

MATERIAL SAFETY DATA SHEET

Prepared to U.S. OSHA, CMA, ANSI, Canadian WHMIS, European Community Standards, and the Japanese Industrial Standard JIS Z 7250: 2000

PART I What is the material and what do I need to know in an emergency?

1. PRODUCT IDENTIFICATION

TRADE NAME (AS LABELED): **BORANE, TRIFLUORO-**
CHEMICAL NAME/CLASS: Borane Gas
SYNONYMS: Boron Trifluoride; Trifluoroborane
FORMULA: 10BF₃
PRODUCT USE: Various Uses
SUPPLIER/MANUFACTURER'S NAME: **BORON PRODUCTS, LLC. A CERADYNE COMPANY**
ADDRESS: 3250 South 614 Road, Quapaw, OK 74363
 PO Box 798, Quapaw, OK 74363
24 HR EMERGENCY PHONE: InfoTrac: 1-800-535-5053
TECHNICAL CONTACT PHONE: 1-918-673-2201 (8:00 a.m. to 4:30 p.m., Mon.-Fri.)
DATE OF REVISION: August 17, 2010

2. COMPOSITION and INFORMATION ON INGREDIENTS

This product is an inorganic gas.

CHEMICAL NAME	CAS #	EINECS #	ENCS #	w/w%	EXPOSURE LIMITS IN AIR					
					ACGIH-TLV		OSHA-PEL		NIOSH IDLH ppm	OTHER ppm
					TWA ppm	STEL ppm	TWA ppm	STEL ppm		
Borane-10B, Trifluoro	15875-25-9	Unlisted	Unlisted	100	NE	1 (ceiling)	1 (ceiling)	NE	25	NIOSH REL: TWA = 1 (ceiling)

EC CLASSIFICATION: T+ [Very Toxic]; C [Corrosive]

EC RISK PHRASES: [R: 26]: [R: 35]:

NE = Not Established. NOTE (1): ALL WHMIS required information is included 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, EC Directives and the Japanese Industrial Standard JIS Z 7250: 2000.

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: Boron Trifluoride is a pungent-smelling, toxic, corrosive gas having a suffocating odor. This gas is heavier than air and fumes strongly in moist air, producing a dense, white cloud containing fluoroboric acid mist. Inhalation will cause moderate to severe irritation or burns to the respiratory system. Skin or eye contact is moderately to severely irritating or may cause burns. **Flammability Hazards:** This gas is non-flammable. If exposed to extremely high temperatures, this product can decompose to generate irritating vapors and toxic gases (e.g. boron oxides). **Reactivity Hazards:** This reacts with moisture or water to form corrosive fluoroboric acid. See Section 10 (Stability and Reactivity Hazards) **Environmental Hazards:** Releases to the environment can be harmful or fatal to plants and animals. **Emergency Recommendations:** Persons who respond to releases of this product must protect themselves from inhalation of the Boron Trifluoride gases and mists, especially in areas which are downwind of the release. Boron Trifluoride is heavier than air, and pockets of this gas can accumulate in low-lying areas. Extreme caution must be used when responding to releases.

SYMPTOMS OF OVEREXPOSURE BY ROUTE OF EXPOSURE: The most significant route of over-exposure for this gas is by inhalation and skin and eye contact. The symptoms of overexposure to this product, via route of exposure are as follows:

INHALATION: The concentration of this gas that produces acute effects after inhalation varies with the duration of the exposure. For example, an exposure of 50 ppm may be fatal if inhaled for 30-60 minutes (due to massive inflammation and congestion of the lungs). Inhalation of lower concentrations of this gas can lead to irritation of the nose and throat.

Exposures to higher concentrations of this gas can lead to symptoms such as coughing, labored breathing, sore throat, and in some instances, chemical pneumonitis and pulmonary edema. High concentrations of Borane-11B, Trifluoro- gas may cause an oxygen deficient atmosphere. Exposure to high concentrations may cause unconsciousness, and under some circumstances, death.

CONTACT WITH SKIN or EYES: Contact with Borane, Trifluoro-, or Fluoroboric Acid mist (one of the decomposition products of this gas upon contact with air) can burn the skin or eyes.

