the sudden release of a pressurized gas (such as may occur in the event of a valve failure), presents a severe hazard of mechanical injury.

**ROUTES OF ENTRY, SYMPTOMS OF CHRONIC EXPOSURE:**

**ROUTE OF ENTRY:** Inhalation, skin contact.

**TARGET ORGANS:** Respiratory system, liver, kidneys, blood.

**SYMPTOMS:** Persistent irritation may result from repeated exposure to this gas mixture. Some reports of long-term effects on the central nervous system on persons exposed to Dibromomethane over more than a year (unspecified concentrations). Animal tests for a similar chemical, methylene chloride, suggest that long term exposure may cause damage to the liver, kidneys and lungs. Chronic exposure to low-levels of Phosphine can cause anemia, bronchitis, gastrointestinal disorders, and visual, speech, and motor disturbances.

**MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE:** Pre-existing dermatitis, other skin conditions, liver, kidney and respiratory disorders may be aggravated by over-exposure to this gas mixture.

**CARCINOGENICITY:** The Phosphine component is listed by the EPA as EPA-D (Not Classifiable as to Human Carcinogenicity). The remaining components of this gas mixture are not listed as a carcinogen or as a potential carcinogen on EPA, NIOSH, GERMAN MAK, OSHA, NTP, IARC, or CAL/OSHA Carcinogenicity lists.

#### SECTION 4. FIRST AID MEASURES

**EYE CONTACT:** Flush contaminated eyes for 15 minutes with water, having victim rolling eyes. Seek medical attention immediately following decontamination. If mechanical injury occurs, cover eye with bandage and seek appropriate medical attention.

**INGESTION:** Ingestion is an unlikely route of exposure for this gas.

**INHALATION:** Remove victim(s) to fresh air, as quickly as possible. Trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation, if necessary. Seek immediate medical attention.

**SKIN CONTACT:** Flush contaminated area with plenty of water for 15 minutes. If adverse effects continue after flushing, seek medical attention. In case of frostbite, place the frostbitten part in warm water. DO NOT USE HOT WATER. If warm water is not available, or is impractical to use, wrap the affected parts gently in blankets. Alternatively, if the fingers or hands are frostbitten, place the affected area in the armpit. Encourage victim to gently exercise the affected part while being warmed. Seek immediate medical attention.

**NOTES TO PHYSICIANS:** Administer oxygen, if necessary, and treat symptoms. Victims of exposure to Phosphine must be monitored closely for delayed pulmonary edema. There is no specific antidote to Phosphine poisoning; therefore, treatment is symptomatic and supportive.

#### SECTION 5. FIRE FIGHTING MEASURES

**FLASH POINT:** Not Applicable

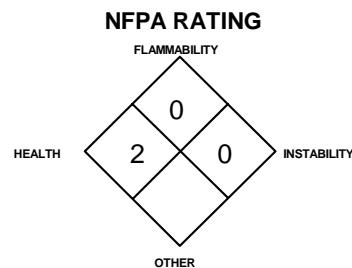
**AUTOIGNITION:** Not Applicable

**FLAMMABLE RANGE:** Not Applicable

**NFPA RATINGS:**

HEALTH: = 2 FLAMMABILITY: = 0

REACTIVITY: = 0 SPECIAL: None



**EXTINGUISHING MEDIA:** This is a non-flammable gas mixture; use fire-extinguishing media appropriate for the surrounding materials.

**SPECIAL FIRE-FIGHTING PROCEDURES:** Non-flammable. Use extinguishing media appropriate for surrounding fire. In the event of fire, cool containers of this product with water spray to prevent failure.

**UNUSUAL FIRE AND EXPLOSION HAZARDS:** This gas does not burn; however, containers, when involved in fire, may rupture or burst in the heat of the fire. Most cylinders have a pressure release device, which will vent contents if the cylinder is exposed to high temperatures. When this gas mixture contains Phosphine, small amounts of phosphoric acid may be produced in contact with water.

**EXPLOSION SENSITIVITY TO MECHANICAL IMPACT:** Not sensitive.

**EXPLOSION SENSITIVITY TO STATIC DISCHARGE:** Not sensitive.

**HAZARDOUS COMBUSTION PRODUCTS:** The inert gases in this mixture will not decompose in fire to produce toxic compounds. The Dibromomethane component of this gas mixture will decompose into hydrogen and bromine and the Phosphine component will decompose to phosphorous oxides.

#### SECTION 6. ACCIDENTAL RELEASE MEASURES

**STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:** In the event of a leak of this product, operator should close the gas source if possible to do so safely. Evacuate immediate area. Only trained personnel, wearing Self-Contained Breathing Apparatus (SCBA) and a chemically resistant suit should re-enter a contaminated area. Persons responding to a release of a pressurized gas should be aware of the severe hazard of mechanical injury in the event of valve failure or other event causing a rapid release of cylinder contents.

If leak is in user's gas handling equipment or system, close cylinder valve, safely vent high pressure and purge with inert gas, being sure to bring purge gas to near atmospheric pressure before attempting repairs. If leak is from the cylinder, cylinder valve or the valve pressure relief device (PRD), contact your supplier.

