



**MATHESON
TRI-GAS**

ask. . The Gas Professionals™

MATERIAL SAFETY DATA SHEET

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

1. PRODUCT IDENTIFICATION

CHEMICAL NAME; CLASS: ARSINE/HYDROGEN GAS MIXTURE

CHEMICAL FAMILY: Inorganic Flammable Gas Mixture

PRODUCT USE: Various

MANUFACTURER

MATHESON TRI-GAS, INC.

150 ALLEN ROAD
BASKING RIDGE, NJ 07920
USA

Phone: 908/991-9200

EMERGENCY PHONE: **CHEMTREC (U.S. DOMESTIC):** **1-800-424-9300**
 CHEMTREC INTERNATIONAL: **1-703-527-3887**
 CANUTEC (CANADA): **1-613-996-6666**

2. COMPOSITION and INFORMATION ON INGREDIENTS

(10,000 ppm = 1%)

CHEMICAL NAME	CAS #	mole %	EXPOSURE LIMITS IN AIR								
			ACGIH-TLVs		OSHA-STELs		NIOSH-RELs		NIOSH	OTHER	
			TWA ppm	STEL ppm	TWA ppm	STEL ppm	TWA ppm	STEL ppm			IDLH ppm
Arsine	7784-42-1	20 ppm- 3999 ppm	0.005	NE	0.05	NE	NE	NE	0.002 (ceiling) 15 min.	3	Carcinogen: NIOSH- Ca
Hydrogen	1333-74-0	Balance	There are no specific exposure limits for Hydrogen. Hydrogen is a simple asphyxiant (SA). Oxygen levels should be maintained above 19.5%.								

NOTE: All WHMIS required information is included. It is located in appropriate sections based on the ANSI Z400.1-1998 format. This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR.

See Section 16 for Definitions of Terms Used.

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: Product Description: This gas mixture is a colorless, flammable, harmful gas mixture with a garlicky odor (due to the presence of Arsine). **Health Hazards:** This gas mixture may cause significant, adverse health effects, because of the Arsine content, which can exceed exposure limits at the percentage in this mixture. The health effects associated with Arsine over-exposures are primarily related to the destruction of red blood cells. Exposure to even very small quantities can result in severe health effects and death. Arsine is a potential human carcinogen. Arsine has a garlicky odor and a low odor threshold; the odor of this product provides a good warning of a release of this gas mixture. **Flammability Hazards:** This gas mixture can form flammable mixtures in air and presents an extreme fire hazard when accidentally released. **Reactivity Hazards:** Pure Arsine is a strong reducing agent and can react vigorously with mild to strong oxidizing agents; this gas mixture can present the same hazard when Arsine reaches the higher level possible in the mixture. **Environmental Hazards:** Release of this gas mixture may cause harm to plants and animals in the environment. **Emergency Response Considerations:** Persons responding to releases of this gas mixture must protect themselves appropriately.

ARSINE/HYDROGEN (Balance) GAS MIXTURE MSDS

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EFFECTIVE DATE: May 10, 2007

MATHESON TRI-GAS

3. HAZARD IDENTIFICATION

SYMPTOMS OF OVER-EXPOSURE BY ROUTE OF EXPOSURE: The most significant route of over-exposure for this product is by inhalation.

INHALATION: This gas mixture can cause serious health effects, due to the presence of Arsine, which is extremely toxic at very low levels. Both chronic and acute over-exposures to this gas mixture are dangerous. Arsine is an extremely toxic gas and is one of the most potent hemolytic agents in current industrial use. Both chronic and acute over-exposures to this gas are dangerous. Development of symptoms may be delayed for up to 24 hours. Effects of an acute over-exposure are related to hemolysis (destruction of red blood cells), due to the reaction of the Arsine molecule with hemoglobin within red blood cells. Symptoms of such over-exposure may include the following: blood in urine, malaise, dizziness, headache, nausea, vomiting, abdominal pain, pain in the lower back (as a result of kidneys effects), liver dysfunction, heart damage, diarrhea, collapse, and coma. Hemolysis can continue for 96 hours after the over-exposure ends. In severe over-exposures, the mucous membranes, the rear side of the lips, and the flesh under the finger nails, may have a bluish discoloration. Pulmonary edema may occur following over-exposure. Arsine is moderately irritating to contaminated skin and eyes. Effects of chronic over-exposures can result in peripheral neuropathy (i.e. tingling and pain in the extremities), changes in pigmentation, cardiovascular problems, anemia, jaundice, and kidney damage. There is evidence that Arsine is potentially carcinogenic to humans. Specific effects, based on the concentration of Arsine, are presented below:

<u>ARSINE CONCENTRATION</u>	<u>HEALTH EFFECT</u>
3 ppm	The maximum concentration tolerated for several hours without serious symptoms.
6.25-15.5 ppm	Lethal within 30 -60 minutes.
250 - 500 ppm	Lethal within 30 minutes.
500 ppm or higher	Instantly lethal.

In addition, high concentrations of this gas mixture can cause an oxygen-deficient environment, especially if released in a poorly-ventilated area (e.g., an enclosed or confined space). 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. The effects associated with various levels of oxygen are as follows:

<u>CONCENTRATION OF OXYGEN</u>	<u>OBSERVED EFFECT</u>
12-16% Oxygen:	Breathing and pulse rate increase, muscular coordination slightly disturbed.
10-14% Oxygen:	Emotional upset, abnormal fatigue, disturbed respiration.
6-10% Oxygen:	Nausea, vomiting, collapse, or loss of consciousness.
Below 6%:	Convulsive movements, possible respiratory collapse, and death.

It must be noted that the effects of Arsine may be felt before oxygen-deficiency is a significant hazard.

CONTACT WITH SKIN or EYES: This gas mixture is moderately irritating to contaminated skin and eyes.

Contact with rapidly expanding gases (which are released under high pressure) may cause frostbite.

SKIN ABSORPTION: No component of this gas mixture presents a hazard of skin absorption.

HEALTH EFFECTS OR RISKS FROM EXPOSURE: Over-exposure to this gas mixture may cause the following health effects:

ACUTE: This gas mixture may cause severe health effects due to the presence of Arsine. Arsine is an extremely toxic gas; even brief over-exposures can result in severe health problems and may be fatal. Acute over-exposure can cause damage to the blood system. Pulmonary edema may also occur following over-exposure. In addition, acute overexposure to this gas mixture can cause an oxygen-deficient atmosphere.

