



**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: PHOSPHINE/HYDROGEN GAS MIXTURE

CHEMICAL FAMILY: Phosphorous Hydride / Inorganic Flammable Gas Mixture **PRODUCT USE:** Research Gas

MANUFACTURER

MATHESON TRI-GAS, INC.

150 ALLEN ROAD, Ste 302
BASKING RIDGE, NJ 07920
USA

Phone: 973/257-1100

EMERGENCY PHONE:

CHEMTREC (U.S. DOMESTIC): 1-800-424-9300

CHEMTREC INTERNATIONAL: 1-703-527-3887

CANUTEC (CANADA): 1-613-996-6666

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.

2. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: Product Description: This gas mixture is a colorless, highly flammable, toxic gas mixture with a distinct fishy odor (due to the presence of Phosphine). This gas mixture may cause significant, adverse health effects, because of the Phosphine content, which exceeds exposure limits at the possible percentage ranges in this mixture. Phosphine is an irritant and general systemic poison. Exposure to even very small quantities can result in adverse health effects (such as pulmonary edema) and may be fatal. Phosphine has a fishy odor and a low odor threshold; the odor 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:** As pure Phosphine is a strong reducing agent and can react vigorously with mild to strong oxidizing agents, this gas mixture can present the same hazard when Phosphine reaches the higher level possible in the mixture. **Environmental Hazards:** This gas mixture may cause adverse effects to plants and animals in the environment. **Emergency Response Considerations:** Persons responding to releases of this gas mixture must protect themselves appropriately.

SYMPTOMS OF OVER-EXPOSURE BY ROUTE OF EXPOSURE: The most significant routes of over-exposure for this gas are by inhalation, skin or eye contact. Symptoms of exposure by all routes of exposure may be delayed.

INHALATION: This gas mixture can cause, serious health effects, due to the presence of Phosphine, which is extremely toxic at very low levels. Both chronic and acute over-exposures to this gas mixture are dangerous. Minor exposures may result in the following symptoms: lacrymation (watery eyes), substernal chest pain, chest tightness, shortness of breath, a slight cough, and cyanosis. Such exposures can cause gastrointestinal tract irritation and central nervous system effects. Abdominal symptoms include nausea, vomiting, severe epigastric pain, and diarrhea. Neurologic symptoms include vertigo, headache, restlessness, involuntary tremors, lack of muscular coordination, double vision, drowsiness, and a decreased sensation in the extremities. Death can occur in humans after exposure as low as 8 ppm for 1-2 hours.

It should be noted that before adverse health effects or suffocation could occur, the lower flammability limits of the components of this gas mixture in air may be exceeded, possibly causing an explosive atmosphere as well as an oxygen-deficient environment.

2. HAZARD IDENTIFICATION (Continued)

INHALATION (continued): In severe over-exposures, this gas mixture can cause death (due to the presence of Phosphine), from pulmonary edema (a dangerous condition of fluid accumulation in the lungs), or from tissue anoxia secondary to interference with tissue respiration. The symptoms of pulmonary edema can be delayed. Severe overexposure can also lead to damage to the liver and kidneys.

Although high concentrations of this gas mixture can cause an oxygen-deficient environment, the toxic effects of Phosphine will be a more significant hazard than oxygen deficiency. Individuals breathing an oxygen-deficient 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:

CONCENTRATION OF OXYGEN OBSERVED EFFECT

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.

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

CONTACT WITH SKIN or EYES: Contact of this gas mixture with the skin can cause injury. Contact with the skin in the presence of moisture can cause burns, due to the formation of phosphoric acid. Contact with the eyes (1-2 ppm), even briefly, will cause irritation. Contact of longer duration and concentration can cause serious injury to the eyes, possibly blindness, due to the formation of phosphoric acid. In addition, contact with rapidly expanding gases (which are released under high pressure) may cause frostbite.

SKIN ABSORPTION: Phosphine can be absorbed via intact skin and can cause systemic toxic effect by this route of exposure as described under 'Inhalation' when a large area of skin is involved.