3. HAZARD IDENTIFICATION (Continued)

CONTACT WITH SKIN or EYES (continued) : Burns may not be immediately painful or visible. Depending on the nature of the exposure, the effects can be immediate or delayed. Skin contact can lead to pain, redness, and burns which can leave scars. Eye contact may result in blindness. Contact with rapidly expanding gases may also lead to frostbite.

SKIN ABSORPTION : Fluoroboric acid (one of the decomposition products of this gas upon contact with air), can penetrate the skin, causing destruction of the deep tissue layers, including bone tissue. This damage to the body's tissues may continue for days, as the fluoride ion reacts with the calcium in the skin and bone. Severe exposure to fluoroboric acid can lower the serum level of calcium (hypocalcemia), which can be fatal.

INGESTION: While ingestion is highly unlikely, ingestion of Borane, Trifluoro- can damage the tissues of the mouth, throat, esophagus, and other tissues of the digestive system. Ingestion of Borane, Trifluoro- can be fatal. Additionally, aspiration by inhalation is possible, causing chemical pneumonia or death.

INJECTION: Injection is not a significant route of exposure for this product.

OTHER HEALTH EFFECTS: Reproductive effects, such as low sperm count, have been seen in men exposed to Boron over the long-term.

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in **Lay Terms**.

ACUTE: This gas is extremely corrosive, and can burn and damage eyes, skin, mucous membranes, and any other exposed tissue. If inhaled, irritation of the respiratory system may occur, with coughing, and breathing difficulty. Over-exposure to this gas may be fatal. Though unlikely to occur during occupational use, ingestion of large quantities may be fatal.

CHRONIC: Persistent irritation may result from repeated low-level exposures to this gas. Repeated inhalation exposure to low levels of this gas can result in permanent damage to the respiratory system.

TARGET ORGANS: **ACUTE**: Skin, eyes, respiratory system. **CHRONIC**: Skin, respiratory system.

HAZARDOUS MATERIAL IDENTIFICATION SYSTEM			
HEALTH HAZARD	(BLUE)	4	
FLAMMABILITY HAZARD	(RED)	0	
PHYSICAL HAZARD	(YELLOW)	1	
PROTECTIVE EQUIPMENT			
EYES	RESPIRATORY	HANDS	BODY
SEE SECTION 8			
For Routine Industrial Use and Handling Applications			

See Section 16 for Definition of Ratings

PART II *What should I do if a hazardous situation occurs?*

4. FIRST-AID MEASURES

Contaminated individuals should be taken for medical attention if they feel unwell or if adverse effects occur. Take copy of label and MSDS to physician or health professional with contaminated individual.

SKIN EXPOSURE: If this gas contaminates the skin, immediately begin decontamination with running water. Minimum flushing is for 15 minutes. Remove exposed or contaminated clothing, taking care not to contaminate eyes. Seek immediate medical attention.

EYE EXPOSURE: If this product enters the eyes, open contaminated individual's eyes while under gently running water. Use sufficient force to open eyelids. Have contaminated individual "roll" eyes. Minimum flushing is for 15 minutes. Do not interrupt flushing. Contaminated individual must seek medical attention.

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

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Skin and respiratory disorders may be aggravated by prolonged overexposure to this product.

RECOMMENDATIONS TO PHYSICIANS: **For Inhalation Exposure**: As soon as possible (as a precautionary measure), 2.5% calcium gluconate in saline solution mist by inhalation should be provided for 20 minutes. Be observant for the initial stages of pulmonary edema or pneumonitis. Delayed pulmonary edema may occur. Keep the patient under medical observation for at least 24 hours. It is reported that inhalation of 100 percent oxygen for the first 6-8 hours of treatment is beneficial to the patient.

For Skin Contact: Exposed skin should be flushed for 15 minutes, and the following additional treatment be provided: Calcium gluconate gel (2.5%) should be rubbed into all exposed areas until pain subsides (but not longer than 30 minutes). If pain continues longer than 30 minutes, proceed with calcium gluconate injections. Care should be taken to see that all medical personnel providing treatment wear chemically-impervious gloves. In cases of severe over-exposure (more than 160 cm²), there is a potential for hypocalcemia. Therefore, systemic administration of calcium gluconate may be necessary. Frequent monitoring of serum calcium, cardiac, renal, and hepatic functions is necessary.

