



MATERIAL SAFETY DATA SHEET

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

SECTION 1. PRODUCT IDENTIFICATION

PRODUCT NAME: < 57% HYDROGEN BROMIDE, OXYGEN (0-5%) in ARGON, KRYPTON, NITROGEN and/or Xenon
CHEMICAL NAME: Mixture of Hydrogen Bromide (< 57%), Oxygen (0-5%) in Argon, Krypton, Nitrogen, and/or Xenon (Balance)
FORMULA: Hydrogen Bromide = HBr; Oxygen = O₂; Argon = Ar; Krypton = Kr; Nitrogen = N₂; Xenon = Xe
SYNONYMS: Not Applicable

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DATE OF PREPARATION: November 28, 2002

MSDS NUMBER: 1149

PRODUCT USE: Lighting applications, research and development.

SECTION 2. COMPOSITION and INFORMATION ON INGREDIENTS

COMPOSITION: Hydrogen Bromide (< 57%), Oxygen (0-5%) in Argon, Krypton, Nitrogen, and/or Xenon (Balance)
CAS NUMBER: Hydrogen Bromide 10035-10-6; Argon 7440-37-1; Krypton: 7439-90-9; Nitrogen: 7727-37-9; Oxygen = 7782-44-7; Xenon = 7440-63-3
EINECS NUMBER: Hydrogen Bromide 233-113-0; Argon 231-098-5; Krypton: 231-098-5; Nitrogen: 231-783-9; Oxygen = 231-956-9; Xenon = 231-172-7
EXPOSURE LIMITS: (10,000 ppm = 1%)

OSHA PELs:	ACGIH TLVs:	NIOSH RELs:
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Hydrogen Bromide: TWA = 3 ppm (ceiling = 3 ppm, vacated 1989 PEL)	STEL = 3 ppm (ceiling)	CEILING = 3 ppm IDLH = 30 ppm
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Argon:
There are no exposure limits for Argon, Argon is a simple asphyxiant.

Krypton:
There are no exposure limits for Krypton, Krypton is a simple asphyxiant.

Nitrogen:
There are no exposure limits for Nitrogen, Nitrogen is a simple asphyxiant.

Oxygen
There are no exposure limits for Oxygen.

Xenon
There are no exposure limits for Xenon, Xenon is a simple asphyxiant.

SECTION 3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: This gas is a colorless, non-flammable gas mixture with a sharp, suffocating odor (due to the presence of Hydrogen Bromide), shipped under pressure. This gas mixture may cause significant, adverse health effects because of the Hydrogen Bromide content, which can reach exposure limits at the level present in the mixture. Due to presence of Hydrogen Bromide, releases of this product should be responded to with caution. Hydrogen Bromide has a sharp, suffocating odor and a low odor threshold; the odor of this gas provides a good warning of a release of this gas mixture. Persons responding to releases of this gas mixture must protect themselves appropriately.

SECTION 3. HAZARD IDENTIFICATION (Continued)

ROUTES OF ENTRY, SYMPTOMS OF ACUTE EXPOSURE: WARNING - If rescue personnel need to enter an area suspected of having a toxic level of Hydrogen Bromide (a component of this gas mixture), they should be equipped with Self-Contained Breathing Apparatus (SCBA), and appropriate body protection for Hydrogen Bromide exposure. Acute overexposure to this gas mixture may cause the following health effects:

EYE CONTACT: Minor contact with this gas will cause tearing and irritation including swelling and redness, due to the presence of Hydrogen Bromide. Over-exposure to the eyes when this mixture has a higher level of Hydrogen Bromide has the potential to cause burns, or possibly blindness, if contact is prolonged. Release of a high-pressure gas may result in airborne objects.

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

INHALATION: This gas mixture can cause significant, adverse effects, due to the presence of Hydrogen Bromide, which is corrosive. Minor inhalation exposure of this gas mixture may cause irritation to the lungs, nose, throat and mucous membranes, resulting in coughing and breathing difficulty. In the event of prolonged inhalation overexposures, there is the potential for tissue damage. Overexposure by inhalation to this mixture when it contains a higher level of Hydrogen Bromide may result in pulmonary edema (an accumulation of fluid in the lungs), a potentially fatal condition. The symptoms associated with specific Hydrogen Bromide concentrations are as follows:

CONCENTRATION	SYMPTOM(s)
< 2 ppm	Odor Threshold
30 ppm	IDLH level determined by NIOSH.
< 35 ppm	Irritation of the eyes and mucous membranes, which can only be tolerated briefly.
> 35 ppm	Brief exposures in excess of 35 ppm will cause immediate irritation of the throat and respiratory system, and may result in pulmonary edema and laryngeal spasm.
1000-1300 ppm	Inhalation at this level for 30 minutes can cause severe damage to lungs and upper respiratory tract, requiring emergency treatment and hospitalization.
1300-2000 ppm	Exposure to concentrations in excess of 1300 ppm may cause laryngeal spasms, resulting in death.

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. Under some circumstances of overexposure, death may occur.

SKIN CONTACT: Depending on the concentration and duration of overexposure, skin contact may lead to severe burns or dermatitis (red, cracked, irritated skin).

OTHER HEALTH EFFECTS: Inhalation of mixtures containing levels of Hydrogen Bromide above 1000 ppm can cause destruction of mucous membranes and upper respiratory tract tissue, making resuscitation difficult. 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.

HMIS RATINGS: HEALTH HAZARD: = 3; FLAMMABILITY HAZARD: = 0; PHYSICAL HAZARD: = 1;

PPE: Level X (see Section 8, Exposure Controls/Personal protective Equipment)

ROUTES OF ENTRY, SYMPTOMS OF CHRONIC EXPOSURE:

ROUTE OF ENTRY: Inhalation

TARGET ORGANS: Respiratory System, Eyes, Skin

SYMPTOMS: Dermatitis may result from repeated skin contact with this gas mixture. Repeated overexposures by inhalation may result in erosion of tooth enamel. Repeated over-exposure to a mixture that contains Hydrogen Bromide can result in emphysema.

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

CARCINOGENICITY: The components of this gas mixture are not found on the IARC, FEDERAL OSHA Z LIST, NTP, CAL/OSHA, or Carcinogenicity lists and therefore are neither considered to be nor suspected to be cancer-causing agents by these agencies.