CHRONIC: Effects of chronic over-exposure can result in peripheral neuropathy (i.e. tingling and pain in the extremities), changes in pigmentation, cardiovascular problems, anemia, jaundice, and kidney damage. There is evidence that Arsine is potentially carcinogenic to humans. Refer to Section 11 (Toxicology Information) for additional data.

3. HAZARD IDENTIFICATION (Continued)

TARGET ORGANS: ACUTE: Red blood cells and the blood system; circulatory system; nervous system; kidneys; liver. CHRONIC: Respiratory system, blood system, central nervous system, kidneys.

HMIS RATING: HEALTH = 3 FLAMMABILITY = 4 REACTIVITY = 1

Hazard Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

4. FIRST-AID MEASURES

RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO THIS GAS MIXTURE WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. At a minimum, Self-Contained Breathing Apparatus and Chemically-Resistant and Fire-Retardant Personal Protective equipment should be worn. Adequate fire protection must be provided during rescue situations.

GENERAL INFORMATION: Remove to fresh air, as quickly as possible. Only trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation, if necessary. **Seek medical attention immediately.**

SKIN EXPOSURE: If this gas mixture contaminates the skin, immediately begin decontamination with large quantities of running water. Minimum flushing is for 15 minutes. Remove exposed or contaminated clothing, taking care not to contaminate eyes. Victim must seek medical attention if any adverse reaction occurs. If release of this gas mixture has resulted in frostbite, warm affected area slowly. Seek immediate medical attention. **NOTE:** DECONTAMINATION WITH LIMITED VOLUMES OF WATER MAY CAUSE A SEVERE REACTION WHICH CAN BURN THE SKIN. DECONTAMINATION SHOULD BE DONE WITH COPIOUS AMOUNTS OF WATER AS QUICKLY AS POSSIBLE.

EYE EXPOSURE: If release of this gas mixture has affected the eyes, seek immediate medical attention.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Due to the presence of Arsine, acute or chronic respiratory conditions may be aggravated by over-exposure to this product. Additionally, blood, kidney, liver and cardiovascular conditions may also be aggravated (depending on the severity and duration of the over-exposure).

RECOMMENDATIONS TO PHYSICIANS: The health effects of Arsine over-exposure are related to the destruction of the blood's red cells. The oxygen transport capability will be diminished and there is a risk of kidney failure. Administer oxygen. Be observant for pulmonary edema. Exchange transfusion through heparinized femoral catheters is the standard treatment for severe Arsine over-exposures. Such transfusions may require 10-15 exchanges of whole blood. The plasma hemoglobin treatment is used as a guideline; attempts should be made to lower the concentration by 75-85% of the plasma hemoglobin and also return the hematocrit level to normal. Preservation of renal function is essential. Early intravenous Mannitol (25-50 g) is given if the patient is oliguric, and bicarbonate is used to alkalize the urine. Dialysis is a recommended treatment if renal failure supervenes. There is no specific treatment for Arsine poisoning; treatment with BAL (British Anti-Lewisite; Dimercaprol) is a suggested treatment (though its efficacy has been questioned). BAL will not prevent arsine-induced hemolysis, BAL may bind with circulating oxidation products of arsine after the red cells lyse, thus preventing acute and chronic toxicity to other organ systems. The dosage of BAL is 2.5 mg/kg body weight; this dosage should be repeated four to six times the first two days and reduced to twice daily for up to ten days.

5. FIRE-FIGHTING MEASURES

FLASH POINT: Not applicable for a flammable gas.

AUTOIGNITION TEMPERATURE: Not determined for mixture.

For Arsine: Not Available

For Hydrogen: 500-571°C (932-1059.8°F)

FLAMMABLE LIMITS (in air by volume, %): Not determined for mixture. The following are available for the flammable components:

HYDROGEN

Lower (LEL): 4.0%

Upper (UEL): 75.0%

ARSINE

Lower (LEL): 4.5-5.1%

Upper (UEL): 64.0-78%

5. FIRE-FIGHTING MEASURES (Continued)

FIRE EXTINGUISHING MATERIALS: Extinguish fires of this gas mixture by shutting-off the source of gas. Use water spray to cool fire-exposed structures and equipment. Do not use halogenated extinguishing agents. Cool fire-exposed cylinders with water spray, from the maximum distance possible. Carbon Dioxide and dry chemical can also be used to extinguish fires involving Arsine mixtures.

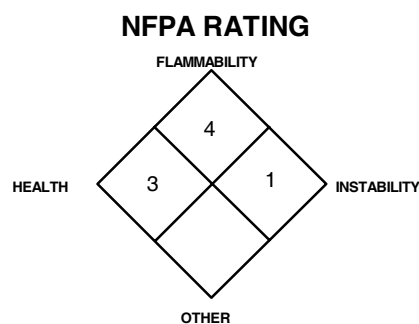
UNUSUAL FIRE AND EXPLOSION HAZARD: DANGER! This gas is extremely flammable and readily forms explosive mixtures with air over a very wide range. An extreme explosion hazard exists in areas in which the gas has been released, but the material has not yet ignited. **Hydrogen burns with an almost invisible blue flame. When this gas mixture contains a high level of Hydrogen, fire-fighters must be aware of this.** If released into a confined space, an extreme fire hazard exists.

Fires impinging (direct flame) on the outside surface of unprotected cylinders of this product can be very dangerous. Direct flame exposure on the cylinder wall can cause a catastrophic failure of the cylinder releasing the contents into a massive fireball and explosion. The resulting fire and explosion can result in severe equipment damage and personnel injury or death over a large area around the cylinder. Due to the presence of Arsine, this gas mixture presents a serious inhalation health hazard to firefighters. Thermal decomposition products of this gas mixture include a variety of arsenic compounds (predominately arsenic trioxide). Pure Arsine is a strong reducing agent and can react vigorously with mild to strong oxidizing agents; this gas mixture can present the same hazard when Arsine reaches the higher level possible in the mixture.

EXPLOSION SENSITIVITY TO MECHANICAL IMPACT: Not sensitive.