For Eye Contact: Exposed eyes should be flushed for 15 minutes, and the following additional treatment be provided: Treat with a continuous drip of 1 percent calcium gluconate in normal, sterile saline. No oils or ointments should be used.

5. FIRE-FIGHTING MEASURES

FLASH POINT: Not applicable.

AUTOIGNITION TEMPERATURE: Not applicable.

FLAMMABLE LIMITS (in air by volume, %):

Lower: Not applicable.

Upper: Not applicable.

FIRE EXTINGUISHING MATERIALS: Use extinguishing material suitable to the surrounding fire.

Water Spray: YES Carbon Dioxide: YES

Foam: YES Dry Chemical: YES

Halon: YES Other: Any "ABC" Class

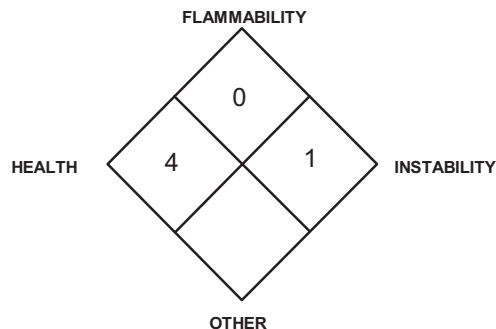
UNUSUAL FIRE AND EXPLOSION HAZARDS: In the event of fire, cool containers of this gas with water to prevent failure. This gas reacts with water to form corrosive fluoroboric acid. Use a water spray or fog to reduce or direct vapors. Do not direct a water spray at the source of a release. Water spray should be used with care. This gas can react with water to form heat, steam, and corrosive fumes.

Explosion Sensitivity to Mechanical Impact: Not applicable.

Explosion Sensitivity to Static Discharge: Not applicable.

SPECIAL FIRE-FIGHTING PROCEDURES: Incipient fire responders should wear eye protection. Structural fire fighters must wear Self-Contained Breathing Apparatus and full protective equipment. If this product is involved in a fire, fire run-off water should be contained to prevent possible environmental damage. It may be prudent to remove potentially heat-exposed cylinders from the area surrounding a fire, if it is safe for fire-fighters to do so.

NFPA RATING



See Section 16 for Definition of Ratings

6. ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK RESPONSE: Uncontrolled releases should be responded to by trained personnel using pre-planned procedures. Proper protective equipment should be used. In case of a large spill, clear the affected area, protect people, and respond with trained personnel. Minimum Personal Protective Equipment should be **Level A: triple-gloves (rubber gloves and nitrile gloves, over latex gloves), fully-encapsulating chemically resistant suit and boots, hard-hat, and Self Contained Breathing Apparatus.** Large releases of Borane, Trifluoro- will be evident by the dense, white cloud of fluoroboric acid mist which is formed. Small releases of Borane, Trifluoro- 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. Releases of Borane, Trifluoro- may also be detected by the use of wet pH paper, which will turn red upon contact with the released product. Monitor the surrounding area for oxygen and Borane, Trifluoro- gas levels. The atmosphere must have at least 19.5 percent oxygen AND the Borane, Trifluoro- level must be below 1 ppm before personnel can be allowed in the area without Self-Contained Breathing Apparatus. Attempt to close the main source valve prior to entering the area. If this does not stop the release (or it is not possible to reach the valve), allow the gas to be released in place or remove it to a safe area and allow the gas to be released there.

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

PART III *How can I prevent hazardous situations from occurring?*

7. HANDLING and STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting this product IN YOU. Wash thoroughly after using this material. Do not eat, smoke, apply cosmetics, or drink while handling this material. Use ventilation and other engineering controls to minimize potential exposure to this gas. Remove contaminated clothing immediately.