SECTION 4. FIRST AID MEASURES

EYE CONTACT: If this gas mixture contaminates the eyes, open victim's eyes while under gentle running water. Use sufficient force to open eyelids. Have victim "roll" eyes. Minimum flushing is for 15 minutes. Administer anesthetic eye drops after one minute of flushing if victim suffers from spasms to the eyes, in order to facilitate irrigation. In the event of a severe overexposure, victim should consult with an ophthalmologist. In the event of mechanical injury, cover eye with bandage and seek appropriate medical attention.

SECTION 4. FIRST AID MEASURES (Continued)

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. In the event of severe, immediate effects or delayed symptoms which develops after exposure, victim must seek appropriate medical attention.

SKIN CONTACT: If this gas mixture contaminates the skin, immediately begin decontamination with running water. Minimum flushing is for 15 minutes. Remove exposed or contaminated clothing, taking care not to contaminate eyes. Victim should seek appropriate medical attention if symptoms persist. 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.

SECTION 5. FIRE FIGHTING MEASURES

FLASH POINT: Not Applicable

AUTOIGNITION: Not Applicable

FLAMMABLE RANGE: Not Applicable

NFPA RATINGS:

HEALTH: = 3 FLAMMABILITY: = 0

REACTIVITY: = 1 SPECIAL: None

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

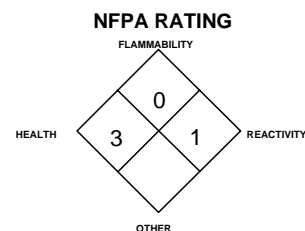
SPECIAL FIRE-FIGHTING PROCEDURES: Non-flammable. Use extinguishing media appropriate for surrounding fire. In the event of fire, cool containers of this product with water spray to prevent failure.

UNUSUAL FIRE AND EXPLOSION HAZARDS: This gas mixture can mildly to severely irritate the skin, eyes, and other contaminated tissues depending on the level of Hydrogen Bromide in the mixture; subsequently, it can present a significant health hazard to firefighters. Exposure to high heat, as in a fire situation, can cause the cylinder to rupture.

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. Hydrogen Bromide will decompose into hydrogen and bromine.



See Section 16 for Definition of Ratings

SECTION 6. ACCIDENTAL RELEASE MEASURES

FIRST RESPONSE: In the event of a leak of this product, operator should close the gas source, if possible to do so safely. Evacuate immediate area. In the event of a significant release from a single cylinder, the North American Response Guidebook (ID #1048, Guide # 125) recommends 200 feet initial isolation from release for pure Hydrogen Bromide.

TRAINED RESPONSE TEAM: Personal Protective Equipment should include appropriate body protection for Hydrogen Bromide exposure, gloves, and Self-Contained Breathing Apparatus (SCBA). A water fog or mist can be used to control the vapor cloud resulting from the release. Do not direct a water spray directly at the source of release. Allow the gas, which is lighter than air, to dissipate. Any supplemental ventilation should be explosion-proof equipment.

ENTRY TO AREA: Monitor the surrounding area for toxic gas level. Hydrogen Bromide levels should be below the limits shown in Section 2 (Composition and Information on Ingredients), before personnel are allowed in the area without Self-Contained Breathing Apparatus.

REPAIR/FOLLOW-UP: If leak was in user's gas handling equipment or system, ensure cylinder is closed, system is purged and all high pressure is vented before attempting repairs. If leak was from the cylinder, cylinder valve or the valve pressure relief device (PRD), contact your supplier. Do not flush contaminated water down the sewer systems. Flush into a retention area, and neutralize with soda ash or limestone. Dilute with large amounts of water, then dispose of according to local regulations.

THIS IS A POTENTIALLY TOXIC, CORROSIVE GAS. Protection of all personnel and the area must be maintained. All responders must be adequately protected from exposure.

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.

MATERIALS OF CONSTRUCTION: The major physical hazard associated with this mixture is that Hydrogen Bromide becomes extremely corrosive when it comes into contact with moisture. Although Hydrogen Bromide is normally inert to metals under normal conditions of temperature and pressure, Hydrogen Bromide becomes extremely corrosive when it comes into contact with moisture, forming Hydrobromic acid. Hydrobromic acid will corrode gas handling systems and other metal structures, possibly causing leaks and damage to expensive equipment. Hydrobromic acid will react with most metals to liberate flammable hydrogen gas, which may pose a fire hazard in the event of an emergency. When used at higher than normal pressures, use of extra heavy black iron, high-pressure steel, monel or aluminum-iron-bronze piping and/or valves should be used. Galvanized piping or brass or bronze fittings should not be used, due to the potential for corrosion and subsequent leaks in system.

HANDLING: This mixture can be dangerous and should only be handled by trained personnel. Wearing contact lenses is not recommended when handling this gas mixture. Spectra Gases, Inc., strongly recommends that this gas mixture only be handled in areas with extensive venting capabilities, preferably a gas handling cabinet. Eye wash stations/safety showers should be near areas where this product is used or stored. All work operations should be monitored in such a way that emergency personnel can be immediately contacted in the event of a release. Monitoring may be considered for areas in which this gas mixture is used. Detection of Hydrogen Bromide odor should trigger immediate response and corrective action. Contaminated clothing should be removed and laundered separately before reuse.

Before using this gas, meticulous leak checking using inert gas is strongly recommended, particularly after new connections are made. 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.

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. The failure of a valve can result in violent release of the pressurized gas, creating a severe mechanical injury hazard.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Purge gas handling equipment with inert gas and relieve pressure before attempting repairs.

SPECIAL PRECAUTIONS: 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. Spectra Gases, Inc. recommends that cylinders in use be secured within a ventilated enclosure such as a gas cabinet. Employee exposure should be monitored and reduced to the lowest practical levels using ventilation or other appropriate engineering controls.

SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION (Continued)

RESPIRATORY PROTECTION: Maintain exposure levels of Hydrogen Bromide below the levels listed in Section 2 (Composition / Information on Ingredients). Use supplied air respiratory protection if Hydrogen Bromide levels exceed exposure limits, 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 EN149, and EC member states. The following guidelines, based NIOSH respiratory protection recommendations, are for Hydrogen Bromide.

**CONCENTRATION
of HYDROGEN BROMIDE**

RESPIRATORY EQUIPMENT

Up to 30 ppm

Any supplied-air respirator (SAR) operated in a continuous-flow mode, or any powered, air-purifying respirator with acid gas cartridge(s), or any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister, or any self-contained breathing apparatus with a full facepiece, or any supplied-air respirator with a full facepiece.