EXPLOSION SENSITIVITY TO STATIC DISCHARGE: Static discharge may cause this gas mixture to ignite explosively.

SPECIAL FIRE-FIGHTING PROCEDURES: Evacuate all personnel from danger area. Immediately cool cylinders with water spray from maximum distance, taking care to NOT extinguish flames if source of gas has not been stopped. Stop the leak and flow of gas before extinguishing fire. If release is still occurring, explosive re-ignition may occur. In event that fire is extinguished before the leak is stopped, attempt to increase ventilation to area to prevent formation of explosive air/gas mixtures. Incipient fire responders should wear eye protection. Structural fire fighters must wear Self-Contained Breathing Apparatus and full protective equipment. When cool, move cylinders from fire area if this can be done without risk to firefighters. Other information for pre-planning can be found in the American Petroleum Institute Publications 2510 and 1510A, and the North American Emergency Response Guidebook (Guide Number 115).



Hazard Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

6. ACCIDENTAL RELEASE MEASURES

LEAK RESPONSE: Evacuate immediate area. Uncontrolled releases should be responded to by trained personnel using pre-planned procedures. Eliminate any possible source of ignition and provide maximum explosion-proof ventilation. Proper protective equipment, including fire protection, should be used in the event of a significant release from a single cylinder. Use only non-sparking tools. Call CHEMTREC (1-800-424-9300) for emergency assistance. Or if in Canada, call CANUTEC (613-996-6666).

Attempt to close the main source valve prior to entering the area. If this does not stop the release (or if it is not possible to reach the valve), allow the gas to release in-place or remove it to a safe area and allow the gas to be released there. Protect personnel attempting to shut-off with water spray. Monitor the surrounding area for combustible gas levels and the level of Oxygen. The atmosphere must have not more than 10% of the LEL of each component gas (see Section 5, Fire-Fighting Measures) and at least 19.5 percent Oxygen before non-emergency personnel can be allowed in the area without Self-Contained Breathing Apparatus and fire protection.

7. HANDLING and USE

WORK PRACTICES AND HYGIENE PRACTICES

Do not eat or drink while handling chemicals.

Be aware of all potential exposure symptoms; exposures to a fatal oxygen-deficient atmosphere 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.

Workers who handle this gas mixture should wear protective clothing, as listed in Section 8 (Exposure Controls and Personal Protection).

If ventilation controls are not adequate to provide sufficient oxygen content, proper respiratory protection equipment should be provided and workers using such equipment should be carefully trained in its operation and limitations.

Precautions must always be taken to prevent suck-back of foreign materials into the cylinder by using a check-valve, or vacuum break, since suck-back may cause dangerous pressure changes within the cylinder.

All areas where this gas mixture is used should be monitored with very sensitive gas detection instruments, due to the presence of Arsine. Detection of concentrations below 50% of the TLV level of 0.05 ppm should trigger immediate response and corrective action. Detection of higher levels should initiate an alarm calling for evacuation of all personnel with the potential to be exposed. Due to the toxic effects of Arsine, cylinders of this product should always be placed in a properly designed and constructed gas cabinet. Double wall piping should be used to deliver gas to the point of use. Exhaust from the cabinet and from the annular space of the tubing should be monitored. Due to the extreme toxicity of Arsine, all contaminated clothing should be removed and placed in a sealed container for proper disposal.

STORAGE AND HANDLING PRACTICES:

Cylinders should be stored upright and be firmly secured to prevent falling or being knocked-over. Cylinders can be stored in the open, but in such cases, should be protected against extremes of weather and from the dampness of the ground to prevent rusting. Cylinders should be stored in dry, well-ventilated areas away from sources of heat or ignition. Do not allow the area where cylinders are stored to exceed 52°C (125°F).

Cylinders should be separated from oxygen cylinders, or other oxidizers, by a minimum distance of 20 ft., or by a barrier of non-combustible material at least 5 ft. high, having a fire-resistance rating of at least 0.5 hours. Isolate from other incompatible chemicals (refer to Section 10, Stability and Reactivity). Storage areas must meet National Electrical Codes for Class 1 Hazardous Areas. Post "No Smoking or Open Flames" signs in storage or use areas. Consider leak detection and alarm for storage and use areas. Have appropriate extinguishing equipment in storage area (i.e. sprinkler system, portable fire extinguishers).

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS: Compressed gases can present significant safety hazards. The following rules are applicable to work situations in which cylinders are being used.

Before Use: Move cylinders with a suitable hand-truck. Do not drag, slide or roll cylinders. Do not drop cylinders or permit them to strike each other. Secure cylinders firmly. Leave the valve protection cap (where provided) in-place until cylinder is ready for use.

During Use: Use designated CGA fittings and other support equipment. Do not use adapters. Do not use oils or grease on gas-handling fittings or equipment. Immediately contact the supplier if there are any difficulties associated with operating the cylinder valve. Never insert an object (e.g wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage the valve, causing a leak to occur. Use an adjustable strap wrench to remove over-tight or rusted caps. Never strike an arc, on a compressed gas cylinder or make a cylinder part of an electric circuit.

After Use: Close main cylinder valve. Replace valve protection cap. Close valve after each use and when empty. Mark empty cylinders "EMPTY".

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Refer to current CGA Guidelines for information on protective practices during maintenance of contaminated equipment.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Install automatic monitoring equipment to detect the level of Arsine and combustible gas levels. Provide explosion-proof ventilation adequate to minimize Arsine concentrations. Due to the extreme toxicity of Arsine, cylinders of this product should always be placed in a properly designed and constructed gas cabinet. Double wall piping should be used to deliver gas to the point of use. Exhaust from the cabinet and from the annular space of the tubing should be monitored.