Levels of components should be below applicable exposure levels listed in Section 8 (Exposure Limits / Personal Protective Equipment) and the level of oxygen should above 19.5% before personnel can be allowed in the area without SCBA.

**SECTION 7. HANDLING AND STORAGE**

**STORAGE:** Cylinders should be stored upright (with valve protection caps or plugs in place) and firmly secured to prevent falling or being knocked over. Cylinders should be stored in dry, well-ventilated areas. Protect from salt or other corrosive materials. Storage should be away from heavily traveled areas, walkways, elevators, platform edges or other objects or situations that could damage the cylinder wall. Do not store in a manner that will block emergency exits, fire extinguishers or other safety equipment. Do not allow storage temperature to exceed 125°F (52°C). Use a first-in, first-out inventory system to prevent full containers from being stored for long periods of time. Store empty cylinders away from full cylinders. Consideration should be taken to install leak detection and alarm equipment for storage areas. **NOTE:** Use only DOT or ASME code cylinders designed for compressed gas storage. Cylinders must not be recharged except by or with the consent of owner.

**HANDLING: Releases of this gas mixture can create an oxygen-deficient atmosphere.** Be aware of any signs of dizziness or fatigue; exposures to fatal concentrations of this gas mixture could occur without any significant warning symptoms, due to oxygen-deficiency. Wearing contact lenses is not recommended when handling this gas.

Cylinder valves should be inspected regularly for physical damage or corrosion (apparent by discoloration or rust). Care should be taken to inspect the following valve locations for corrosion: neck (where valve inserts into cylinder); bonnet nut (where handle attaches to valve body). Close valve after each use and when empty. The failure of a valve can result in violent release of the pressurized gas, creating a severe mechanical injury hazard.

Do not drag, roll, slide or drop cylinder. Use a suitable hand truck designed for cylinder movement. Never attempt to lift a cylinder by its cap. Secure cylinders at all times while in use. Use a pressure regulator to safely discharge product from cylinder. Use a check valve to prevent reverse flow into cylinder. Once cylinder has been connected to properly purged process, open cylinder valve slowly and carefully. If user experiences any difficulty operating cylinder valve, discontinue use and contact supplier. Never insert an object (e.g., wrench, screwdriver, etc.) into valve cap openings; doing so may damage valve, causing a leak to occur. Use an adjustable strap-wrench to remove over-tight or rusted caps.

Do not heat cylinders by any means to increase the discharge rate of product from the cylinder. Never apply flame or localized heat directly to any part of the cylinder. Cylinders should not be artificially cooled as certain types of steel undergo property changes when cryogenically cooled, thus making the cylinder unstable.

**EQUIPMENT:** Purge gas handling equipment with inert gas and relieve pressure before attempting repairs. Follow all cautionary procedures described above during maintenance operations.

**SPECIAL PRECAUTIONS:** Be aware of any signs of dizziness or fatigue; exposures to fatal concentrations of this gas could occur without any significant warning symptoms. All work operations should be monitored in such a way that emergency personnel can be immediately contacted in the event of a release. Always store and handle compressed gas cylinders in accordance with Compressed Gas Association, Inc. (telephone 703-412-0900) pamphlet CGA P-1, *Safe Handling of Compressed Gases in Containers*. Local regulations may require specific equipment for storage and use.

**SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION**

**VENTILATION AND ENGINEERING CONTROLS:** Forced ventilation systems for the general work area should be provided. If appropriate, install automatic monitoring equipment to detect the level of oxygen.

**EXPOSURE LIMITS:**

Chemical Name	CAS #	OSHA PELs ppm	ACGIH TLVs ppm	NIOSH RELs ppm	NIOSH IDLH ppm	DFG MAKs ppm	AIHA WEELs ppm
Phosphine	7803-51-2	TWA = 0.3 (Vacated 1989 PEL)	TWA = 0.3 STEL = 1	TWA = 0.3 STEL = 1	50	TWA = 0.1 PEAK = 1•MAK 15 min. average value, 1-hr interval	NE
Dibromomethane It is recommended that the following exposure limits for Bromomethane be used	74-95-3	TWA = 200 (Vacated 1989 PEL)	TWA = 5 (skin)	NE	2000	NE	NE
Argon	7440-37-1	Simple Asphyxiant					
Krypton	7439-09-9	Simple Asphyxiant					
Xenon	7440-63-3	Simple Asphyxiant					

NE = Not Established

**SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION (Continued)**

The following information on appropriate Personal Protective Equipment is provided to assist employers in complying with OSHA regulations found in 29 CFR Subpart I (beginning at 1910.132) or equivalent standard of Canada, or standards of EC member states (including EN 149 for respiratory PPE, and EN 166 for face/eye protection). Please reference applicable regulations and standards for relevant details.

**RESPIRATORY PROTECTION:** Maintain exposure levels of components below levels listed above and oxygen levels above 19.5% in the workplace. Use supplied air respiratory protection if oxygen level is below 19.5%, or during emergency response to a release of this product. If respiratory protection is required, follow the requirements of the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), or equivalent U.S. State standards, standards of Canada, the European Standard EN166, and EC member states. The following are NIOSH respiratory guidelines for the Phosphine component of this gas mixture, which may reach exposure limits in this gas mixture.