Emergency or Planned

Entry into Unknown Concentration or IDLH Conditions Any Self-Contained Breathing Apparatus (SCBA) that has a full facepiece and is operated in a pressure-demand or other positive-pressure, or any Supplied-Air Respirator (SAR) that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA 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 acid gas canister, or any appropriate escape-type, self-contained breathing apparatus

The IDLH concentration for Hydrogen Bromide is 30 ppm.

EYE PROTECTION: Use approved safety goggles or safety glasses, with side-shields, and faceshield, as described in OSHA 29 CFR 1910.133 or by the European Standard EN166. Eye wash stations/safety showers should be available.

SKIN PROTECTION: Work (such as leather) gloves are recommended when handling cylinders of this gas. Use appropriate gloves for spill response. Wear Neoprene Rubber gloves for industrial use. If necessary, refer to U.S. OSHA 29 CFR 1910.138, and appropriate Standards of the EC and Canada for further information.

OTHER PROTECTIVE EQUIPMENT: Use body protection appropriate for task. In some circumstances of use, chemically-resistant clothing appropriate for use with corrosive materials may be appropriate. Steel-toe safety shoes are recommended when handling cylinders. If a hazard of injury to the feet exists due to falling objects, rolling objects, where objects may pierce the soles of the feet or where employee's feet may be exposed to electrical hazards, use foot protection, as described in U.S. OSHA 29 CFR 1910.136.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

The following information is for Argon, which may be a component of this mixture:

- MOLECULAR WEIGHT:** 39.95
- GAS DENSITY @ 21.1°C (70°F):** 0.103 lb./ft³ (1.650 kg/m³)
- BOILING POINT @ 1 atm:** -185.9°C (-302.6°F)
- FREEZING/MELTING POINT @ 1 atm:** -189.2°C (-308.6°F)
- SPECIFIC GRAVITY (air = 1) @ 21.1°C (70°F):** 1.38
- SOLUBILITY IN WATER vol/vol at 0°C (32°F) and 1 atm:** 0.056
- SPECIFIC VOLUME @ 21.1°C (70°F):** 9.71 lb/ft³ (0.606 m³/kg)
- CRITICAL PRESSURE:** 711.5 psia (4905 kPa abs)
- COEFFICIENT WATER/OIL DISTRIBUTION:** Not applicable.

The following information is for Krypton, which may be a component of this mixture:

- MOLECULAR WEIGHT:** 83.80
- GAS DENSITY @ 21.1°C (70°F):** 0.2172 lbs ft³ (3.479 kg/m³)
- BOILING POINT @ 1 atm:** -153.4°C (-244.0°F)
- FREEZING/MELTING POINT @ 1 atm:** -157°C (-251°F)
- SPECIFIC GRAVITY (air = 1) @ 21.1°C (70°F):** 2.899
- SOLUBILITY IN WATER vol/vol at 20°C (68°F) and 1 atm:** 0.0594
- SPECIFIC VOLUME @ 21.1°C (70°F):** 4.604 lb/ft³ (0.287 m³/kg)
- CRITICAL PRESSURE:** 798.0 psia (5502 kPa abs)
- COEFFICIENT WATER/OIL DISTRIBUTION:** Not applicable.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES (Continued)

The following information is for Nitrogen, which may be a component of this mixture.

MOLECULAR WEIGHT: 28.01
GAS DENSITY @ 21.1°C (70°F): 0.072 lb./ft³ (1.153 kg/m³)
BOILING POINT @ 1 atm: -195.8°C (-320.4°F)
FREEZING/MELTING POINT @ 1 atm: -210°C (-345.8°F)
SPECIFIC GRAVITY (air = 1) @ 21.1°C (70°F): 0.906
SOLUBILITY IN WATER vol/vol at 0°C (32°F) and 1 atm: 0.023
SPECIFIC VOLUME @ 21.1°C (70°F): 13.8 lb/ft³ (0.867 m³/kg)
CRITICAL PRESSURE: 492.9 psia (3399 kPa abs)
COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.

The following information is for Xenon, which may be a component of this mixture:

MOLECULAR WEIGHT: 131.3
GAS DENSITY @ 21.1°C (70°F): 0.3416 lbs ft³ (5.472 kg/m³)
BOILING POINT @ 1 atm: -108.2°C (-162.6°F)
FREEZING/MELTING POINT @ 1 atm: -168°F (-111°C)
SPECIFIC GRAVITY (air = 1) @ 21.1°C (70°F): 4.560
SOLUBILITY IN WATER vol/vol at 20°C (68°F) and 1 atm: 0.108
SPECIFIC VOLUME @ 21.1°C (70°F): 2.927 lb/ft³ (0.183 m³/kg)
CRITICAL PRESSURE: 847.0 psia (5840 kPa abs)
COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.
ODOR THRESHOLD: Xenon is odorless.

The following information is for Hydrogen Bromide, which may be a significant component of this mixture:

MOLECULAR WEIGHT: 80.912
GAS DENSITY @ 21.1°C (70°F): 0.23 lb./ft³ (3.636 kg/m³)
BOILING POINT @ 1 atm: -66.9°C (-88.1°F)
FREEZING/MELTING POINT @ 1 atm: -86.9°C (-124.4°F)
SPECIFIC GRAVITY (air = 1) @ 25°C (77°F): 2.812
SOLUBILITY IN WATER vol/vol at 20°C (68°F) and 1 atm: 0.49
SPECIFIC VOLUME @ 25°C (77°F): 4.76 lb/ft³ (0.297 m³/kg)
CRITICAL PRESSURE: 1234 psia (8508 kPa abs)
VAPOR PRESSURE @ 93°C (33.9°F): 441 psia (3039 kPa)
ODOR THRESHOLD: 2-5 ppm (detection)

Information for gas mixture:

APPEARANCE, ODOR AND STATE: Colorless gas with sharp, suffocating odor.

WARNING PROPERTIES FOR THIS GAS MIXTURE: The odor is a distinctive warning property associated with this gas mixture.

SECTION 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Argon, Krypton, Nitrogen, and Xenon are inert and stable. Oxygen is stable under condition of normal temperature and pressure. Hydrogen Bromide will fume to form hydrobromic acid mist in air, and is unstable over prolonged periods of time.