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

ACUTE: This gas mixture may cause moderate to severe irritation to the respiratory system, skin and eyes, depending of the duration of exposure. Severe over-exposure to this gas may cause the extremely dangerous condition of pulmonary edema (an accumulation of fluid in the lungs) and may be fatal. Severe overexposure may also cause damaging effects to the central nervous system, lung damage, adverse effects on the heart, and congestion of blood in the visceral organs. In addition, acute overexposure to this gas mixture can cause an oxygen-deficient atmosphere. Symptoms of oxygen deficiency include ringing in ears, headaches, shortness of breath, wheezing, dizziness, indigestion, and nausea.

CHRONIC: Although no good data is available, persistent irritation may result from repeated, low-level, non-toxic exposure to this gas mixture. Refer to Section 11 (Toxicology Information) for additional data.

TARGET ORGANS: ACUTE: Respiratory system, skin, eyes, cardiac and central nervous systems, liver and kidneys. CHRONIC: Respiratory system, skin.

HMIS RATING: HEALTH HAZARD = 4 FLAMMABILITY HAZARD = 4 PHYSICAL HAZARD = 2
Hazard Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

3. COMPOSITION and INFORMATION ON INGREDIENTS

(10,000 ppm = 1%)

CHEMICAL NAME	CAS #	mole %
Phosphine	7803-51-2	Ranges Can Include:
		0.4 to < 0.67%
		0.67 to < 2.0%
		2.0 to < 10.0%
Hydrogen	1333-74-0	10.0-20.0%
		Balance

4. FIRST-AID MEASURES

GENERAL INFORMATION: 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 Fire-Retardant clothing must be worn. 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.**

4. FIRST-AID MEASURES (Continued)

SKIN EXPOSURE: Rinse exposed skin for 15 minutes if any irritation adverse effects occur. If release of this gas mixture has resulted in frostbite, warm affected area slowly. Seek immediate medical attention.

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 Phosphine, consideration should be taken as to the possible aggravation of respiratory disorders, heart conditions, or central nervous system conditions. Additionally, skin and eye conditions may be aggravated by this gas mixture.

RECOMMENDATIONS TO PHYSICIANS: Administer oxygen. Victims of exposure to Phosphine must be monitored closely for delayed pulmonary edema. There is no specific antidote to Phosphine poisoning; therefore, treatment is symptomatic and supportive. The usual treatments for pulmonary edema (such as digitalis, diuretics, and phlebotomy) may be necessary. Pressor agents such as aramine and massive doses of steroids may be necessary to support blood pressure. A central venous pressure catheter is highly recommended for determining rates of infusion and following the course of the pulmonary edema. The use of mannitol diuresis may be used to prevent early renal shutdown. If oliguria supervenes, extracorporeal hemodialysis must be available for survival. Cerebral edema should be treated by usual methods with agents such as decadron. Also, appropriate sedation and anti-epileptic drugs are employed as indicated. Frequent electrolyte determinations should be performed for early detection of hyperkalemia with ensuing renal failure, which is treated by ion exchange resins, such as polystyrene sulfonate (kayexalate). Cardiac monitoring is essential for arrhythmia problems which might ensue.

5. FIRE-FIGHTING MEASURES

FLASH POINT: Not determined for mixture. Components have no determined flash point.

AUTOIGNITION TEMPERATURE: Not determined for mixture.

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

For Phosphine: 38-100°C (100-212°F). The autoignition temperature of Phosphine varies due to possible impurities.

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

	<u>Lower (LEL):</u>	<u>Upper (UEL):</u>
For Hydrogen:	4.0%	75.0%
For Phosphine:	1.6%	98.0%

FIRE EXTINGUISHING MATERIALS: Extinguish fires of this gas mixture by shutting-off the source of the gas. Use a flooding quantity of water as a spray. 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 Phosphine.