RESPIRATORY PROTECTION: Maintain Arsine levels below 50% of the TLV (0.05 ppm) and oxygen levels above 19.5% in the workplace. The use of supplied air respiratory protection is recommended when changing cylinders or working on systems containing this gas mixture. Use supplied air respiratory protection when Arsine levels exceed 50% of the TLV (0.05 ppm), oxygen levels are below 19.5%, or during emergency response to a release of this product. During an emergency situation, before entering the area, check the concentration of Arsine and oxygen. If necessary, use only respiratory protection authorized in the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), or equivalent U.S. State standards and Canadian CSA Standard Z94.4-93. Oxygen levels below 19.5% are considered IDLH by OSHA. In such atmospheres, use of a full-facepiece pressure/demand SCBA or a full facepiece, supplied air respirator with auxiliary self-contained air supply is required under OSHA's Respiratory Protection Standard (1910.134-1998). The following NIOSH guidelines for respirator selection for Arsine are provided for additional information:

ARSINE

CONCENTRATION

At Concentrations above the NIOSH REL, or Where There is No REL, at Any Detectable Concentration: Any Self-Contained Breathing Apparatus (SCBA) that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, 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:

RESPIRATORY PROTECTION

Any Air-Purifying, Full-Facepiece Respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern, or any appropriate escape-type, SCBA.

EYE PROTECTION: Splash goggles or safety glasses. If necessary, refer to U.S. OSHA 29 CFR 1910.133, the Canadian CSA Standard Z94.3-02, *Industrial Eye and Face Protectors*.

HAND PROTECTION: Wear mechanically-resistant gloves when handling cylinders containing this gas mixture. If necessary, refer to U.S. OSHA 29 CFR 1910.138, or appropriate Standards of Canada.

BODY PROTECTION: Use body protection appropriate for task. Transfer of large quantities under pressure may require protective equipment appropriate to the task. If necessary, refer to the OSHA Technical Manual (Section VII: Personal Protective Equipment), or appropriate Standards of Canada. 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 and the Canadian CSA Standard Z195-02, *Protective Footwear*.

9. PHYSICAL and CHEMICAL PROPERTIES

The following information is for the Arsine component of this gas mixture:

GAS DENSITY @ 21.1°C (70°F): 0.2025 lb/ft³ (3.24 kg/m³)

BOILING POINT @ 1 atm: -62.5°C (-80.5°F)

FREEZING/MELTING POINT: -116.9°C (-178.4°F)

SPECIFIC GRAVITY (air = 1) @ 21.1°C (70°F) atm: 2.69

EVAPORATION RATE (nBuAc = 1): Not applicable.

VAPOR PRESSURE @ 20°C (68°F): 205 psig

ODOR THRESHOLD: 0.14 ppm (recognition)

COEFFICIENT WATER/OIL DISTRIBUTION: Not available.

ODOR THRESHOLD: 0.26-0.62 ppm (detection or recognition unspecified)

pH: Not applicable.

MOLECULAR WEIGHT: 77.93

EXPANSION RATIO: Not applicable.

SPECIFIC VOLUME (ft³/lb): 5.0

SOLUBILITY IN WATER: 20 g/100 mL

9. PHYSICAL and CHEMICAL PROPERTIES (Continued)

The following information is for the Hydrogen component of this gas mixture:

GAS DENSITY: 0.00521 lb/cu ft (0.08342 kg/m³) **EVAPORATION RATE (nBuAc = 1):** Not applicable.
SPECIFIC GRAVITY (air = 1): 0.06860 **FREEZING POINT:** -259.2°C (-434.55°F)
SOLUBILITY IN WATER: 0.019 **BOILING POINT (@ 1 atmos.):** -252.8°C (-423.9°F)
EXPANSION RATIO: Not applicable. **SPECIFIC VOLUME (ft³/lb):** 192.0
ODOR THRESHOLD: Not applicable. **MOLECULAR WEIGHT:** 2.016
VAPOR PRESSURE (psia): Not applicable.
COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.

The following information is for the gas mixture:

APPEARANCE, ODOR AND COLOR: Colorless gas with a garlicky odor (due to the presence of Arsine).

HOW TO DETECT THIS SUBSTANCE (warning properties): The odor caused by the presence of Arsine can be a distinctive warning property associated with this product. Monitoring systems must be used for detection of this gas.

10. STABILITY and REACTIVITY

STABILITY: Stable at standard temperatures and pressures. Hydrogen is stable Pure Arsine is stable at room temperature, but begins to decompose at 230-240°C (446-464°F).

DECOMPOSITION PRODUCTS: Arsenic can be generated from Arsine when the gas is exposed to light or it is heated above 300°C (572°F). Arsenic trioxide is a combustion product of arsine.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: The Hydrogen component is incompatible with strong oxidizers, halogen compounds (e.g. bromine, chlorine, fluorine), lithium, Argon trifluoride, oxygen difluoride. Finely divided platinum and some other metals will cause hydrogen to react explosively with oxygen in air. Arsine will react readily with bromine, potassium permanganate, sodium hypochlorite to form arsenic compounds. Arsine is a strong reducing agent and will react with mild to strong oxidizers.

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Contact with incompatible material, heat, spark or flame. Cylinders exposed to high temperatures or direct flame can rupture or burst.

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: Hydrogen is a simple asphyxiant (SA), which act to displace oxygen in the environment. No toxicity data are available. The following are toxicity data currently available for the Arsine component.

ARSINE:

TCLo (Inhalation-Human) 3 ppm: Blood: pigmented or nucleated red blood cells, other hemolysis with or without anemia
TCLo (Inhalation-Man) 325 µg/m³: Gastrointestinal: other changes; Kidney/Ureter/Bladder: hematuria
LCLo (Inhalation-Human) 25 ppm/30 minutes: Blood: other hemolysis with or without anemia; Endocrine: changes in growth hormone
LCLo (Inhalation-Human) 300 ppm/5 minutes
LD₅₀ (Intraperitoneal-Mouse) 3 mg/kg
LC₅₀ (Inhalation-Rat) 390 mg/m³/10 minutes
LC₅₀ (Inhalation-Rat) 0.3 mg/m³/15 minutes
LC₅₀ (Inhalation-Mouse) 250 mg/m³/10 minutes
LC₅₀ (Inhalation-Mouse) 0.5 mg/m³/2 minutes
LC₅₀ (Inhalation-Mouse) 0.1 mg/m³/15 minutes
LC₅₀ (Inhalation-Mouse) 0.05 gm/m³/2 hours
LC₅₀ (Inhalation-Mouse) 17.2 ppm/2 hours
LC₅₀ (Inhalation-Rabbit) 650 mg/m³/10 minutes
LC₅₀ (Inhalation-Rabbit) 0.4 mg/m³/15 minutes: Peripheral Nerve and Sensation: flaccid paralysis with appropriate anesthesia; Gastrointestinal: necrotic changes; Kidney/Ureter/Bladder: hematuria
LC₅₀ (Inhalation-Dog) 350 mg/m³/30 minutes
LC₅₀ (Inhalation-Dog) 0.5 mg/m³/15 minutes
LC₅₀ (Inhalation-Mammal Domestic) 1 gm/m³/10 minutes
LDLo (Intraperitoneal-Cat) 2 mg/kg
LCLo (Inhalation-Mouse) 0.63 ppm/30 minutes