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

MATERIALS WITH WHICH GAS MIXTURE IS INCOMPATIBLE: The components of this gas mixture Argon, Krypton, Nitrogen and Xenon are inert. The Hydrogen Bromide component, in the presence of moisture, will rapidly corrode most metals except silver, platinum, and tantalum. A violent reaction may occur with Hydrogen Bromide and strong caustics and strong oxidizers, fluorine, ferric oxide, ammonia, and ozone. Hydrogen Bromide is incompatible with halogens. An explosive reaction can occur with 1,2-Diaminoethaneminediperoxochromium. Oxygen is incompatible with chlorinated hydrocarbons, hydrazine, reduced boron compounds, ethers, phosphine, phosphorous tribromide, phosphorous trioxide, tetrafluorethylene, and compounds which readily form peroxides.

REACTIVITY:

A) HAZARDOUS DECOMPOSITION PRODUCTS: Hydrogen Bromide can undergo slow decomposition to Hydrogen plus Bromine when in contact with catalytically active metal surfaces, such as the interior of cylinders. Never inventory more than a six month supply of the product. In addition, Hydrogen Bromide will react with water to form acidic solutions.

B) HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: There are no specific toxicology data for Argon, Krypton, Nitrogen and Xenon. These gases are simple asphyxiants, which act to displace oxygen in the environment. There are data for the Oxygen component, however they are only applicable to persons in a hyperbaric environment, which not be applicable to this gas mixture. The following toxicological data are available for Hydrogen Bromide.

HYDROGEN BROMIDE: LC₅₀ (inhalation-rat) = 2858 ppm for 60 minutes. LC₅₀ (inhalation-mouse) = 814 ppm for 60 minutes
DOT LC₅₀ (inhalation) 2860 LD₅₀ (Intraperitoneal-rat) = 76 mg/kg

CARCINOGENICITY: No component of this product has been found to be carcinogenic.

IRRITANCY OF PRODUCT: This gas mixture may be mildly to severely irritating to contaminated tissue, depending on the duration of contact and the level of Hydrogen Bromide present in the mixture.

SENSITIZATION OF PRODUCT: The components of this gas mixture are not 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: This gas mixture is not expected to cause mutagenic effects in humans.

Embryotoxicity: This gas mixture is not expected to cause embryotoxic effects in humans.

Teratogenicity: This gas mixture is not expected to cause teratogenic effects in humans.

Reproductive Toxicity: This gas mixture is not expected to cause adverse reproductive effects in humans. Hydrogen Bromide has been reported to cause teratogenic effects in research animals at very high doses, but not 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, Biological Exposure Indices (BEIs) are not applicable for the components of this gas mixture.

SECTION 12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: Argon, Krypton, Nitrogen, Oxygen and Xenon occur naturally in the atmosphere and are stable. Hydrogen Bromide will fume in air to form hydrobromic acid, which will slowly biodegrade to other organic compounds.

EFFECT OF MATERIAL ON PLANTS or ANIMALS: Due to the potentially corrosive and toxic nature of this gas mixture, animals exposed to this product will experience tissue damage, burns, and may be killed. Plants contaminated with this product may be adversely affected or destroyed.

EFFECT OF CHEMICAL ON AQUATIC LIFE: The Hydrogen Bromide component of this gas mixture, is very soluble in water, and even low concentrations of Hydrogen Bromide in water are detrimental to aquatic life. If a release this product occurs near a river or other body of water, the release has the potential to kill fish and other aquatic life. The following aquatic toxicity data are available for Hydrobromic Acid, which would be formed upon contact with water:

TLm (species not identified) 96 hours = 10-100 ppm

MOBILITY: Argon, Krypton, Nitrogen, and Xenon are inert and do not present a hazard of mobility. Hydrogen Bromide will fume to hydrobromic acid, which, especially in the presence of water, will be mobile in soil (the rate of infiltration will depend on the amount of water/moisture present in the soil).

PERSISTENCE AND BIODEGRADABILITY: Persistence: Argon, Krypton, Nitrogen, Oxygen and Xenon are natural elements and present no hazard of persistence. If spilled in soil, Hydrogen Bromide will convert to hydrobromic acid, which, as it moves through the soil, will dissolve soil materials, particularly if of carbonate base. The acid will be somewhat neutralized, but is expected to transport to the ground water table. Biodegradation: Hydrogen Bromide will biodegrade.

POTENTIAL TO BIOACCUMULATE: No data currently available.

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 unused product. Return used 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: Small quantities of this gas mixture may be disposed of by bubbling it through a 15% solution of sodium hydroxide. A trap should be used to prevent hazardous backflow. Neutralization should only be done by appropriately trained and experienced personnel. Disposal 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., (Hydrogen Bromide, Argon, Oxygen) **or**
or (Hydrogen Bromide, Oxygen, Krypton)
or (Hydrogen Bromide, Oxygen, Nitrogen)
or (Hydrogen Bromide, Oxygen, 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. It is not recommended that cylinder are transported in a 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 considered 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., (Hydrogen Bromide, Argon, Oxygen) **or**
or (Hydrogen Bromide, Oxygen, Krypton)
or (Hydrogen Bromide, Oxygen, Nitrogen)
or (Hydrogen Bromide, Oxygen, Xenon)

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

UN IDENTIFICATION NUMBER: UN 1956

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

PLACARD (When required): Non-Flammable Gas

SPECIAL PROVISIONS: None

EXPLOSIVE LIMIT & LIMITED QUANTITY INDEX: 0.12

ERAP INDEX: None

PASSENGER CARRYING SHIP INDEX: None

PASSENGER CARRYING ROAD OR RAIL VEHICLE INDEX: 75

INTERNATIONAL AIR TRANSPORT ASSOCIATION SHIPPING INFORMATION (IATA):

IATA DESIGNATION: This gas mixture is considered as dangerous goods, per the International Air Transport Association.