PHOSPHINECONCENTRATIONRESPIRATORY PROTECTION

Up to 3 ppm:

Any Supplied-Air Respirator (SAR).

Up to 7.5 ppm:

Any SAR operated in a continuous-flow mode (APF = 25)

Up to 15 ppm:

Any Air-Purifying, Full-Facepiece Respirator (gas mask) with a chin-style, front- or back-mounted canister, or any Self-Contained Breathing Apparatus (SCBA) with a full facepiece, or any SAR with a full facepiece.

Up to 50 ppm:

Any SAR operated in a pressure-demand or other positive-pressure mode.

Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions: Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, or any SAR (that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode.

Escape:

Any Air-Purifying, Full-Facepiece Respirator (gas mask) with a chin-style, front- or back-mounted canister, or any appropriate escape-type, SCBA.

**EYE PROTECTION:** Use approved safety goggles or safety glasses, when cylinders are not closed and capped. Be aware that particles or objects propelled by high pressure gas can fly significant distances. Eyewear should be as described in OSHA 29 CFR 1910.133 or by the European Standard EN166.

**SKIN PROTECTION:** Work (such as leather) gloves are recommended when handling cylinders of this gas. Wear gloves appropriate to the specific operation for which this gas mixture is used. Use triple gloves for spill response. If necessary, refer to U.S. OSHA 29 CFR 1910.138, and the European Standard DIN EN 374, or appropriate Standards of Canada.

**OTHER PROTECTIVE EQUIPMENT:** Use body protection appropriate for task. Safety shoes are recommended when handling cylinders. Transfer of large quantities under pressure may require use of chemically impervious clothing. Information on general protective measures can be found in U.S. OSHA 29 CFR 1910.136.

**SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES**

The following information is for inert components that may be part of this mixture:

	<b>Argon</b>	<b>Krypton</b>	<b>Xenon</b>
<b>Molecular Weight</b>	39.95	83.80	131.3
<b>Gas Density @ 21.1°C (70°F)</b>	0.103 lb/ft <sup>3</sup> (1.650 kg/m <sup>3</sup> )	0.2172 lb/ft <sup>3</sup> (3.479 kg/m <sup>3</sup> )	0.3416 lbs ft <sup>3</sup> (5.472 kg/m <sup>3</sup> )
<b>Boiling Point @ 1 atm</b>	-185.9°C (-302.6°F)	-153.4°C (-244.0°F)	-108.2°C (-162.6°F)
<b>Freezing/Melting Point @ 1 atm</b>	-189.2°C (-308.6°F)	-157°C (-251°F)	-168°F (-111°C)
<b>Specific Gravity (air = 1) @ 21.1°C (70°F)</b>	1.38	2.899	4.560
<b>Solubility in Water vol/vol at 0°C (32°F) and 1 atm</b>	0.056	0.0594	0.108
<b>Specific Volume @ 21.1°C (70°F)</b>	9.71 ft <sup>3</sup> /lb (0.606 m <sup>3</sup> /kg)	4.604 ft <sup>3</sup> /lb (0.287 m <sup>3</sup> /kg)	2.927 ft <sup>3</sup> /lb (0.183 m <sup>3</sup> /kg)
<b>Critical Pressure</b>	711.5 psia (4905 kPa abs)	798.0 psia (5502 kPa abs)	847.0 psia (5840 kPa abs)
<b>Odor Threshold</b>	odorless	odorless	odorless

**SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES (Continued)**

The following information is for the Dibromomethane and Phosphine components of this mixture:

	Dibromomethane	Phosphine
<b>Molecular Weight</b>	173.85	34.00
<b>Gas Density @ 15°C (70°F)</b>	Not available	Not available
<b>Boiling Point @ 1 atm</b>	97°C (207°F)	-87.8°C (-126.04°F)
<b>Freezing/Melting Point @ 1 atm</b>	-52°C (-62°F)	-133 to -133.8°C (-207.4 to -208.8°F)
<b>Specific Gravity (air = 1)</b>	2.490 at 25°C	1.405 at 21.1°C
<b>Solubility in Water</b>	Moderately soluble (1.18 g/100 mL of water at 20°C)	Slightly soluble (26 mL/100 mL) @ 17°C and 101.33 kPa (1 atm)
<b>Specific Volume</b>	Not available	Not available
<b>Critical Pressure</b>	71 atm	6536 kPa (64.5 atm)
<b>Critical Temperature</b>	583 K	51.6°C (124.9°F)
<b>Odor Threshold</b>	Not available	0.010-2.014 ppm.
<b>Vapor Density (air = 1)</b>	6.05	1.184 at 25°C and 101.33 kPa
<b>Vapor Pressure</b>	35 mm Hg at 20°C	4020 kPa (583 psig; 39.67 atm) at 21.1°C
<b>Viscosity-Dynamic</b>	1.320 mPa @ 0°C; 0.980 mPa @ 25°C	0.010 mPa.s (0.010 centipoise) at 0°C and 101.33 kPa
<b>Liquid Density</b>	Not available	45.2 lb/ft <sup>3</sup> (581 kg/m <sup>3</sup> )

Information for **gas mixture**:

**APPEARANCE, ODOR AND STATE:** Colorless gas with slight, fishy odor, or odorless, depending on composition.

**WARNING PROPERTIES FOR THIS GAS:** When this gas contains Phosphine, the fishy, garlic-like odor cannot be relied upon as a warning property of a release due to potential olfactory fatigue. In terms of leak detection, fittings and joints can be painted with a soap solution to detect leaks, which will be indicated by a bubble formation.