ARSINE (continued):

LCLo (Inhalation-Mouse) 0.5 ppm/1 hour
LCLo (Inhalation-Mouse) 0.13 ppm/4 hours
LCLo (Inhalation-Mouse) 0.06 ppm/8 hours
LCLo (Inhalation-Monkey) 600 mg/m³/1 hour
LCLo (Inhalation-Cat) 150 mg/m³/20 minutes
LCLo (Inhalation-Frog) 4500 mg/m³/3 hours: Peripheral Nerve and Sensation: spastic paralysis with or without sensory change; Behavioral: altered sleep time (including change in righting reflex); Cardiac: other changes
TCLo (Inhalation-Rat) 2500 ppm/6 hours/14 days-intermittent: Liver: changes in liver weight; Endocrine: changes in spleen weight; Blood: other changes
TCLo (Inhalation-Rat) 500 ppm/6 hours/28 days-intermittent: Endocrine: changes in spleen weight; Blood: other changes; Biochemical: Enzyme inhibition, induction, or change in blood or tissue levels: other Enzymes
TCLo (Inhalation-Rat) 500 ppm/6 hours/90 days-intermittent: Endocrine: changes in spleen weight; Blood: pigmented or nucleated red blood cells, changes in erythrocyte (RBC) count
TCLo (Inhalation-Rat) 0.3 mg/m³/24 hours/13 weeks-continuous: Kidney/Ureter/Bladder: other changes; Blood: methemoglobinemia-carboxyhemoglobin, changes in leukocyte (WBC): count
TCLo (Inhalation-Rat) 2.5 ppm/10 days-intermittent: Endocrine: changes in spleen weight; Blood: changes in cell count (unspecified)

11. TOXICOLOGICAL INFORMATION (Continued)

TOXICITY DATA (continued):

ARSINE (continued):

TCLo (Inhalation-Rat) 2.5 ppm: female 6-15 day(s) after conception: Reproductive: Effects on Embryo or Fetus: fetotoxicity (except death, e.g., stunted fetus)
 TCLo (Inhalation-Mouse) 5 ppm/6 hours/14 days-intermittent: Liver: changes in liver weight; Endocrine: changes in spleen weight; Blood: changes in other cell count (unspecified)
 TCLo (Inhalation-Mouse) 500 ppb/12 weeks-intermittent: Endocrine: changes in spleen weight; Blood: changes in spleen, changes in leukocyte (WBC) count

ARSINE (continued):

TCLo (Inhalation-Mouse) 2.5 ppm/10 days-intermittent: Endocrine: changes in spleen weight
 TCLo (Inhalation-Hamster) 2500 ppm/6 hours/28 days-intermittent: Liver: changes in liver weight; Endocrine: changes in spleen weight; Blood: other changes
 TDLo (Intraperitoneal-Mouse) 12 mg/kg/10 days-intermittent: Related to Chronic Data: death
 TDLo (Intraperitoneal-Mouse) 5500 µg/kg/11 days-intermittent: Related to Chronic Data: death
 TCLo (Inhalation-Rat) 5 ppm/12 days-intermittent: Blood: other changes

SUSPECTED CANCER AGENT: The Arsine component of this product is listed by the following agencies tracking the carcinogenic potential of chemical compounds, as follows:

ARSINE: NIOSH-Ca (Potential Occupational Carcinogen, with No Further Categorization)

The Hydrogen component of this gas mixture are not found on the following lists: FEDERAL OSHA Z LIST, IARC, NTP, CAL/OSHA, and therefore is not considered to be, nor suspected to be a cancer-causing agent by these agencies.

IRRITANCY OF PRODUCT: This gas mixture is irritating to contaminated tissue.

SENSITIZATION TO THE PRODUCT: The components of this product are not known to be 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.

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.

BIOLOGICAL EXPOSURE INDICES (BEIs): Currently, Biological Exposure Indices (BEIs) are applicable for the Arsine component of this mixture, as follows:

CHEMICAL DETERMINANT	SAMPLING TIME	BEI
ARSENIC AND SOLUBLE COMPOUNDS INCLUDING ARSINE • Inorganic Arsenic plus Metabolites in Urine	• End of workweek	• 35 µg/g AS/L

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: This gas mixture will be dissipated rapidly in well-ventilated areas. The Arsenic component will rapidly hydrolyze in water to form arsenic acids and hydrides.

EFFECT OF MATERIAL ON PLANTS or ANIMALS: Any adverse effect on animals would be related to oxygen deficient environments.

EFFECT OF CHEMICAL ON AQUATIC LIFE: No an adverse effect from this gas mixture on aquatic life is expected.

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations. Return cylinders with any residual product to Matheson Tri-Gas. Do not dispose of locally.

14. TRANSPORTATION INFORMATION

THIS GAS MIXTURE IS HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.

PROPER SHIPPING NAME: Compressed gases, flammable, n.o.s.
(Hydrogen, Arsine)

HAZARD CLASS NUMBER and DESCRIPTION: 2.1 (Flammable Gas)

UN IDENTIFICATION NUMBER: UN 1954

PACKING GROUP: Not Applicable

D.O.T HAZARD LABEL: Class 2.1 (Flammable Gas)

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2004): 115

MARINE POLLUTANT: The components of this gas mixture are not classified by the DOT as a Marine Pollutants (as defined by 49 CFR 172.101, Appendix B).

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure position, in a well-ventilated vehicle. The transportation of compressed gas cylinders in automobiles or in closed-body vehicles present serious safety hazards and should be discouraged.

NOTE: Shipment of compressed gas cylinders which have not been filled with the owner's consent is a violation of Federal law (49 CFR, Part 173.301 (b)).