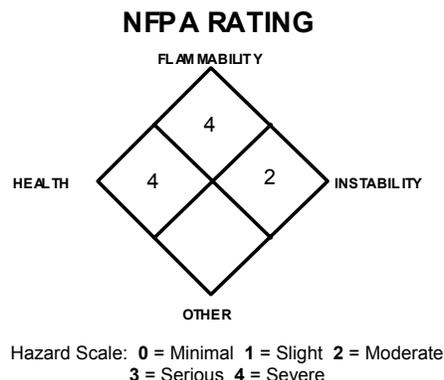
FIRE EXTINGUISHING MATERIALS NOT TO BE USED: Do NOT use halogenated extinguishing agents.

UNUSUAL FIRE AND EXPLOSION HAZARD: This gas mixture presents a serious fire hazard due to the presence of Phosphine. This gas mixture will form dangerous explosive mixtures in air. Phosphine is toxic to humans in relatively low concentrations and so this gas mixture poses an extreme health hazards to fire-fighters. When involved in a fire, the decomposition products are phosphorous oxides, phosphoric acid and hydrogen. Due to the presence of Phosphine, this gas mixture may readily undergo violent chemical change at normal or elevated temperatures, when levels are at their highest. **DANGER!** Fires impinging (direct flame) on the outside surface of cylinders or storage vessels can be very dangerous. Direct flame exposure on the cylinder wall can cause an explosion due to pressure-build-up. The resulting fire and explosion can result in severe equipment damage and personnel injury or death over a large area around the vessel. For massive fires in large areas, use unmanned hose holder or monitor nozzles; if this is not possible, withdraw from area and allow fire to burn.

EXPLOSION SENSITIVITY TO MECHANICAL IMPACT: Not sensitive.

EXPLOSION SENSITIVITY TO STATIC DISCHARGE: Not sensitive.

SPECIAL FIRE-FIGHTING PROCEDURES: Evacuate all personnel from danger area. Immediately cool cylinders with water spray from maximum distance, to avoid danger of cylinder rupture. 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 North American Emergency Response Guidebook (Guide Number 126).



6. ACCIDENTAL RELEASE MEASURES

LEAK RESPONSE: Evacuate immediate area. Uncontrolled releases should be responded to by trained personnel using pre-planned procedures. Proper protective equipment 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. Small releases of Phosphine leaks can be detected by means of an atomizer or squeeze bottle filled with aqueous ammonia. A white cloud will show the location of the leak. Monitor the surrounding area for Phosphine and oxygen levels. The atmosphere must have at least 19.5 percent oxygen and the level of Phosphine must be 10% below the exposure levels given in Section 8 (Exposure Limits and Personal Protection) before non-emergency personnel can be allowed in the area without Self-Contained Breathing Apparatus.

7. HANDLING and USE

WORK PRACTICES AND HYGIENE PRACTICES: Be aware of any signs of dizziness or fatigue; exposures to fatal concentrations of this gas mixture could occur without any significant warning symptoms, due to oxygen deficiency. All areas where gas mixtures that include Phosphine are used should be monitored with very sensitive gas detection instruments. Detection of concentrations above 50% of the PEL (PEL = 0.3 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.

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.

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 installation of leak detection and alarm for storage and use areas.

Have appropriate extinguishing equipment in the storage area (i.e. sprinkler system, portable fire extinguishers). Keep the smallest amount on-site as is necessary. Full and empty cylinders should be segregated. Use a first-in, first-out inventory system to prevent full containers from being stored for long periods of time. Use non-sparking ventilation systems, approved explosion-proof equipment, and appropriate electrical systems. Electrical equipment used in gas-handling operations, or located in storage areas, should be non-sparking or explosion proof. Use a check valve in the discharge line to prevent hazardous backflow. Never tamper with pressure relief devices in valves and cylinders.

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.

7. HANDLING and USE (Continued)

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS (continued):

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: Use with adequate, explosion-proof ventilation to ensure compliance with exposure limits described in this section. Local exhaust ventilation is preferred, because it prevents dispersion of this gas mixture into the work place by eliminating it at its source. If appropriate, install automatic monitoring equipment to detect the level of Oxygen.