PROPER SHIPPING NAME: Compressed gas, n.o.s., (Hydrogen Bromide, Argon, Oxygen) **or**
or (Hydrogen Bromide, Oxygen, Krypton)
or (Hydrogen Bromide, Oxygen, Nitrogen)
or (Hydrogen Bromide, Oxygen, Xenon)

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

UN IDENTIFICATION NUMBER: UN 1956

HAZARD LABEL(S) REQUIRED: Non-Flammable Gas

The following Packaging Information is applicable to this product:

PASSENGER AND CARGO AIRCRAFT				CARGO AIRCRAFT ONLY	
Limited Quantity		Packing Instruction	Max. Qty per Pkg	Packing Instruction	Max. Qty per Pkg
Packing Instruction	Max. Qty per Pkg				
//////	//////	200	75 kg	200	150 kg

SECTION 14. TRANSPORT INFORMATION (Continued)

INTERNATIONAL MARITIME ORGANIZATION SHIPPING INFORMATION (IMO):

IMO DESIGNATION: This gas mixture is considered as dangerous goods, per the International Maritime Organization.

PROPER SHIPPING NAME: Compressed gas, n.o.s., (Hydrogen Bromide, Argon, Oxygen) **or**
or (Hydrogen Bromide, Oxygen, Krypton)
or (Hydrogen Bromide, Oxygen, Nitrogen)
or (Hydrogen Bromide, Oxygen, Xenon)

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

UN IDENTIFICATION NUMBER: UN 1956

HAZARD LABEL(S) REQUIRED: Non-Flammable Gas

STOWAGE CATEGORY: Category A

EmS: 2-04

MARINE POLLUTANT: The components of this gas mixture are not designated by the IMO to be Marine Pollutants.

EUROPEAN SHIPPING INFORMATION:

EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS

BY ROAD (ADR): This gas mixture is considered by the Economic Commission for Europe to be dangerous goods. Additional information is as follows:

UN NO.: 1956

NAME & DESCRIPTION: Compressed gas, n.o.s., (Hydrogen Bromide, Argon, Oxygen) **or r**
or (Hydrogen Bromide, Oxygen, Krypton)
or (Hydrogen Bromide, Oxygen, Nitrogen)
or (Hydrogen Bromide, Oxygen, Xenon)

CLASS: 2

CLASSIFICATION CODE: 1A

PACKING GROUP: None

LABELS: 2.2

SPECIAL PROVISIONS: 274, 567

LIMITED QUANTITIES: LQ1

PACKING INSTRUCTIONS: P200

HAZARDOUS IDENTIFICATION NUMBER: 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): Not applicable.

SARA TITLE III: Superfund Amendment and Reauthorization Act

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

Extremely Hazardous Substances: No component of this gas mixture is listed.

Threshold Planning Quantity (TPQ): There are no specific Threshold Planning Quantity levels for the components of this product. The default Federal MSDS submission and inventory requirement filing threshold of 10,000 lbs (4,540 kg) therefore applies, per 40 CFR 370.20.

Reportable Quantity (RQ): Not applicable.

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)

No component of this gas mixture require reporting under Section 313.

CLEAN AIR ACT:

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

Threshold Planning Quantity (TPQ): Not applicable.

TSCA: Toxic Substances Control Act

All components of this gas mixture are listed on the TSCA Inventory.

SECTION 15. REGULATORY INFORMATION (Continued)

U.S. FEDERAL REGULATIONS (continued):

OSHA - OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION:

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

Threshold Planning Quantity (TPQ): Hydrogen Bromide = 5000 lb. (2270 kg)

U.S. STATE REGULATORY INFORMATION:

CALIFORNIA PROPOSITION 65: No component of this gas mixture is a listed substance which the State of California requires warning under this statute.

The components of this gas mixture are covered under the following specific State regulations (more specific regulations exist in some States):

Alaska - Designated Toxic and Hazardous Substances: Argon, Hydrogen Bromide.

California - Permissible Exposure Limits for Chemical Contaminants: Argon, Hydrogen Bromide, Nitrogen.

Florida - Substance List: Argon, Hydrogen Bromide, Nitrogen, Oxygen.

Illinois - Toxic Substance List: Argon, Hydrogen Bromide.

Kansas - Section 302/313 List: Hydrogen Bromide

Massachusetts - Substance List: Argon, Hydrogen Bromide, Nitrogen, Oxygen.

Michigan - Critical Materials Register: No.

Minnesota - List of Hazardous Substances: Argon, Hydrogen Bromide.

Missouri - Employer Information/Toxic Substance List: Argon, Hydrogen Bromide.

New Jersey - Right to Know Hazardous Substance List: Argon, Hydrogen Bromide, Krypton, Nitrogen, Oxygen.

North Dakota - List of Hazardous Chemicals, Reportable Quantities: No.

Pennsylvania - Hazardous Substance List: Argon, Hydrogen Bromide, Nitrogen, Oxygen.

Rhode Island - Hazardous Substance List: Argon, Hydrogen Bromide, Nitrogen, Oxygen.

Texas - Hazardous Substance List: Hydrogen Bromide.

West Virginia - Hazardous Substance List: Hydrogen Bromide.

Wisconsin - Toxic and Hazardous Substances: Hydrogen Bromide.

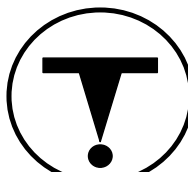
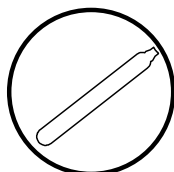
CANADIAN FEDERAL REGULATIONS:

CANADIAN DSL INVENTORY STATUS: All components of this gas mixture are listed on the Canadian DSL Inventory.

OTHER CANADIAN REGULATIONS: This gas mixture would be categorized as a Controlled Product, Hazard Classes A, and D2, as per the Controlled Product Regulations. The components of this gas mixture are not on the CEPA Priorities Substances Lists.

CANADIAN WHMIS SYMBOLS: **Class A:** Compressed Gas

Class D2: Toxic Material/Materials Causing Other Toxic Effects



EUROPEAN ECONOMIC COMMUNITY REGULATIONS:

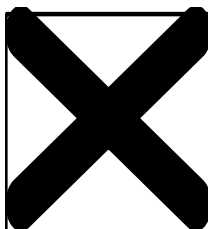
EC LABELING AND CLASSIFICATION: This product meets the following definition, per the European Community Council Directive 67/548/EEC.