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: This gas mixture is considered as dangerous goods, per regulations of Transport Canada.

PROPER SHIPPING NAME: Compressed gases, flammable, n.o.s. (Hydrogen, Arsine)

HAZARD CLASS NUMBER and DESCRIPTION: 2.1 (Flammable Gas)

UN IDENTIFICATION NUMBER: UN 1954

PACKING GROUP: Not Applicable

HAZARD LABEL: Class 2.1 (Flammable Gas)

SPECIAL PROVISIONS: None

EXPLOSIVE LIMIT AND LIMITED QUANTITY INDEX: 0.125

ERAP INDEX: 3000

PASSENGER CARRYING SHIP INDEX: Forbidden

PASSENGER CARRYING ROAD VEHICLE OR PASSENGER CARRYING RAILWAY VEHICLE INDEX: Forbidden

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2004): 115

NOTE: Shipment of compressed gas cylinders via Public Passenger Road Vehicle is a violation of Canadian law (Transport Canada Transportation of Dangerous Goods Act, 1992).

15. REGULATORY INFORMATION

ADDITIONAL U.S. REGULATIONS:

U.S. SARA REPORTING REQUIREMENTS: Components of this gas mixture are subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act., as follows:

COMPOUND	SARA 302 (40 CFR 355, Appendix A)	SARA 304 (40 CFR Table 302.4)	SARA 313 (40 CFR 372.65)
Arsine	YES	YES	No

U.S. SARA SECTION 302 EXTREMELY HAZARDOUS THRESHOLD PLANNING QUANTITY (TPQ):
Hydrogen = not applicable; Arsine = 100 lb (45.53 kg)

U.S. SARA SECTION 302 EXTREMELY HAZARDOUS REPORTABLE QUANTITY: Hydrogen = not applicable; Arsine = 100 lb (45.53 kg)

U.S. SARA HAZARD CATEGORIES (SECTION 311/312, 40 CFR 370-21): ACUTE: Yes; CHRONIC: Yes; FIRE: Yes; REACTIVE: No; SUDDEN RELEASE: Yes

U.S. TSCA INVENTORY STATUS: Components of this product are listed on the TSCA Inventory.

15. REGULATORY INFORMATION (Continued)

ADDITIONAL U.S. REGULATIONS:

U.S. CERCLA REPORTABLE QUANTITY (RQ): Hydrogen - not applicable. Arsine has a 1 lb (0.45 kg) Reportable Quantity as an Extremely Hazardous Substance.

OTHER U.S. FEDERAL REGULATIONS:

- Arsine and Hydrogen are subject to the reporting requirements of Section 112(r) of the Clean Air Act. Threshold Quantity: Arsine = 1,000 lbs (454 kg). Hydrogen: 10,000 pounds (4,554 kg).
- This gas mixture does not contain any Class I or Class II ozone depleting chemicals (40 CFR part 82).
- Arsine is subject to requirements of CFR 29 1910.1000. Arsine is listed in Table Z.1.
- Arsine is listed in 40 CFR, Part 68 (Risk Management for Chemical Release Prevention), Table 1, as an extremely hazardous and flammable substance. The threshold quantity for Arsine under this regulation is 1,000 lbs (454 kg). Hydrogen is listed as a Regulated Substance in quantities of 10,000 lbs (4,553 kg) or greater, per 40 CFR, Part 68, of the Risk Management for Chemical Accidental Release.
- Depending on specific operations involving the use of this product, the regulations of the Process Safety Management of Highly Hazardous Chemicals may be applicable (29 CFR 1910.119). Under this regulation Arsine is listed in Appendix A. The threshold quantity for Arsine, under this regulation is 100 lbs (45 kg).

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): As an inorganic arsenic compound, the Arsine component of this gas mixture is on the California Proposition 65 lists. **WARNING!** This product contains compounds which are known to the State of California to cause cancer.

LABELING: Cylinders of this gas mixture should be labeled for precautionary information per the guidelines of the CGA. Refer to the CGA for further information.

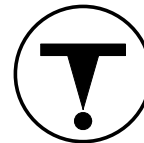
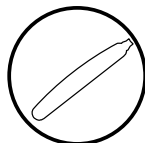
ADDITIONAL CANADIAN REGULATIONS:

CANADIAN DSL/NDSL INVENTORY STATUS: The components of this product are listed on the DSL Inventory.

OTHER CANADIAN REGULATIONS: Not applicable.

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) PRIORITIES SUBSTANCES LISTS: The components of this product are not on the CEPA Priorities Substances Lists.

CANADIAN WHMIS SYMBOLS: This gas mixture would be categorized as a Controlled Product, Hazard Classes: **A** (compressed gas), **D1A** (Material Causing Serious and Immediate Effects), **D2B** (Other Toxic Effects) and **F** (flammable). The following symbol is required for WHMIS compliance for this gas mixture.



16. OTHER INFORMATION

CREATION DATE: May 9, 2007

REVISION DATE: New

MIXTURES: When two or more gases or liquefied gases are mixed, their hazardous properties may combine to create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you use the mixture. Consult an Industrial Hygienist or other trained person when you make your safety evaluation of the end product. Remember, gases and liquids have properties which can cause serious injury or death.

Further information can be found in the following pamphlets published by: Compressed Gas Association Inc. (CGA), 421 Walney Road, 5th Floor, Chantilly, VA 20151. Telephone: (703) 788-2700, Fax: (703) 961-1831.

"Safe Handling of Compressed Gases in Containers" (P-1, 1999)

"Safe Handling and Storage of Compressed Gases" (AV-1, 1999)

"Handbook of Compressed Gases" (1992)

PREPARED BY:

CHEMICAL SAFETY ASSOCIATES, Inc.
PO Box 3519, La Mesa, CA 91944-3519
800/441-3365

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.