EXPOSURE LIMITS:

CHEMICAL NAME	CAS #	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	
Phosphine	7803-51-2	0.3	1	0.3	1 (Vacated 1989 PEL)	0.3	1	50	DFG MAKs: TWA = 0.1 PEAK = 1•MAK 15 min., average value, 1-hr interval, 4 per shift Carcinogen: EPA-D
Hydrogen	1333-74-0	There are no specific exposure limits for Hydrogen. Hydrogen is a simple asphyxiant (SA). Oxygen levels should be maintained above 19.5%.							

See Section 16 for Definitions of Terms Used.

RESPIRATORY PROTECTION: Maintain the Oxygen level above 19.5% in the workplace. 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 respiratory protection recommendations are for Phosphine.

PHOSPHINE

CONCENTRATION

Up to 3 ppm:

Up to 7.5 ppm:

Up to 15 ppm:

RESPIRATORY EQUIPMENT

Supplied Air Respirator (SAR)

Supplied Air Respirator (SAR) operated in a continuous-flow mode.

Gas mask with canister to protect against Phosphine, or full-facepiece SCBA or full-facepiece Supplied Air Respirator (SAR).

Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions: Positive pressure, full-facepiece SCBA, or positive pressure, full-facepiece Supplied Air Respirator (SAR).

Escape:

Gas mask with canister to protect against Phosphine or escape-type SCBA.

EYE PROTECTION: Splash goggles or safety glasses. If necessary, refer to U.S. OSHA 29 CFR 1910.133 or and the Canadian CSA Standard Z94.3-M1982, *Industrial Eye and Face Protectors*.

HAND PROTECTION: Chemically resistant gloves should be worn when using this gas mixture. 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*.

ENVIRONMENTAL EXPOSURE CONTROLS: Controls should be engineered to prevent release to the environment, including procedures to prevent spills, atmospheric release and release to waterways.

9. PHYSICAL and CHEMICAL PROPERTIES

The following information is for Hydrogen, a main component of this gas mixture:

GAS DENSITY: 0.00521 lb/cu ft (0.08342 kg/m ³)	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 Phosphine component of this gas mixture.

BOILING POINT @ 1 atm: -87.7°C (-125.9°F)	pH: Not applicable.
EVAPORATION RATE (nBuAc = 1): Not applicable.	MOLECULAR WEIGHT: 33.998
VAPOR PRESSURE @ 21.1°C (70°F) psig: 583	EXPANSION RATIO: Not applicable.
ODOR THRESHOLD: 0.14 ppm (recognition)	SPECIFIC VOLUME (ft³/lb): 11.4
SOLUBILITY IN WATER vol gas/vol water @ 17°C (62.6°F): 0.26	
GAS DENSITY @ 21.1°C (70°F) and 1 atm: 0.0877 lb/ft ³ (1.405 kg/m ³)	
SPECIFIC GRAVITY (air = 1) @ 25°C (77°F) and 1 atm: 1.184	
FREEZING/MELTING POINT @ 10 psig: -133°C (-207.4°F)	

The following information is pertinent to this product:

APPEARANCE, ODOR and COLOR: This gas mixture is a colorless gas mixture with a distinct fishy odor (due to the presence of Phosphine).

HOW TO DETECT THIS SUBSTANCE (warning properties): The odor and potential irritation of the eyes caused by the presence of Phosphine can be a distinctive warning property associated with this product, as the odor threshold for Phosphine is below the TLV. Monitoring systems must be used for detection of this gas.

10. STABILITY and REACTIVITY

STABILITY: Stable at standard temperatures and pressures. Pure Phosphine reacts violently with a broad range of materials, including air.

DECOMPOSITION PRODUCTS: *Combustion:* When heated to decomposition, Phosphine emits toxic fumes of phosphorous oxides. *Hydrolysis:* Decomposition products of Phosphine when in contact with water are phosphoric acid and hydrogen.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Phosphine combines violently with halogens and oxidizers such as oxygen, chlorine, fluorine and nitric oxide. Phosphine reacts with mercury(II) nitrate to form an explosive product. In air, Phosphine will ignite or react violently; also with boron trichloride, aqueous halogen solutions, iodine, metal nitrates and oxidants. The organic derivatives of phosphine react violently with halogens. The Hydrogen component is incompatible with strong oxidizers, halogen compounds (e.g. bromine, chlorine, fluorine), lithium, Xenon trifluoride, oxygen difluoride. Finely divided platinum and some other metals will cause hydrogen to react explosively with oxygen in air.