**SECTION 10. STABILITY AND REACTIVITY**

**CHEMICAL STABILITY:** This gas mixture is stable under conditions of normal temperature and pressure.

**CONDITIONS TO AVOID:** Cylinders should not be exposed to temperatures in excess of 125°F (52°C).

**MATERIALS WITH WHICH GAS MIXTURE IS INCOMPATIBLE:** Although the components of greatest percentage are inert, the Dibromomethane present in this mixture will react vigorously with strong oxidizers and strong bases. If combined with metals (e.g. potassium, magnesium, aluminum), shock-sensitive compounds are formed. When present, the Phosphine component may cause this gas mixture to be incompatible with powdered metals, metal alloys and metal acetylides, phosphorous hydrides, such as diphosphine, halogens and oxidizers such as oxygen, chlorine, fluorine and nitric oxide. Phosphine reacts with mercury(II) nitrate to form an explosive product.

**REACTIVITY:**

**A) HAZARDOUS DECOMPOSITION PRODUCTS:** The Dibromomethane component of this gas mixture will decompose into hydrogen and bromine and the Phosphine component will decompose to phosphorous oxides.

**B) HAZARDOUS POLYMERIZATION:** Will not occur.

**SECTION 11. TOXICOLOGICAL INFORMATION**

**TOXICITY DATA:** There are no specific toxicology data for Argon, Krypton or Xenon. These gases are simple asphyxiants, which cause suffocation by replacing air (oxygen). Suffocation without warning is a hazard with this mixture because the component does not provides an odor warning. The following toxicological data are available for Dibromomethane and Phosphine.

**DIBROMOMETHANE:**

TCLo (Inhalation- Human) 40 mg/m<sup>3</sup>/2 years-intermittent Behavioral: anorexia (human), headache; Lungs, Thorax, or Respiration: dyspnea  
LD<sub>50</sub> (Oral-Rat) 108 mg/kg  
LD<sub>50</sub> (Oral-Rabbit) 1 gm/kg  
LD<sub>50</sub> (Subcutaneous-Mouse) 3738 mg/kg  
LD<sub>50</sub> (Skin-Rabbit) > 4 gm/kg  
LC<sub>50</sub> (Inhalation-Rat) 40 gm/m<sup>3</sup>/2 hours  
LC<sub>50</sub> (Inhalation-Rat) 40,000 gm/m<sup>3</sup>

**DIBROMOMETHANE (continued):**

LDLo (Rectal-Rabbit) 5 gm/kg: Behavioral: convulsions or effect on seizure threshold; Lungs, Thorax, or Respiration: respiratory stimulation; Gastrointestinal: changes in structure or function of salivary glands  
TCLo (Inhalation-Rat) 1000 mg/m<sup>3</sup>/2 hours: Brain and Coverings: changes in surface EEG

**DIBROMOMETHANE (continued):**

TDLo (Oral-Rat) 333 mg/kg/28 days-continuous: Blood: changes in serum composition (e.g. TP, bilirubin, cholesterol); Biochemical: Enzyme inhibition, induction, or change in blood or tissue levels: dehydrogenases  
Mutation in Microorganisms (Bacteria-*Salmonella typhimurium*) 100 ng/plate  
Mutation in Microorganisms (Bacteria-*Salmonella typhimurium*) 10 µg/plate  
Cytogenetic Analysis (Hamster-Lung) 1 µmol/L

## SECTION 11. TOXICOLOGICAL INFORMATION (Continued)

## TOXICITY DATA (continued):

## PHOSPHINE:

TCLo (Inhalation-Human) 2.7 ppm/20 minutes: Behavioral: headache; Lungs, Thorax, or Respiration: cough; Gastrointestinal: hypermotility, diarrhea  
 TCLo (Inhalation-Human) 2 mg/m<sup>3</sup>: Sense Organs and Special Senses (Olfaction): change in sensation of smell  
 TCLo (Inhalation-Human) 10 mg/m<sup>3</sup>: Sense Organs and Special Senses (Olfaction): change in sensation of smell  
 TCLo (Inhalation-Woman) 2.7 ppm/20 minutes: Behavioral: headache; Lungs, Thorax, or Respiration: cough; Gastrointestinal: hypermotility, diarrhea  
 LCLo (Inhalation-Human) 1000 ppm/5 minutes  
 LC<sub>50</sub> (Inhalation-Rat) 11 ppm/4 hours: Lungs, Thorax, or Respiration: dyspnea  
 LCLo (Inhalation-Mouse) 380 mg/m<sup>3</sup>/2 hours  
 LCLo (Inhalation-Rat) 140 mg/m<sup>3</sup>/4 hours  
 LCLo (Inhalation-Rat) 139 mg/m<sup>3</sup>/4 hours  
 LCLo (Inhalation-Mouse) 380 mg/m<sup>3</sup>/1 hour  
 LCLo (Inhalation-Mouse) 760 mg/m<sup>3</sup>/35 minutes  
 LCLo (Inhalation-Rabbit) 2500 ppm/20 minutes  
 LCLo (Inhalation-Rabbit) 139 mg/m<sup>3</sup>/4 hours  
 LCLo (Inhalation-Mammal-Species Unspecified) 1000 ppm/5 minutes