DFG MAK Germ Cell Mutagen Categories: 1: Germ cell mutagens which have been shown to increase the mutant frequency in the progeny of exposed humans. 2: Germ cell mutagens which have been shown to increase the mutant frequency in the progeny of exposed mammals. 3A: Substances which have been shown to induce genetic damage in germ cells of human or animals, or which produce mutagenic effects in somatic cells of mammals *in vivo* and have been shown to reach the germ cells in an active form. 3B: Substances which are suspected of being germ cell mutagens because of their genotoxic effects in mammalian somatic cell *in vivo*; in exceptional cases, substances for which there are no *in vivo* data, but which are clearly mutagenic *in vitro* and structurally related to known *in vivo* mutagens. 4: Not applicable (Category 4 carcinogenic substances are those with non-genotoxic mechanisms of action. By definition, germ cell mutagens are genotoxic. Therefore, a Category 4 for germ cell mutagens cannot apply. At some time in the future, it is conceivable that a Category 4 could be established for genotoxic substances with primary targets other than DNA [e.g. purely aneugenic substances] if research results make this seem sensible.) 5: Germ cell mutagens, the potency of which is considered to be so low that, provided the MAK value is observed, their contribution to genetic risk for humans is expected not to be significant.

DFG MAK Pregnancy Risk Group Classification: **Group A:** A risk of damage to the developing embryo or fetus has been unequivocally demonstrated. Exposure of pregnant women can lead to damage of the developing organism, even when MAK and BAT (Biological Tolerance Value for Working Materials) values are observed. **Group B:** Currently available information indicates a risk of damage to the developing embryo or fetus must be considered to be probable. Damage to the developing organism cannot be excluded when pregnant women are exposed, even when MAK and BAT values are observed. **Group C:** There is no reason to fear a risk of damage to the developing embryo or fetus when MAK and BAT values are observed. **Group D:** Classification in one of the groups A-C is not yet possible because, although the data available may indicate a trend, they are not sufficient for final evaluation.

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.

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.

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".

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM

HAZARD RATINGS (continued):

HEALTH HAZARD (continued):

0 (continued): *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.; **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 coarse 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.

16. OTHER INFORMATION (Continued)

DEFINITIONS OF TERMS (Continued)

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM

HAZARD RATINGS (continued):

PHYSICAL HAZARD (continued):

1 (continued): *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.); **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.).

NATIONAL FIRE PROTECTION ASSOCIATION HAZARD RATINGS:

HEALTH HAZARD: 0 (materials that, under emergency conditions, would offer no hazard beyond that of ordinary combustible materials): Gases and vapors whose LC₅₀ for acute inhalation toxicity is greater than 10,000 ppm. Dusts and mists whose LC₅₀ for acute inhalation toxicity is greater than 200 mg/L. Materials whose LD₅₀ for acute dermal toxicity is greater than 2000 mg/kg. Materials whose LD₅₀ for acute oral toxicity is greater than 2000 mg/kg. Materials that are essentially non-irritating to the respiratory tract, eyes and skin. **1 (materials that, under emergency conditions, can cause significant irritation):** Gases and vapors whose LC₅₀ for acute inhalation toxicity is greater than 5,000 ppm but less than or equal to 10,000 ppm. Dusts and mists whose LC₅₀ for acute inhalation toxicity is greater than 10 mg/L but less than or equal to 200 mg/L. Materials whose LD₅₀ for acute dermal toxicity is greater than 1000 mg/kg but less than or equal to 2000

mg/kg. Materials whose LD₅₀ for acute oral toxicity is greater than 500 mg/kg but less than or equal to 2000 mg/kg.

NATIONAL FIRE PROTECTION ASSOCIATION HAZARD RATINGS (continued):

HEALTH HAZARD (continued): **1 (continued):** Materials that cause slight to moderate irritation to the respiratory tract, eyes and skin. **2** (materials that, under emergency conditions, can cause temporary incapacitation or residual injury): Gases and vapors whose LC₅₀ for acute inhalation toxicity is greater than 3,000 ppm but less than or equal to 5,000 ppm. Dusts and mists whose LC₅₀ for acute inhalation toxicity is greater than 2 mg/L but less than or equal to 10 mg/L. Materials whose LD₅₀ for acute dermal toxicity is greater than 200 mg/kg but less than or equal to 1000 mg/kg. Materials whose LD₅₀ for acute oral toxicity is greater than 50 mg/kg but less than or equal to 500 mg/kg. Any liquid whose saturated vapor concentration at 20°C (68°F) is equal to or greater than one-fifth its LC₅₀ for acute inhalation toxicity, if its LC₅₀ is less than or equal to 5000 ppm and that does not meet the criteria for either degree of hazard 3 or degree of hazard 4. Compressed liquefied gases with boiling points between -30°C (-22°F) and -55°C (-66.5°F) that cause severe tissue damage, depending on duration of exposure. Materials that are respiratory irritants. Materials that cause severe, but reversible irritation to the eyes or are lachrymators. Materials that are primary skin irritants or sensitizers. **3** (materials that, under emergency conditions, can cause serious or permanent injury): Gases and vapors whose LC₅₀ for acute inhalation toxicity is greater than 1,000 ppm but less than or equal to 3,000 ppm. Dusts and mists whose LC₅₀ for acute inhalation toxicity is greater than 0.5 mg/L but less than or equal to 2 mg/L. Materials whose LD₅₀ for acute dermal toxicity is greater than 40 mg/kg but less than or equal to 200 mg/kg. Materials whose LD₅₀ for acute oral toxicity is greater than 5 mg/kg but less than or equal to 50 mg/kg. Any liquid whose saturated vapor concentration at 20°C (68°F) is equal to or greater than one-fifth its LC₅₀ for acute inhalation toxicity, if its LC₅₀ is less than or equal to 3000 ppm and that does not meet the criteria for degree of hazard 4. Compressed liquefied gases with boiling points between -30°C (-22°F) and -55°C (-66.5°F) that cause frostbite and irreversible tissue damage. Materials that are respiratory irritants. Cryogenic gases that cause frostbite and irreversible tissue damage. Materials that are corrosive to the respiratory tract. Materials that are corrosive to the eyes or cause irreversible corneal opacity. Materials that are corrosive to the skin. **4** (materials that, under emergency conditions, can be lethal): Gases and vapors whose LC₅₀ for acute inhalation toxicity less than or equal to 1,000 ppm. Dusts and mists whose LC₅₀ for acute inhalation toxicity is less

than or equal to 0.5 mg/L. Materials whose LD₅₀ for acute dermal toxicity is less than or equal to 40 mg/kg. Materials whose LD₅₀ for acute oral toxicity is less than or equal to 5 mg/kg. Any liquid whose saturated vapor concentration at 20°C (68°F) is equal to or greater than one-fifth its LC₅₀ for acute inhalation toxicity, if its LC₅₀ is less than or equal to 1000 ppm.