EC CLASSIFICATION: Irritating: [Xi]

EC RISK PHRASES: Causes severe burns. Irritating to the respiratory system. [R: 35, 37]

EC SAFETY PHRASES: 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.* Keep container tightly closed and in a well ventilated place. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable protective clothing, gloves and eye/face protection. In case of accident or if you feel unwell, seek medical advice immediately (show label where possible). [S:(1/2)*, 7/9, 26, 36/37/39, 45]

EUROPEAN COMMUNITY ANNEX II HAZARD SYMBOLS:



SECTION 15. REGULATORY INFORMATION (Continued)

EUROPEAN COMMUNITY INFORMATION FOR COMPONENTS:

ARGON:

EC EINECS/ELINCS NUMBER: 231-147-0

EC 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.

HYDROGEN BROMIDE:

EC EINECS/ELINCS NUMBER: 233-113-0

EC LABELING AND CLASSIFICATION: Hydrogen Bromide is been classified as follows, per the European Community Council Directive 67/548/EEC.

EC CLASSIFICATION: Corrosive: [C]; Irritating [Xi]

EC RISK PHRASES: Causes severe burns. Irritating to the respiratory system. [R: 35, 37]

EC SAFETY PHRASES: 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.* Keep container tightly closed and in a well ventilated place. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable protective clothing, gloves and eye/face protection. In case of accident or if you feel unwell, seek medical advice immediately (show label where possible). [S:(1/2)*, 7/9, 26, 36/37/39, 45]

KRYPTON:

EC EINECS/ELINCS NUMBER: 231-098-5

EC 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.

NITROGEN:

EC EINECS/ELINCS NUMBER: 231-783-9

EC 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.

OXYGEN:

EC EINECS/ELINCS NUMBER: 231-956-9

EC CLASSIFICATION: [O]: Oxidizing.

RISK PHRASES: [R: 8]: Contact with combustible material may cause fire..

EC CLASSIFICATION: [S: 2½-]: 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: 17]: Keep away from combustible material.

XENON:

EC EINECS/ELINCS NUMBER: 231-172-7

EC 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.

Further information about compressed gases can be found in the following pamphlets published by: Compressed Gas Association Inc. (CGA), 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202-4102. Telephone: (703) 412-0900.

- P-1 "Safe Handling of Compressed Gases in Containers"
- AV-1 "Safe Handling and Storage of Compressed Gases"
- "Handbook of Compressed Gases"

PREPARED BY: CHEMICAL SAFETY ASSOCIATES, Inc.
PO Box 3519, La Mesa, CA 91944
619/670-0609

DEFINITIONS OF TERMS

A large number of abbreviations and acronyms appear on a MSDS. Some of these, which are commonly used, include the following:

CAS #: This is the Chemical Abstract Service Number that uniquely identifies each constituent.

EXPOSURE LIMITS IN AIR:

CEILING LEVEL: The concentration that shall not be exceeded during any part of the working exposure.

LOQ: Limit of Quantitation.

MAK: Federal Republic of Germany Maximum Concentration Values in the workplace.

NE: Not Established. When no exposure guidelines are established, an entry of NE is made for reference.

NIC: Notice of Intended Change.

NIOSH CEILING: The exposure that shall not be exceeded during any part of the workday. If instantaneous monitoring is not feasible, the ceiling shall be assumed as a 15-minute TWA exposure (unless otherwise specified) that shall not be exceeded at any time during a workday.

NIOSH RELS: NIOSH's Recommended Exposure Limits.

PEL-Permissible Exposure Limit: OSHA's Permissible Exposure Limits. This exposure value means exactly the same as a TLV, except that it is enforceable by OSHA. The OSHA Permissible Exposure Limits are based in the 1989 PELs and the June, 1993 Air Contaminants Rule (Federal Register; 58: 35338-35351 and 58: 40191). Both the current PELs and the vacated PELs are indicated. The phrase, "Vacated 1989 PEL," is placed next to the PEL that was vacated by Court Order.

SKIN: Used when there is a danger of cutaneous absorption.

STEL-Short Term Exposure Limit: Short Term Exposure Limit, usually a 15-minute time-weighted average (TWA) exposure that should not be exceeded at any time during a workday, even if the 8-hr TWA is within the TLV-TWA, PEL-TWA or REL-TWA.

TLV-Threshold Limit Value: An airborne concentration of a substance that represents conditions under which it is generally believed that nearly all workers may be repeatedly exposed without adverse effect. The duration must be considered, including the 8-hour.

TWA-Time Weighted Average: Time Weighted Average exposure concentration for a conventional 8-hr (TLV, PEL) or up to a 10-hr (REL) workday and a 40-hr workweek.

IDLH-Immediately Dangerous to Life and Health: This level represents a concentration from which one can escape within 30-minutes without suffering escape-preventing or permanent injury.

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS:

This rating system was developed by the National Paint and Coating Association and has been adopted by industry to identify the degree of chemical hazards.

HEALTH HAZARD:

0 (Minimal Hazard): No significant health risk, irritation of skin or eyes not anticipated. *Skin Irritation:* Essentially non-irritating. PII or Draize = "0". *Eye Irritation:* Essentially non-irritating, or minimal effects which clear in < 24 hours [e.g. mechanical irritation]. Draize = "0". *Oral Toxicity LD₅₀ Rat:* < 5000 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit:* < 2000 mg/kg. *Inhalation Toxicity 4-hrs LC₅₀ Rat:* < 20 mg/L.; **1 (Slight Hazard:** Minor reversible Injury may occur; slightly or mildly irritating. *Skin Irritation:* Slightly or mildly irritating. *Eye Irritation:* Slightly or mildly irritating. *Oral Toxicity LD₅₀ Rat:* > 500-5000 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit:* > 1000-2000 mg/kg. *Inhalation Toxicity LC₅₀ 4-hrs Rat:* > 2-20 mg/L.; **2 (Moderate Hazard:** Temporary or transitory injury may occur. *Skin Irritation:* Moderately irritating; primary irritant; sensitizer. PII or Draize > 0, < 5. *Eye Irritation:* Moderately to severely irritating and/or corrosive; reversible corneal opacity; corneal involvement or irritation clearing in 8-21 days. Draize > 0, ≤ 25. *Oral Toxicity LD₅₀ Rat:* > 50-500 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit:* > 200-1000 mg/kg. *Inhalation Toxicity LC₅₀ 4-hrs Rat:* > 0.5-2 mg/L.); **3 (Serious Hazard:** Major injury likely unless prompt action is taken and medical treatment is given; high level of toxicity; corrosive. *Skin Irritation:* Severely irritating and/or corrosive; may destroy dermal tissue, cause skin burns, dermal necrosis. PII or Draize > 5-8 with destruction of tissue. *Eye Irritation:* Corrosive, irreversible destruction of ocular tissue; corneal involvement or irritation persisting for more than 21 days. Draize > 80 with effects irreversible in 21 days. *Oral Toxicity LD₅₀ Rat:* > 1-50 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit:* > 20-200 mg/kg. *Inhalation Toxicity LC₅₀ 4-hrs Rat:* > 0.05-0.5 mg/L.);

HEALTH HAZARD (continued): **4 (Severe Hazard:** Life-threatening; major or permanent damage may result from single or repeated exposure. *Skin Irritation:* Not appropriate. Do not rate as a "4", based on skin irritation alone. *Eye Irritation:* Not appropriate. Do not rate as a "4", based on eye irritation alone. *Oral Toxicity LD₅₀ Rat:* ≤ 1 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit:* ≤ 20 mg/kg. *Inhalation Toxicity LC₅₀ 4-hrs Rat:* ≤ 0.05 mg/L).