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 toxicity data are available for Phosphine:

PHOSPHINE:

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

PHOSPHINE (continued):

LCLo (Inhalation-Mammal species unspecified) 1000 ppm/5 minutes
LCLo (Inhalation-Rat) 140 mg/m ³ /4 hours
LCLo (Inhalation-Guinea Pig) 139 mg/m ³ /4 hours
LCLo (Inhalation-Cat) 70 mg/m ³ /2 hours
TCLo (Inhalation-Rat) 200 ug/m ³ /24 hours/6 weeks-continuous: Brain and Coverings: recordings from specific areas of CNS; Blood: pigmented or nucleated red blood cells; Blood: changes in serum composition (e.g. TP, bilirubin, cholesterol)
TCLo (Inhalation-Rat) 3100 ppb/6 hours/13 weeks-intermittent: Blood: pigmented or nucleated red blood cells, changes in erythrocyte (RBC) count, changes in platelet count
TCLo (Inhalation-Rat) 10 ppm/4 hours/4 days-intermittent: Related to Chronic Data: death
TCLo (Inhalation-Rat) 5 ppm/4 hours/2 weeks-intermittent: Cardiac: changes in heart weight; Lungs, Thorax, or Respiration: changes in lung weight; Liver: changes in liver weight

11. TOXICOLOGICAL INFORMATION (Continued)

TOXICITY DATA (continued):

PHOSPHINE (continued):

TCLo (Inhalation-Mouse) 10 ppm/4 hours/4 days-intermittent: Kidney, Ureter, Bladder: changes in tubules (including acute renal failure, acute tubular necrosis); Blood: changes in leukocyte (WBC) count; Biochemical: Enzyme inhibition, induction, or change in blood or tissue levels: transaminases

TCLo (Inhalation-Mouse) 5 ppm/4 hours/2 weeks-intermittent: Cardiac: changes in heart weight; Lungs, Thorax, or Respiration: changes in lung weight; Blood: changes in serum composition (e.g. TP, bilirubin, cholesterol)

PHOSPHINE (continued):

TCLo (Inhalation-Mouse) 5 ppm/6H/4 weeks-intermittent: Sense Organs and Special Senses (Olfaction): effect, not otherwise specified; Lungs, Thorax, or Respiration: chronic pulmonary edema; Kidney, Ureter, Bladder: changes in bladder weight

TCLo (Inhalation-Rabbit) 14 mg/m³/7 hours/2 days-intermittent: Related to Chronic Data: death

TCLo (Inhalation-Cat) 14 mg/m³/7 hours/2 days-intermittent: Related to Chronic Data: death

Cytogenetic Analysis (Human-Lymphocyte) 1400 ng/L

Micronucleus Test (Inhalation-Mouse) 5 ppm/6 hours/13 weeks-intermittent

CARCINOGENIC POTENTIAL OF COMPONENTS: The Phosphine component is listed by agencies tracking the carcinogenic potential of chemical compounds, as follows:

PHOSPHINE: EPA-D (Not Classifiable as to Human Carcinogenicity)

The remaining component of this gas mixture is not found on the following lists: U.S. EPA, U.S. NTP, U.S. OSHA, U.S. NIOSH, GERMAN MAK, IARC, or ACGIH, and therefore is not considered to be, nor suspected to be a cancer-causing agent by these agencies.

IRRITANCY OF PRODUCT: Phosphine reacts with water or moisture, slowly producing corrosive phosphoric acid; therefore, this gas can be severely irritating and corrosive to the skin, the eyes, and mucous membranes.

SENSITIZATION TO THE PRODUCT: The components of this gas mixture are not known to cause human skin or respiratory sensitization.