FLAMMABILITY HAZARD: 0 Materials that will not burn under typical fire conditions, including intrinsically noncombustible materials such as concrete, stone, and sand: Materials that will not burn in air when exposed to a temperature of 816°C (1500°F) for a period of 5 minutes in accordance with Annex D. **1** Materials that must be preheated before ignition can occur. Materials in this degree require considerable preheating, under all ambient temperature conditions, before ignition and combustion can occur: Materials that will burn in air when exposed to a temperature of 816°C (1500°F) for a period of 5 minutes in accordance with Annex D. Liquids, solids and semisolids having a flash point at or above 93.4°C (200°F) (i.e. Class IIIB liquids). Liquids with a flash point greater than 35°C (95°F) that do not sustain combustion when tested using the *Method of Testing for Sustained Combustibility*, per 49 CFR 173, Appendix H or the UN *Recommendation on the Transport of Dangerous Goods, Model Regulations* (current edition) and the related *Manual of Tests and Criteria* (current edition). Liquids with a flash point greater than 35°C (95°F) in a water-miscible solution or dispersion with a water non-combustible liquid/solid content of more than 85 percent by weight. Liquids that have no fire point when tested by ASTM D 92 Standard Test Method for Flash and Fire Points by Cleveland Open Cup, up to a boiling point of the liquid or up to a temperature at which the sample being tested shows an obvious physical change. Combustible pellets with a representative diameter of greater than 2 mm (10 mesh). Solids containing greater than 0.5 percent by weight of a flammable or combustible solvent are rated by the closed up flash point of the solvent. Most ordinary combustible materials. **2** 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 with air, but under high ambient temperatures or under moderate heating could release vapor in sufficient quantities to produce hazardous atmospheres with air.

16. OTHER INFORMATION (Continued)

DEFINITIONS OF TERMS (Continued)

NATIONAL FIRE PROTECTION ASSOCIATION HAZARD RATINGS (continued):

FLAMMABILITY HAZARD: 2 (continued): Liquids having a flash point at or above 37.8°C (100°F) and below 93.4°C (200°F) (i.e. Class II and Class IIIA liquids.) Solid materials in the form of powders or coarse dusts of representative diameter between 420 microns (40 mesh) and 2 mm (10 mesh) that burn rapidly but that generally do not form explosive mixtures in air. Solid materials in fibrous or shredded form that burn rapidly and create flash fire hazards, such as cotton, sisal and hemp. Solids and semisolids that readily give off flammable vapors. Solids containing greater than 0.5 percent by weight of a flammable or combustible solvent are rated by the closed cup flash point of the solvent. **3** 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, though unaffected by ambient temperatures, are readily ignited under almost all conditions: Liquids having a flash point below 22.8°C (73°F) and having a boiling point at or above 37.8°C (100°F) and those liquids having a flash point at or above 22.8°C (73°F) and below 37.8°C (73°F) and below 37.8°C (100°F) (i.e. Class IB and IC liquids). Materials that, on account of their physical form or environmental conditions, can form explosive mixtures with air and are readily dispersed in air. Flammable or combustible dusts with a representative diameter less than 420 microns (40 mesh). Materials that burn with extreme rapidity, usually by reason of self-contained oxygen (e.g. dry nitrocellulose and many organic peroxides). Solids containing greater than 0.5 percent by weight of a flammable or combustible solvent are rated by the closed cup flash point of the solvent. **4** Materials that will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or that are readily dispersed in air and will burn readily: Flammable gases. Flammable cryogenic materials. Any liquid or gaseous materials 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) (i.e. Class IA liquids). Materials that ignite when exposed to air. Solids containing greater than 0.5 percent by weight of a flammable or combustible solvent are rated by the closed cup flash point of the solvent.

INSTABILITY HAZARD: 0 Materials that in themselves are normally stable, even under fire conditions: Materials that have an estimated instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) below 0.01 W/mL. Materials that do not exhibit an exotherm at temperatures less than or equal to 500°C (932°F) when tested by differential scanning calorimetry. **1** Materials that in themselves are normally stable, but that can become unstable at elevated temperatures and pressures: Materials that have an estimated instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) at or above 0.01 W/mL and below 10 W/mL. **2** Materials that readily undergo violent chemical change at elevated temperatures and pressures: Materials that have an estimated instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) at or above 10 W/mL and below 100W/mL.

NATIONAL FIRE PROTECTION ASSOCIATION HAZARD RATINGS (continued):

INSTABILITY HAZARD (continued): 3 Materials that in themselves are capable of detonation or explosive decomposition or explosive reaction, but that require a strong initiating source or that must be heated under confinement before initiation: Materials that have an estimated instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) at or above 100 W/mL and below 1000 W/mL. Materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures. **4** Materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures: Materials that have an estimated instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) of 1000 W/mL or greater. Materials that are sensitive to localized thermal or mechanical shock at normal temperatures and pressures.

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 **TDL_o**, the lowest dose to cause a symptom and **TCL_o** 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, **ACGIH**, **EPA**, **OSHA**, **NIOSH** and **GERMAN MAK COMMISSION**. 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.

16. OTHER INFORMATION (Continued)

DEFINITIONS OF TERMS (continued)

TOXICOLOGICAL INFORMATION (continued):

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:

BCF = Bioconcentration Factor, which is used to determine if a substance will concentrate in lifeforms which consume contaminated plant or animal matter; **EC** is the Effect Concentration in water; **EC₅₀** is the Effect Concentration for 50% of the organisms exposed; **NOEC** is the No Observed Effect Concentration; **MATC** is the Maximum Acceptable Toxicant Concentration; **NOLC** is the No Observed Lethal Concentration; **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:

This section explains the impact of various laws and regulations on the material. **ACGIH:** American Conference of Governmental Industrial Hygienists, a professional association which establishes exposure limits. **AIHA:** American Industrial Hygiene Association. **AIHA WEELs:** AIHA Workplace Environmental Exposure Limits. **ANSI:** American National Standards Institute: This organization establishes standards for labeling of chemical compounds in the U.S. **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/NDSL**); 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.