STORAGE AND HANDLING PRACTICES: All employees who handle this material should be trained to handle it safely. Avoid breathing the gas or sprays or mists generated by Borane, Trifluoro-. Store containers in a cool, dry location, away from direct sunlight, sources of intense heat, or where freezing is possible. Use only compatible materials for cylinders, process lines, and other Borane, Trifluoro-handling equipment. Chrome and aluminum are not suitable materials for cylinders for this product. Keep cylinder tightly-closed when not in use. Keep cylinders away from incompatible material. Periodic inspections of process equipment by knowledgeable persons should be made to ensure that the equipment is used appropriately and the system is kept in suitable operating condition. Borane, Trifluoro- emergency equipment should be available near the point of use.

- Workers who handle Borane, Trifluoro- should wear protective clothing, as listed in Section 8 (Exposure Controls - Personal Protection).
- Instant-acting showers should be available in the event of an emergency.
- Special eye-wash fountains or similar equipment should be available for eye irrigation.

7. HANDLING and STORAGE (Continued)

STORAGE AND HANDLING PRACTICES (continued):

- Proper respiratory protection equipment must be provided and workers using such equipment must 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, vacuum break, or trap, since suck-back may cause dangerous pressure changes within the cylinder.
- The cylinder valve should be closed after each use.

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. Use a check valve or other protective device in the discharge line to prevent hazardous backflow. Never tamper with pressure relief valves and cylinders.

Cylinders should be stored in dry, well-ventilated areas away from sources of heat, ignition and direct sunlight. Keep storage area clear of materials which can burn. Do not allow area where cylinders are stored to exceed 52 °C (125 °F). Store containers away from heavily trafficked areas and emergency exits. Store away from process and production areas, away from elevators, building and room exits or main aisles leading to exits. Protect cylinders against physical damage. Avoid storage for over six months and keep the smallest amount necessary on-site at any one time. 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.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT : Follow practices indicated in Section 6 (Accidental Release Measures). Make certain that application equipment is locked and tagged-out safely, if necessary. Collect all rinsates and disposal of in accordance with U.S. Federal, State and local regulations and those of Canada and its provinces and those of EC Member States.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

INTERNATIONAL EXPOSURE LIMITS FOR COMPONENTS : The following are exposure limits in place for Boron Trifluoride:

BORON TRIFLUORIDE:

Arab Republic of Egypt: TWA = 1 ppm (3 mg/m³), JAN 1993
 Australia: TWA = 1 ppm (3 mg/m³), JAN 1993
 Austria: MAK = 1 ppm (3 mg/m³), JAN 1999
 Belgium: STEL = 1 ppm (2.8 mg/m³), JAN 1993
 Denmark: TWA = 1 ppm (3 mg/m³), JAN 1999
 Finland: TWA = 1 ppm (3 mg/m³), STEL = 3 ppm (8.3 mg/m³), JAN 1999
 France: VLE = 1 ppm (3 mg/m³), JAN 1999
 Germany: MAK = 1 ppm (3 mg/m³), JAN 1999
 India: TWA = 1 ppm (3 mg/m³), JAN 1993
 Japan: OEL = 0.3 ppm (0.83 mg/m³), JAN 1999

BORON TRIFLUORIDE (continued):

The Netherlands: MAC-TGG = 1 ppm (3 mg/m³), JAN 1999
 Norway: TWA = 1 ppm (3 mg/m³), JAN 1999
 The Philippines: STEL = 1 ppm (3 mg/m³), JAN 1993
 Russia: TWA = 0.3 ppm, STEL = 1 mg/m³, JAN 1993
 Switzerland: MAK-W = 1 ppm (3 mg/m³), KZG-W = 2 ppm (6 mg/m³), JAN 1999
 Thailand: TWA = 1 ppm (3 mg/m³), JAN 1993
 Turkey: TWA = 1 ppm (3 mg/m³), JAN 1993
 United Kingdom: STEL = 1 ppm (2.8 mg/m³), SEP 2000
 In Argentina, Bulgaria, Colombia, Jordan, Korea, New Zealand, Singapore, Vietnam check ACGIH TLV

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation to ensure exposures are below limits provided in Section 2 (Composition and Information on Ingredients). Prudent practice is to ensure eyewash/safety shower stations are available near areas where this product is used.