## PHOSPHINE (continued):

LCLo (Inhalation-Cat) 70 mg/m<sup>3</sup>/2 hours  
 TDLo (Intraperitoneal-Rat) 4 mg/kg: Biochemical: Enzyme inhibition, induction, or change in blood or tissue levels: multiple enzyme effects, Metabolism (Intermediary): lipids including transport, Metabolism (Intermediary): other proteins  
 TCLo (Inhalation-Rat) 3100 ppb/6 hours/13 weeks-intermittent: Blood: pigmented or nucleated red blood cells, changes in erythrocyte (RBC) count, changes in platelet count  
 TCLo (Inhalation-Rat) 200 µg/m<sup>3</sup>/24 hours/6 weeks-continuous: Brain and Coverings: recordings from specific areas of CNS; Blood: pigmented or nucleated red blood cells, changes in serum composition (e.g. TP, bilirubin, cholesterol)  
 TCLo (Inhalation-Rat) 10 ppm/4 hours/4 days-intermittent: Related to Chronic Data: death  
 TCLo (Inhalation-Rat) 5 ppm/4 hours/2 weeks-intermittent: Cardiac: changes in heart weight; Lungs, Thorax, or Respiration: changes in lung weight; Liver: changes in liver weight

## PHOSPHINE (continued):

TCLo (Inhalation-Mouse) 10 ppm/4 hours/4 days-intermittent: Kidney, Ureter, Bladder: changes in tubules (including acute renal failure, acute tubular necrosis); Blood: changes in leukocyte (WBC) count; Biochemical: Enzyme inhibition, induction, or change in blood or tissue levels: transaminases  
 TCLo (Inhalation-Mouse) 5 ppm/4 hours/2 weeks-intermittent: Cardiac: changes in heart weight; Lungs, Thorax, or Respiration: changes in lung weight; Blood: changes in serum composition (e.g. TP, bilirubin, cholesterol)  
 TCLo (Inhalation-Mouse) 5 ppm/6 hours/4 weeks-intermittent: Sense Organs and Special Senses (Olfaction): effect, not otherwise specified; Lungs, Thorax, or Respiration: chronic pulmonary edema; Kidney, Ureter, Bladder: changes in bladder weight  
 TCLo (Inhalation-Rabbit) 14 mg/m<sup>3</sup>/7 hours/2 days-intermittent: Related to Chronic Data: death  
 TCLo (Inhalation-Cat) 14 mg/m<sup>3</sup>/7 hours/2 days-intermittent: Related to Chronic Data: death  
 Cytogenetic Analysis (Human-Lymphocyte) 1400 ng/L  
 Micronucleus Test (Inhalation-Mouse) 5 ppm/6 hours/13 weeks-intermittent

Note: In the absence of toxicological information for a specific mixture, the following formula is published by these agencies/groups for classifying toxicity of a gas mixture with more than one toxic component:

US Dept. of Transportation (D.O.T.) (49 CFR 173.133(b)); Compressed Gas Association (CGA P-20)  
 International Air Transport Association (IATA 3.2.3);  
 National Fire Protection Association (NFPA 55 2003 ed.) ref CGA P-20

$$LC_{50}(\text{mix}) = \frac{1}{\sum \frac{\text{concentration of toxic component}_i \text{ (in decimal percent)}}{LC_{50} \text{ of toxic component}_i \text{ (in ppm)}}$$

Calculated LC<sub>50</sub> (0.1% phosphine (LC<sub>50</sub> 20 ppm), 0.2% dibromomethane (LC<sub>50</sub> 5626 ppm) mix) = 20,000 ppm

**IRRITANCY OF PRODUCT:** This gas mixture may be mildly to moderately irritating to contaminated tissue, depending on the duration of contact and whether Phosphine is present.

**SENSITIZATION OF PRODUCT:** The components of this gas mixture are not known to be human skin or respiratory sensitizers.

**REPRODUCTIVE TOXICITY INFORMATION:** Listed below is information concerning the effects of the components of this gas mixture on the human reproductive system.

**Mutagenicity:** The components of this gas mixture are not reported to cause mutagenic effects in humans. Mutation in microorganism tests involving Dibromomethane provided weakly positive results were reported in bacterial tests (in-vitro) with and without activation with liver enzyme systems. Animal information suggests that the Phosphine component may be mutagenic at concentrations which also produce significant other toxicity. Positive and negative results have been obtained in cultured mammalian cells and bacteria.

**Embryotoxicity:** The components of this gas mixture are not reported to cause embryotoxic effects in humans.

**Teratogenicity:** The components of this gas mixture are not reported to cause teratogenic effects in humans.

**Reproductive Toxicity:** The components of this gas mixture are not reported to cause adverse reproductive effects in humans.