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. There is not enough information available to conclude that the Phosphine component is mutagenic in live animals. Some marginally positive results have been produced in studies in which animals were exposed by inhalation to concentrations which produced toxicity. Negative results have been produced in other in vivo studies (a dominant lethal test, sister chromatid exchange, chromosomal aberration and micronuclei tests). Positive and negative results have been produced in cultured mammalian cells and bacteria.

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

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

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

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

12. ECOLOGICAL INFORMATION

ALL WORK PRACTICES MUST BE AIMED AT ELIMINATING ENVIRONMENTAL CONTAMINATION.

MOBILITY: As a gas mixture, this product does not present a hazard of mobility in the soil. The following information is for the Phosphine component.

PHOSPHINE:

Soil Adsorption/Mobility: Phosphine is a gas and expected to volatilize rapidly from water and both moist and dry soil; however studies have shown that phosphine may bind to soil. Laboratory studies do suggest that Phosphine present below the soil surface is quickly adsorbed and degraded. A 50% degradation rate after 11 days in water saturated soil was observed using gaseous phosphine added to soil headspace at 1000 mg/kg dry soil in closed containers. Phosphine interaction with soil is soil-type dependent.

PERSISTENCE AND BIODEGRADABILITY: The components of this gas mixture will volatilize and degrade into other organic compounds. The following information is for the Phosphine component.

PHOSPHINE:

Persistence and Biodegradability: If released to air, a vapor pressure of 29,300 mm Hg at 25°C indicates phosphine will exist solely as a gas in the atmosphere. Gas-phase phosphine will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; and has a reported atmospheric half-life of less than 1 day. Phosphine does not contain chromophores that absorb at wavelengths > 290 nm and therefore is not expected to be susceptible to direct photolysis by sunlight. Phosphine is a gas and therefore is expected to volatilize from water and moist and dry soil surfaces. Studies have shown that sub-surface phosphine may bind to soil; volatilization is expected to be the most important fate process since phosphine is a gas.

BIO-ACCUMULATION POTENTIAL: The components of this gas mixture do not present a hazard of bio-accumulation.

ECOTOXICITY: This gas mixture has not been tested for aquatic or animal toxicity. All release to terrestrial, atmospheric and aquatic environments should be avoided. The following aquatic toxicity data are available for the Phosphine component:

PHOSPHINE: EC₅₀: *Bacillus subtilis* growth inhibition = 2.7 mg/L

OTHER ADVERSE EFFECTS: The components of this gas mixture are not listed as having ozone depletion potential.

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

U.S. DEPARTMENT OF TRANSPORTATION REGULATIONS: This product is classified as dangerous goods, per U.S. DOT regulations, under 49 CFR 172.101.

PROPER SHIPPING NAME: Compressed gas, toxic, flammable n.o.s. (Phosphine, Hydrogen)

HAZARD CLASS NUMBER and DESCRIPTION: 2.3 (Toxic Gas); 2.1 (Flammable Gas)

UN IDENTIFICATION NUMBER: UN 1953

PACKING GROUP: Not applicable.

D.O.T HAZARD LABEL: Class 2.3 (Toxic Gas); Class 2.1 (Flammable Gas)

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

SPECIAL PROVISION: Shipments must be described as "Poison Inhalation Hazard - ZONE D", for mixtures which contain Phosphine from 0.40% to less than 0.67%. Shipments must be described as "Poison Inhalation Hazard - ZONE C", for mixtures which contain Phosphine at 0.67% to less than 2.0%. Shipments must be described as "Poison Inhalation Hazard - ZONE B", for mixtures which contain Phosphine at 2.0% to less than 10.0%. Shipments must be described as "Poison Inhalation Hazard - ZONE A", for mixtures which contain Phosphine at 10.0% or above.

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 classified as dangerous goods, per regulations of Transport Canada.