FLAMMABILITY HAZARD:

0 (Minimal Hazard-Materials that will not burn in air when exposure to a temperature of 815.5°C [1500°F] for a period of 5 minutes.); **1 (Slight Hazard-**Materials that must be pre-heated before ignition can occur. Material require considerable pre-heating, under all ambient temperature conditions before ignition and combustion can occur, Including: Materials that will burn in air when exposed to a temperature of 815.5°C (1500°F) for a period of 5 minutes or less; Liquids, solids and semisolids having a flash point at or above 93.3°C [200°F] (e.g. OSHA Class IIIB, or; Most ordinary combustible materials [e.g. wood, paper, etc.]; **2 (Moderate Hazard-**Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not, under normal conditions, form hazardous atmospheres in air, but under high ambient temperatures or moderate heating may release vapor in sufficient quantities to produce hazardous atmospheres in air, Including: Liquids having a flash-point at or above 37.8°C [100°F]; Solid materials in the form of course dusts that may burn rapidly but that generally do not form explosive atmospheres; Solid materials in a fibrous or shredded form that may burn rapidly and create flash fire hazards (e.g. cotton, sisal, hemp; Solids and semisolids that readily give off flammable vapors.); **3 (Serious Hazard-** Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials in this degree produce hazardous atmospheres with air under almost all ambient temperatures, or, unaffected by ambient temperature, are readily ignited under almost all conditions, including: Liquids having a flash point below 22.8°C [73°F] and having a boiling point at or above 38°C [100°F] and below 37.8°C [100°F] [e.g. OSHA Class IB and IC]; Materials that on account of their physical form or environmental conditions can form explosive mixtures with air and are readily dispersed in air [e.g., dusts of combustible solids, mists or droplets of flammable liquids]; Materials that burn extremely rapidly, usually by reason of self-contained oxygen [e.g. dry nitrocellulose and many organic peroxides];

4 (Severe Hazard-Materials that will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or that are readily dispersed in air, and which will burn readily, including: Flammable gases; Flammable cryogenic materials; Any liquid or gaseous material that is liquid while under pressure and has a flash point below 22.8°C [73°F] and a boiling point below 37.8°C [100°F] [e.g. OSHA Class IA; Material that ignite spontaneously when exposed to air at a temperature of 54.4°C [130°F] or below [e.g. pyrophoric]).

PHYSICAL HAZARD:

0 (Water Reactivity: Materials that do not react with water. *Organic Peroxides:* Materials that are normally stable, even under fire conditions and will not react with water. *Explosives:* Substances that are Non-Explosive. *Unstable Compressed Gases:* No Rating. *Pyrophorics:* No Rating. *Oxidizers:* No "0" rating allowed. *Unstable Reactives:* Substances that will not polymerize, decompose, condense or self-react.); **1 (Water Reactivity:** Materials that change or decompose upon exposure to moisture. *Organic Peroxides:* Materials that are normally stable, but can become unstable at high temperatures and pressures. These materials may react with water, but will not release energy. *Explosives:* Division 1.5 & 1.6 substances that are very insensitive explosives or that do not have a mass explosion hazard. *Compressed Gases:* Pressure below OSHA definition. *Pyrophorics:* No Rating. *Oxidizers:* Packaging Group III; *Solids:* any material that in either concentration tested, exhibits a mean burning time less than or equal to the mean burning time of a 3:7 potassium bromate/cellulose mixture and the criteria for Packing Group I and II are not met. *Liquids:* any material that exhibits a mean pressure rise time less than or equal to the pressure rise time of a 1:1 nitric acid (65%)/cellulose mixture and the criteria for Packing Group I and II are not met. *Unstable Reactives:* Substances that may decompose, condense or self-react, but only under conditions of high temperature and/or pressure and have little or no potential to cause significant heat generation or explosive hazard. Substances that readily undergo hazardous polymerization in the absence of inhibitors.);

(continued on following page)

< 57% Hydrogen Bromide, 0-5% Oxygen in Argon, Krypton, Nitrogen and/or Xenon
DEFINITIONS OF TERMS (Continued)

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS (continued):

PHYSICAL HAZARD (continued):

2 (Water Reactivity): Materials that may react violently with water.

Organic Peroxides: Materials that, in themselves, are normally unstable and will readily undergo violent chemical change, but will not detonate. These materials may also react violently with water. **Explosives:** Division 1.4 – Explosive substances where the explosive effect are largely confined to the package and no projection of fragments of appreciable size or range are expected. An external fire must not cause virtually instantaneous explosion of almost the entire contents of the package.

Compressed Gases: Pressurized and meet OSHA definition but < 514.7 psi absolute at 21.1°C (70°F) [500 psig]. **Pyrophorics:** No Rating.