A *mutagen* is a chemical that causes permanent changes to genetic material (DNA) such that the changes will propagate through generational lines. An *embryotoxin* is a chemical that causes damage to a developing embryo (i.e., within the first eight weeks of pregnancy in humans), but the damage does not propagate across generational lines. A *teratogen* is a chemical that causes damage to a developing fetus, but the damage does not propagate across generational lines. A *reproductive toxin* is any substance that interferes in any way with the reproductive process.

**BIOLOGICAL EXPOSURE INDICES (BEIs):** Currently, there are no Biological Exposure Indices (BEIs) for the components of this gas mixture.

## SECTION 12. ECOLOGICAL INFORMATION

**ENVIRONMENTAL STABILITY:** Argon, Krypton and Xenon occur naturally in the atmosphere. Dibromomethane will mainly volatilize from soil, water and the atmosphere; however, Dibromomethane is resistant to hydrolysis so any remaining compound not lost by volatilization can persist. The estimated hydrolysis half-life is 183 years.

**EFFECT OF MATERIAL ON PLANTS or ANIMALS:** It is unknown if any effects of this gas mixture will occur to exposed plants or animals. Due to the presence of Phosphine and Dibromomethane, releases of this gas mixture may harm plants and animals.

**EFFECT OF CHEMICAL ON AQUATIC LIFE:** Currently, there are no data on the effects of this gas mixture on an aquatic environment. Both the Phosphine and Dibromomethane component can cause harm to aquatic organisms, even in low concentration.

**MOBILITY:** It is unknown if any effects of this gas mixture will occur to exposed plants or animals. Due to the presence of Phosphine and Dibromomethane, releases of this gas mixture may harm plants and animals.

**PERSISTENCE AND BIODEGRADABILITY:** Persistence: Argon, Krypton and Xenon are natural elements and present no hazard of persistence. If released on soil, Dibromomethane is expected to volatilize from soil surface and leach into the ground. If released to water, Dibromomethane would primarily volatilize, with an estimated half-life of 5.2 hours from a model river. If released to the atmosphere, Dibromomethane will react with photochemically produced hydroxyl radicals. The estimated half-life for this reaction is estimated to be 213 days. Biodegradation: Dibromomethane will biodegrade. Pure Phosphine is inert, but will oxidize under influence of radiation and UV light.

**POTENTIAL TO BIOACCUMULATE:** No data are currently available on the components of this gas mixture for bioaccumulation.

**OZONE-DEPLETION POTENTIAL:** The components of this gas mixture are not a Class I or Class II ozone depleting chemicals (40 CFR Part 82).

## SECTION 13. DISPOSAL CONSIDERATIONS

**UNUSED PRODUCT / EMPTY CONTAINER:** Do not dispose of residual product. Return residual product in cylinders to: Spectra Gases, Inc., 80 Industrial Drive, Alpha, NJ 08865 or Spectra Gases, Inc., 1261 Activity Drive, Vista, CA 92083.

**DISPOSAL INFORMATION:** Residual product may be safely released in a well-ventilated area. This shall be done in accordance with U.S. Federal, State and local regulations, regulations of the provinces of Canada or EC member states.

## SECTION 14. TRANSPORT INFORMATION

### U.S. SHIPPING INFORMATION:

**U.S. DOT PROPER SHIPPING NAME:** Compressed gases, n.o.s. (phosphine, dibromomethane, argon) **or** (phosphine, dibromomethane, krypton) **or** (phosphine, dibromomethane, xenon)

**HAZARD CLASS NUMBER and DESCRIPTION:** 2.2 (Non-Flammable Gas)

**UN IDENTIFICATION NUMBER:** UN 1956

**U.S. DOT SHIPPING LABEL(S) REQUIRED:** Non-Flammable Gas

**PLACARD (When required):** Non-Flammable Gas

**SPECIAL SHIPPING INFORMATION:** Cylinders should be transported in a secure position in a well-ventilated truck (never transport in passenger compartment of a vehicle). Ensure cylinder valve is properly closed, valve outlet cap has been reinstalled, and valve protection cap is secured before shipping cylinder.

**CAUTION:** Compressed gas cylinders shall not be refilled except by qualified producers of compressed gases. Shipment of a compressed gas cylinder which has not been filled by the owner or with the owner's written consent is a violation of Federal law (49 CFR 173.301).

**NAERG (NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK) #: 126**

### CANADIAN SHIPPING INFORMATION:

**TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS:** This gas is classified as Dangerous Goods, per regulations of Transport Canada. The use of the above U.S. DOT information from the U.S. 49 CFR regulations is allowed for shipments that originate in the U.S. For shipments via ground vehicle or rail that originate in Canada, the following information is applicable.