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

RESPIRATORY PROTECTION : Maintain airborne contaminant concentrations below guidelines listed in Section 2 (Composition and Information on Ingredients) if applicable. If respiratory protection is needed, use only respiratory protection authorized in the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), or equivalent U.S. State standards, Canadian CSA Standard Z94.4-93, and the European Standard EN149, and EC member states, as well as requirements of Japan. 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 are NIOSH respiratory guidelines for the related gas, Boron Trifluoride.

BORON TRIFLUORIDE

CONCENTRATION RESPIRATORY PROTECTION

- Up to 10 ppm: Any Supplied-Air Respirator (SAR). Substance reported to cause eye irritation or damage; requires eye protection.
- Up to 25 ppm: Any SAR operated in a continuous-flow mode, or any Self-Contained Breathing Apparatus (SCBA) with a full facepiece, or any SAR with a full facepiece.
- Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions: Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, or any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode.
- Escape: Any Air-Purifying, Full-Facepiece Respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against Boron Trifluoride, or any appropriate escape-type, SCBA.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION (Continued)

EYE PROTECTION: Splash goggles or safety glasses. If necessary, refer to U.S. OSHA 29 CFR 1910.133, Canadian Standards, the European Standard EN166 or applicable Standards of Japan for further information.

HAND PROTECTION: Wear light-weight plastic or rubber gloves for routine industrial use. Check gloves for leaks prior to use. If necessary, refer to U.S. OSHA 29 CFR 1910.138 appropriate Standards of Canada, the European Economic Community and applicable Standards of Japan.

BODY PROTECTION: If necessary, use body protection appropriate for task (e.g., Tyvek suit, rubber apron). If necessary, use body protection appropriate for task (e.g., Tyvek suit, rubber apron). If necessary, refer to appropriate Standards of Canada, the European Economic Community or Japan. 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.

9. PHYSICAL and CHEMICAL PROPERTIES

PHYSICAL STATE: Gas

EVAPORATION RATE (nBuAc = 1): Not applicable.

VAPOR DENSITY @ 21.1°C (70°F) (air = 1): 2.34

SPECIFIC GRAVITY (water = 1): See vapor density

MELTING/FREEZING POINT @ 1 ATM: -128.4 °C (-199.12°F)

SOLUBILITY IN WATER (wt %): 77% with some hydrolysis

BOILING POINT: -100°C (-148°F)

VAPOR PRESSURE: Not applicable.

pH: Not applicable

ODOR: Sharp pungent odor

% VOLATILE: 100%

MOLECULAR WEIGHT: 67.81

COEFFICIENT OF OIL/WATER DISTRIBUTION (PARTITION COEFFICIENT): Not available.

APPEARANCE, ODOR AND COLOR: This is a colorless, fuming, pungent smelling gas. This gas is heavier than air and fumes strongly in moist air, producing a dense, white, cloud of fluoroboric acid mist.

HOW TO DETECT THIS SUBSTANCE (warning properties): The odor and dense, white appearance of this gas, upon release, are distinctive warning properties associated with this product.

10. STABILITY and REACTIVITY

STABILITY: Boron Trifluoride decomposes upon exposure to air.

DECOMPOSITION PRODUCTS: Boron Trifluoride reacts with water to form fluoroboric acid, boric acid, heat and steam.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: This gas is not compatible with polymerizable materials, water, alkali metals, and all alkaline earth metals except magnesium. Hydrogen Fluoride, a decomposition product of this gas, is not compatible with the following materials: strong bases, glass, ceramics, silicon-based compounds, metals, metal alkalis.

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Moisture, water and contact with incompatible chemicals. Avoid exposing cylinders to extremely high temperatures, which can cause cylinders to rupture or burst.

PART IV *Is there any other useful information about this material?*

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: The following are toxicological data for Boron Trifluoride:

BORON TRIFLUORIDE:

LC (Inhalation-Dog) > 1000 ppm/3 hours:
Lungs, Thorax, or Respiration: structural or functional change in trachea or bronchi, respiratory depression

LC₅₀ (Inhalation-Rat) 1180 mg/m³/4 hours

LC₅₀ (Inhalation-Rat) 1180 mg/m³: Sense Organs and Special Senses (Eye): lacrimation; Lungs, Thorax, or Respiration: acute pulmonary edema, dyspnea