Oxidizers: Packing Group II **Solids:** any material that, either in concentration tested, exhibits a mean burning time of less than or equal to the mean burning time of a 2:3 potassium bromate/cellulose mixture and the criteria for Packing Group I are not met. **Liquids:** any material that exhibits a mean pressure rise time less than or equal to the pressure rise of a 1:1 aqueous sodium chlorate solution (40%)/cellulose mixture and the criteria for Packing Group I are not met. **Unstable Reactives:** Substances that may polymerize, decompose, condense, or self-react at ambient temperature and/or pressure, but have a low potential for significant heat generation or explosion. Substances that readily form peroxides upon exposure to air or oxygen at room temperature);

3 (Water Reactivity): Materials that may form explosive reactions with water. **Organic Peroxides:** Materials that are capable of detonation or explosive reaction, but require a strong initiating source, or must be heated under confinement before initiation; or materials that react explosively with water. **Explosives:** Division 1.2 – Explosive substances that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but do not have a mass explosion hazard. **Compressed Gases:** Pressure \geq 514.7 psi absolute at 21.1°C (70°F) [500 psig]. **Pyrophorics:** No Rating. **Oxidizers:** Packing Group I

Solids: any material that, in either concentration tested, exhibits a mean burning time less than the mean burning time of a 3:2 potassium bromate/cellulose mixture. **Liquids:** Any material that spontaneously ignites when mixed with cellulose in a 1:1 ratio, or which exhibits a mean pressure rise time less than the pressure rise time of a 1:1 perchloric acid (50%)/cellulose mixture. **Unstable Reactives:** Substances that may polymerize, decompose, condense or self-react at ambient temperature and/or pressure and have a moderate potential to cause significant heat generation or explosion.);

4 (Water Reactivity): Materials that react explosively with water without requiring heat or confinement. **Organic Peroxides:** Materials that are readily capable of detonation or explosive decomposition at normal temperature and pressures. **Explosives:** Division 1.1 & 1.2-explosive substances that have a mass explosion hazard or have a projection hazard. A mass explosion is one that affects almost the entire load instantaneously.

Compressed Gases: No Rating. **Pyrophorics:** Add to the definition of Flammability "4". **Oxidizers:** No "4" rating. **Unstable Reactives:** Substances that may polymerize, decompose, condense or self-react at ambient temperature and/or pressure and have a high potential to cause significant heat generation or explosion.).

PPE Rating B: Hand and eye protection is required for routine chemical use. PPE Rating C: Hand, eye, and body protection may be required for routine chemical use.

NATIONAL FIRE PROTECTION ASSOCIATION HAZARD RATINGS:

HEALTH HAZARD: **0** (material that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials); **1** (materials that on exposure under fire conditions could cause irritation or minor residual injury); **2** (materials that on intense or continued exposure under fire conditions could cause temporary incapacitation or possible residual injury); **3** (materials that can on short exposure could cause serious temporary or residual injury); **4** (materials that under very short exposure could cause death or major residual injury).

FLAMMABILITY HAZARD AND REACTIVITY HAZARD: Refer to definitions for "Hazardous Materials Identification System".

FLAMMABILITY LIMITS IN AIR: Much of the information related to fire and explosion is derived from the National Fire Protection Association (NFPA). **Flash Point** - Minimum temperature at which a liquid gives off sufficient vapors to form an ignitable mixture with air. **Autoignition Temperature:** The minimum temperature required to initiate combustion in air with no other source of ignition. **LEL** - the lowest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source. **UEL** - the highest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source.

TOXICOLOGICAL INFORMATION:

Human and Animal Toxicology: Possible health hazards as derived from human data, animal studies, or from the results of studies with similar compounds are presented. Definitions of some terms used in this section are: **LD₅₀** - Lethal Dose (solids & liquids) which kills 50% of the exposed animals; **LC₅₀** - Lethal Concentration (gases) which kills 50% of the exposed animals; **ppm** concentration expressed in parts of material per million parts of air or water; **mg/m³** concentration expressed in weight of substance per volume of air; **mg/kg** quantity of material, by weight, administered to a test subject, based on their body weight in kg. Other measures of toxicity include **TDLo**, the lowest dose to cause a symptom and **TCLo** the lowest concentration to cause a symptom; **TDo**, **LDLo**, and **LDo**, or **TC**, **TCo**, **LCLo**, and **LCo**, the lowest dose (or concentration) to cause lethal or toxic effects. **Cancer Information:** The sources are: **IARC** - the International Agency for Research on Cancer; **NTP** - the National Toxicology Program, **RTECS** - the Registry of Toxic Effects of Chemical Substances, **OSHA** and **CAL/OSHA**. IARC and NTP rate chemicals on a scale of decreasing potential to cause human cancer with rankings from 1 to 4. Subrankings (2A, 2B, etc.) are also used. **Other Information:** **BEI** - ACGIH Biological Exposure Indices, represent the levels of determinants which are most likely to be observed in specimens collected from a healthy worker who has been exposed to chemicals to the same extent as a worker with inhalation exposure to the TLV.

ECOLOGICAL INFORMATION:

EC is the effect concentration in water. **BCF** = Bioconcentration Factor, which is used to determine if a substance will concentrate in lifeforms which consume contaminated plant or animal matter. **TL_m** = median threshold limit; Coefficient of Oil/Water Distribution is represented by **log K_{ow}** or **log K_{oc}** and is used to assess a substance's behavior in the environment.

REGULATORY INFORMATION:

U.S. and CANADA:

ACGIH: American Conference of Governmental Industrial Hygienists, a professional association which establishes exposure limits.

This section explains the impact of various laws and regulations on the material. **EPA** is the U.S. Environmental Protection Agency. **NIOSH** is the National Institute of Occupational Safety and Health, which is the research arm of the U.S. Occupational Safety and Health Administration (**OSHA**). **WHMIS** is the Canadian Workplace Hazardous Materials Information System. **DOT** and **TC** are the U.S. Department of Transportation and the Transport Canada, respectively. Superfund Amendments and Reauthorization Act (**SARA**); the Canadian Domestic/Non-Domestic Substances List (**DSL/NDL**); the U.S. Toxic Substance Control Act (**TSCA**); Marine Pollutant status according to the **DOT**; the Comprehensive Environmental Response, Compensation, and Liability Act (**CERCLA** or **Superfund**); and various state regulations. This section also includes information on the precautionary warnings which appear on the material's package label. **OSHA** - U.S. Occupational Safety and Health Administration.

EUROPEAN and INTERNATIONAL:

The DFG: This is the Federal Republic of Germany's Occupation Health Agency, similar to the U.S. OSHA. **EC** is the European Community (formerly known as the **EEC**, European Economic Community). **EINECS:** This is the European Inventory of Now-Existing Chemical Substances. The **ARD** is the European Agreement Concerning the International Carriage of Dangerous Goods by Road and the **RID** are the International Regulations Concerning the Carriage of Dangerous Goods by Rail. **AICS** is the Australian Inventory of Chemical Substances. **MITI** is the Japanese Minister of International Trade and Industry