**PROPER SHIPPING NAME:** (Compressed gases, n.o.s. (phosphine, dibromomethane, argon) **or** (phosphine, dibromomethane, krypton) **or** (phosphine, dibromomethane, xenon)

**HAZARD CLASS NUMBER and DESCRIPTION:** 2.2 (Non-Flammable Gas)

**UN IDENTIFICATION NUMBER:** UN 1956

**PACKING GROUP:** Not Applicable

**HAZARD SHIPPING LABEL(S) REQUIRED:** Class 2.2 (Non-Flammable Gas)

**SPECIAL PROVISIONS:** None

**EXPLOSIVE LIMIT & LIMITED QUANTITY INDEX:** 0.125

**ERAP INDEX:** None

**PASSENGER CARRYING SHIP INDEX:** None

**PASSENGER CARRYING ROAD OR RAIL VEHICLE INDEX:** 75

**SECTION 14. TRANSPORT INFORMATION (Continued)**

**INTERNATIONAL AIR TRANSPORT ASSOCIATION SHIPPING INFORMATION (IATA):**

**IATA DESIGNATION:** This gas is classified as dangerous goods, per the International Air Transport Association.  
**UN IDENTIFICATION NUMBER:** UN 1956  
**PROPER SHIPPING NAME/DESCRIPTION:** Compressed gases, n.o.s. (phosphine, dibromomethane, argon) *or* (phosphine, dibromomethane, krypton) *or* (phosphine, dibromomethane, xenon)  
**HAZARD CLASS or DIVISION:** 2.2 (Non-Flammable Gas)  
**HAZARD LABEL(S) REQUIRED:** Class 2.2 (Non-Flammable Gas)  
**PACKING GROUP:** None  
**PASSENGER and CARGO AIRCRAFT PACKING INSTRUCTION:** 200  
**PASSENGER and CARGO AIRCRAFT MAXIMUM NET QUANTITY PER PKG:** 75 kg  
**PASSENGER and CARGO AIRCRAFT LIMITED QUANTITY PACKING INSTRUCTION:** None  
**PASSENGER and CARGO AIRCRAFT LIMITED QUANTITY MAXIMUM NET QUANTITY PER PKG:** None  
**CARGO AIRCRAFT ONLY PACKING INSTRUCTION:** 200  
**CARGO AIRCRAFT ONLY MAXIMUM NET QUANTITY PER PKG:** 150 kg  
**SPECIAL PROVISIONS:** None  
**ERG CODE:** 2L

**INTERNATIONAL MARITIME ORGANIZATION SHIPPING INFORMATION (IMO):**

**IMO DESIGNATION:** This gas is classified as dangerous goods, per the International Maritime Organization.  
**UN No.:** 1956  
**PROPER SHIPPING NAME:** Compressed gases, n.o.s. (phosphine, dibromomethane, argon) *or* (phosphine, dibromomethane, krypton) *or* (phosphine, dibromomethane, xenon)  
**HAZARD CLASS NUMBER:** 2.2  
**PACKING GROUP:** None  
**SPECIAL PROVISIONS:** None  
**LIMITED QUANTITIES:** 120 mL  
**PACKING INSTRUCTIONS:** P200  
**EmS:** F-C, S-V  
**STOWAGE CATEGORY:** Category A  
**MARINE POLLUTANT:** The components of this gas mixture are not designated by the IMO to be a Marine Pollutant.

**EUROPEAN SHIPPING INFORMATION:**

**EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR):** This gas is classified by the Economic Commission for Europe to be dangerous goods. Additional information is as follows:

**UN NO.:** 1956  
**NAME and DESCRIPTOR:** Compressed gases, n.o.s. (phosphine, dibromomethane, argon) *or* (phosphine, dibromomethane, krypton) *or* (phosphine, dibromomethane, xenon)  
**CLASS:** 2  
**CLASSIFICATION CODE:** 2A  
**PACKING GROUP:** Not Applicable  
**LABELS:** 2.2  
**SPECIAL PROVISIONS:** None  
**LIMITED QUANTITIES:** LQ1  
**PACKING INSTRUCTIONS:** P200  
**MIXED PACKING PROVISIONS:** MP9  
**HAZARD IDENTIFICATION No.:** 20

**SECTION 15. REGULATORY INFORMATION**

**U.S. FEDERAL REGULATIONS:**

**EPA - ENVIRONMENTAL PROTECTION AGENCY:**

**CERCLA:** Comprehensive Environmental Response, Compensation, and Liability Act of 1990  
(40 CFR Parts 117 and 302)

Reportable Quantity (RQ): Dibromomethane = 1000 lb (454 kg)

**SARA TITLE III:** Superfund Amendment and Reauthorization Act

**SECTIONS 302/304:** Emergency Planning and Notification (40 CFR Part 355)

Section 304 Extremely Hazardous Reportable Quantity Hazardous Substances (RQ): Phosphine = 100 lb (45.4 kg)

Section 302 Extremely Hazardous Threshold Planning Quantity (TPQ): Phosphine = 500 lb (227 kg)

**SECTION 15. REGULATORY INFORMATION (Continued)**

**U.S. FEDERAL REGULATIONS (continued):**

**EPA - ENVIRONMENTAL PROTECTION AGENCY (continued):**

**SARA TITLE III (continued):**

**SECTIONS 311/312:** Hazardous Chemical Reporting (40 CFR Part 370)

IMMEDIATE HEALTH: Yes      PRESSURE: Yes  
DELAYED HEALTH: Yes      REACTIVITY: No  
FIRE: No

**SECTION 313:** Toxic Chemical Release Reporting (40 CFR 372)

Releases of this gas mixture require reporting under Section 313 when the mixture contains Dibromomethane or Phosphine.