LC₅₀ (Inhalation-Mouse) 3460 mg/m³/2 hours:
Behavioral: somnolence (general depressed activity); Lungs, Thorax, or Respiration: cyanosis; Blood: hemorrhage

LC₅₀ (Inhalation-Mouse) 3460 mg/m³: Sense Organs and Special Senses (Eye): lacrimation; Lungs, Thorax, or Respiration: acute pulmonary edema, dyspnea

LC₅₀ (Inhalation-Guinea Pig) 109 mg/m³/4 hours: Behavioral: somnolence (general depressed activity); Lungs, Thorax, or Respiration: cyanosis; Blood: hemorrhage

BORON TRIFLUORIDE (continued):

LC₅₀ (Inhalation-Guinea Pig) 110 mg/m³: Sense Organs and Special Senses (Eye): lacrimation; Lungs, Thorax, or Respiration: acute pulmonary edema, dyspnea

LCLo (Inhalation-Mouse) 2100 mg/m³/5 hours:
Sense Organs and Special Senses (Eye): lacrimation; Lungs, Thorax, or Respiration: acute pulmonary edema, dyspnea

LCLo (Inhalation-Rat) 2100 mg/m³/5 hours:
Sense Organs and Special Senses (Eye): lacrimation; Lungs, Thorax, or Respiration: acute pulmonary edema, dyspnea

TCLo (Inhalation-Mammal-species unspecified) 8 mg/m³: Lungs, Thorax, or Respiration: cough

LCLo (Inhalation-Guinea Pig) 2100 mg/m³/5 hours: Sense Organs and Special Senses (Eye): lacrimation; Lungs, Thorax, or Respiration: acute pulmonary edema, dyspnea

BORON TRIFLUORIDE (continued):

TCLo (Inhalation-Rat) 12,800 ppb/7 hours/65 days-intermittent: Lungs, Thorax, or Respiration: fibrosis, focal (pneumoconiosis); Related to Chronic Data: death

TCLo (Inhalation-Rat) 10 mg/m³/4 hours/17 weeks-intermittent: Sense Organs and Special Senses (Olfaction): effect, not otherwise specified; Lungs, Thorax, or Respiration: structural or functional change in trachea or bronchi; Blood: changes in leukocyte (WBC) count

TCLo (Inhalation-Rat) 10 mg/m³/4 hours/16 weeks-intermittent: Lungs, Thorax, or Respiration: other changes; Liver: liver function tests impaired; Blood: changes in leukocyte (WBC) count

TCLo (Inhalation-Rat) 34 mg/m³/7 hours/61 days-intermittent: Lungs, Thorax, or Respiration: other changes; Liver: liver function tests impaired; Blood: changes in leukocyte (WBC) count

11. TOXICOLOGICAL INFORMATION (Continued)

TOXICITY DATA (continued):

BORON TRIFLUORIDE (continued):

TCLo (Inhalation-Guinea Pig) 12,800 ppb/7 hours/65 day s-intermittent: Lungs, Thorax, or Respiration: bronchiolar constriction; Nutritional and Gross Metabolic: changes in metals, not otherwise specified; Related to Chronic Data: death

TCLo (Inhalation-Guinea Pig) 3 mg/m³/4 hours/17 weeks-intermittent: Lungs, Thorax, or Respiration: structural or functional change in trachea or bronchi; Blood: changes in leukocyte (WBC) count

TCLo (Inhalation-Mouse) 30 mg/m³/15 day s-intermittent: Blood: changes in serum composition (e.g. TP, bilirubin, cholesterol); Biochemical: Enzyme inhibition, induction, or change in blood or tissue levels: true cholinesterase; Related to Chronic Data: death

BORON TRIFLUORIDE (continued):

TCLo (Inhalation-Guinea Pig) 30 mg/m³/15 days-intermittent: Blood: changes in serum composition (e.g. TP, bilirubin, cholesterol); Biochemical: Enzyme inhibition, induction, or change in blood or tissue levels: true cholinesterase Related to Chronic Data: death

TCLo (Inhalation-Guinea Pig) 10 mg/m³/4 hours/16 weeks-intermittent: Lungs, Thorax, or Respiration: other changes; Liver: liver function tests impaired; Blood: changes in leukocyte (WBC) count