PROPER SHIPPING NAME: Compressed gas, toxic, flammable n.o.s. (Phosphine, Hydrogen)

HAZARD CLASS NUMBER and DESCRIPTION: 2.3 (Toxic Gas); 2.1 (Flammable Gas)

UN IDENTIFICATION NUMBER: UN 1953

PACKING GROUP: Not Applicable

HAZARD LABEL: Class 2.3 (Toxic Gas); Class 2.1 (Flammable Gas)

SPECIAL PROVISIONS: 16, 38

EXPLOSIVE LIMIT AND LIMITED QUANTITY INDEX: 0

ERAP INDEX: 0

PASSENGER CARRYING SHIP INDEX: Forbidden

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

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2004): 119

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).

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.

15. REGULATORY INFORMATION

ADDITIONAL U.S. REGULATIONS:

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

CHEMICAL NAME	SARA 302 (40 CFR 355, Appendix A)	SARA 304 (40 CFR Table 302.4)	SARA 313 (40 CFR 372.65)
Phosphine	Yes	Yes	Yes

U.S. SARA SECTION 302 EXTREMELY HAZARDOUS THRESHOLD PLANNING QUANTITY (TPQ): Phosphine = 500 lb (227 kg)

U.S. SARA SECTION 304 EXTREMELY HAZARDOUS REPORTABLE QUANTITY (RQ): Phosphine = 100 lb (45.4 kg)

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

15. REGULATORY INFORMATION (Continued)

ADDITIONAL U.S. REGULATIONS (continued):

U.S. CERCLA REPORTABLE QUANTITY (RQ): Phosphine = 100 lb (45.4 kg)

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

OTHER U.S. FEDERAL REGULATIONS: Phosphine is subject to the reporting requirements of Section 112(r) of the Clean Air Act. The threshold quantity for this gas is 5,000 lbs (2,270 kg). Phosphine is listed in Table 1, as a Regulated Substance (Toxic Substance) in quantities of 5,000 lb (2,270 kg) or greater. Phosphine is listed in 40 CFR, Part 68 (Risk Management for Chemical Release Prevention), Table 1, as an extremely hazardous substance. The threshold quantity for Phosphine under this regulation is 5,000 lbs (2,270 kg). 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 Phosphine is listed in Appendix A. The threshold quantity for Phosphine, under this regulation is 100 lbs (45 kg).

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): Components of this gas mixture are not on the California Proposition 65 lists.

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/NDL 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), **B1** (Flammable and Combustible Material), **D1A** (Poisonous and Infectious Materials-Immediate and Serious Effects: Very Toxic), **D2A** (Chronic Toxicity: Very Toxic), and **D2B** (Poisonous and Infectious Materials-Immediate and Serious Effects: Materials Causing Other Toxic Effects: Toxic). The following symbols are required for WHMIS compliance for this gas mixture.



16. OTHER INFORMATION

CREATION DATE: January 23, 2008

REVISION DATE: September 8, 2008

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.
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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.

EXPOSURE LIMITS IN AIR:

DFG MAK Germ Cell Mutagen Categories (continued): **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.

16. OTHER INFORMATION (Continued)

DEFINITIONS OF TERMS (continued)

EXPOSURE LIMITS IN AIR:

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". *Oral Toxicity LD₅₀ Rat:* < 5000 mg/kg. *Dermal Toxicity LD₅₀ Rat 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 LD₅₀ Rat 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 LD₅₀ Rat 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 LD₅₀ Rat 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 LD₅₀ Rat 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.);

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS (continued):

FLAMMABILITY HAZARD (continued):

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. *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 ≥ 514.7 psi absolute at 21.1°C (70°F) [500 psig]. *Pyrophorics:* No Rating.

16. OTHER INFORMATION (Continued)

DEFINITIONS OF TERMS (continued)

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS (continued):

PHYSICAL HAZARD (continued):

3 (continued): *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. 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.

NATIONAL FIRE PROTECTION ASSOCIATION HAZARD RATINGS (continued):

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: 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. **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.

16. OTHER INFORMATION (Continued)

DEFINITIONS OF TERMS (continued)

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. **L_{EL}** - the lowest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source. **U_{EL}** - 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:

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:

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/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.