**CLEAN AIR ACT:**

**SECTION 112 (r):** Risk Management Programs for Chemical Accidental Release  
(40 CFR Part 68)

Threshold Planning Quantity (TPQ): Phosphine = 5000 lb (2270 kg)

**TSCA:** Toxic Substances Control Act

Components are listed on the TSCA Inventory.

**OSHA - OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION:**

**29 CFR Part 1910.119:** Process Safety Management of Highly Hazardous Chemicals.

Threshold Planning Quantity (TPQ): Phosphine = 100 lb (45.4 kg)

**U.S. STATE REGULATORY INFORMATION:**

**CALIFORNIA PROPOSITION 65:** The components of this gas mixture are not listed substances which the State of California requires warning under this statute.

**CANADIAN FEDERAL REGULATIONS:**

**CANADIAN DSL INVENTORY STATUS:** Components are listed on the Canadian DSL Inventory.

**OTHER CANADIAN REGULATIONS:** This gas mixture is categorized as a Controlled Product, Hazard Class A as per the Controlled Product Regulations. Components are not on the CEPA Priorities Substances Lists.

**EUROPEAN ECONOMIC COMMUNITY REGULATIONS:**

**EU LABELING AND CLASSIFICATION:** This gas mixture meets the definition of hazardous as defined by the European Community Council Directives.

**EU CLASSIFICATION:** Xn (Harmful)

**EU RISK PHRASES:** R: 20 (Harmful by Inhalation)

**EU SAFETY PHRASES:** S: ½: (Keep locked-up and out of reach of children. *\*This safety phrase can be omitted from the label when the substance or preparation is sold for industrial use only.\**); S: 28 (After contact with skin, wash immediately with plenty of water.); S: 36/37 (Wear suitable protective clothing and gloves.); S: 45 (In case of accident or if you feel unwell, seek medical advice immediately (show label where possible).)

**EUROPEAN COMMUNITY ANNEX II HAZARD SYMBOL:** Not applicable.

**EUROPEAN COMMUNITY INFORMATION FOR COMPONENTS:**

**DIBROMOMETHANE:**

**EU EINECS/ELINCS NUMBER:** 200-824-2

**EU CLASSIFICATION:** [Xn]: Harmful

**EU RISK PHRASES:** R: 20 (Harmful by inhalation.); R: 52/53: (Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.)

**EU SAFETY PHRASES:** S: 2 (Keep out of the reach of children. *\*This safety phrase can be omitted from the label when the substance or preparation is sold for industrial use only.\**); S: 21 (Avoid contact with skin.); S: 61 (Avoid release to the environment. Refer to special instructions/Safety Data Sheets.)

**PHOSPHINE:**

**EU EINECS/ELINCS NUMBER:** 232-260-8

**EU CLASSIFICATION:** [F+]: Extremely Flammable; [T+]: Very Toxic; N: Dangerous for the Environment

**EU RISK PHRASES:** R: 12 (Extremely Flammable); R: 17 (Spontaneously flammable in air.); R: 26 (Very toxic by inhalation.); R: 34 (Causes burns.); R: 50: (Very to aquatic organisms.)

**EU SAFETY PHRASES:** S: 1/2 (Keep locked-up and out of the reach of children. *\*This safety phrase can be omitted from the label when the substance or preparation is sold for industrial use only.\**); S: 28 (After contact with skin, wash immediately with plenty of water.); S: 36/37 (Wear suitable protective clothing and gloves.); S: 45 (In case of accident or if you feel unwell, seek medical advice (show label where possible).) S: 61 (Avoid release to the environment. Refer to special instructions/Safety Data Sheets.); S: 63 (In case of accident by inhalation, remove casualty to fresh air and keep at rest).

**SECTION 15. REGULATORY INFORMATION (Continued)**

**EUROPEAN COMMUNITY INFORMATION FOR COMPONENTS (continued):**

**ARGON:**

**EU EINECS/ELINCS NUMBER:** 231-147-0

**EU CLASSIFICATION:** An official classification for this substance has not been published in Commission Directives 93/72/EEC, 94/69 EC, or and 96/54/EC.

**KRYPTON:**

**EU EINECS/ELINCS NUMBER:** 231-098-5

**EU CLASSIFICATION:** An official classification for this substance has not been published in Commission Directives 93/72/EEC, 94/69 EC, or and 96/54/EC.

**XENON:**

**EU EINECS/ELINCS NUMBER:** 231-172-7

**EU CLASSIFICATION:** An official classification for this substance has not been published in Commission Directives 93/72/EEC, 94/69 EC, or and 96/54/EC.

**SECTION 16. OTHER INFORMATION**

Information contained in this Material Safety Data Sheet is provided to our customers so they may comply with 29 CFR 1910.1200, Hazard Communication Standard, the Canadian WHMIS Standard, and the requirements of the European Community Directives. The intent of this Material Safety Data Sheet is to provide end users of this product with the health and physical hazards associated with possible exposure to this product. All statements, technical data and recommendations are based on readily available texts and data that Spectra Gases, Inc., believes to be reliable and accurate. Spectra Gases, Inc., makes no warranties, guarantees or representations of any kind with respect to this product or this data. It is the responsibility of the user to obtain and use the most recent version of this MSDS.

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