TCLo (Inhalation-Rabbit) 10 mg/m³/4 hours/16 weeks-intermittent: Lungs, Thorax, or Respiration: other changes; Liver: liver function tests impaired; Blood: changes in leukocyte (WBC) count

BORON TRIFLUORIDE (continued):

TCLo (Inhalation-Rabbit) 34 mg/m³/7 hours/61 days-intermittent: Lungs, Thorax, or Respiration: other changes; Liver: liver function tests impaired; Blood: changes in leukocyte (WBC) count

TCLo (Inhalation-Guinea Pig) 34 mg/m³/7 hours/61 day s-intermittent: Lungs, Thorax, or Respiration: other changes; Liver: liver function tests impaired; Blood: changes in leukocyte (WBC) count

SUSPECTED CANCER AGENT: This gas is not found on the following lists: FEDERAL OSHA Z LIST, NTP, IARC, and CAL/OSHA, and therefore is neither considered to be nor suspected to be cancer-causing agents by these agencies.

IRRITANCY OF PRODUCT: This gas is severely irritating or will cause burns to all contaminated tissue.

SENSITIZATION TO THE PRODUCT: Borane, Trifluoride- is not known to be a human skin or respiratory sensitizer.

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

Mutagenicity: Borane, Trifluoride- is not reported to cause reproductive effects in humans.

Embryotoxicity: Borane, Trifluoride- is not reported to produce embryotoxic effects in humans.

Teratogenicity: Borane, Trifluoride- is not reported to cause teratogenic effects in humans.

Reproductive Toxicity: Borane, Trifluoride- is not reported to cause reproductive effects in humans.

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

BIOLOGICAL EXPOSURES INDICES (BEIs): Currently, the following exposure Biological Exposure Indices (BEIs) are applicable to Boron Trifluoride, as a Fluoride Compound.

CHEMICAL DETERMINANT	SAMPLING TIME	BEI
FLUORIDES • Fluorides in urine	• Prior to shift • End of shift	• 3 mg/g creatinine • 10 mg/g creatinine

12. ECOLOGICAL INFORMATION

ALL WORK PRACTICES MUST BE AIMED AT ELIMINATING ENVIRONMENTAL CONTAMINATION.

ENVIRONMENTAL STABILITY: This gas will dissipate rapidly in the environment. The following are environmental data available for Boron Trifluoride:

BORON TRIFLUORIDE:

Soil Adsorption/Mobility: Some boron is adsorbed by iron and aluminum hydroxy compounds and clay minerals. Finer textured soils retain added boron longer than do coarse, sandy soils. Boron sorption by clay minerals and iron and aluminum oxides is pH dependent, with maximum sorption in the range 7-9. The amount of boron adsorbed depends on the surface area of the clay or oxide and this sorption is only partially reversible.

EFFECT OF MATERIAL ON PLANTS OR ANIMALS: This gas may cause adverse effects on terrestrial plants and animals especially if release in large quantities.

EFFECT OF CHEMICAL ON AQUATIC LIFE: This gas may cause adverse effects on aquatic plants and animals if released into an aquatic environment, especially if release in large quantity.

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations. This product, if unaltered by use, may be disposed of by treatment at a permitted facility or as advised by your local waste regulatory authority. Empty containers, as defined by appropriate sections of RCRA, are not RCRA hazardous wastes. Insure proper management of any residuals remaining in containers.

EPA WASTE NUMBER: Not applicable.

14. TRANSPORTATION INFORMATION

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

PROPER SHIPPING NAME: Boron trifluoride, compressed
HAZARD CLASS NUMBER and DESCRIPTION: 2.3
UN IDENTIFICATION NUMBER: UN 1008
DOT LABEL(S) REQUIRED: Class 2.3 (Toxic Gas)
PACKAGING GROUP: Not Applicable
NORTH AMERICAN RESPONSE GUIDEBOOK NUMBER (2000): 125

MARINE POLLUTANT: Boron is not listed as a marine pollutant as per D.O.T. (49 CFR 172.101, Appendix B).

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

PROPER SHIPPING NAME: Boron trifluoride, compressed
HAZARD CLASS NUMBER and DESCRIPTION: Class 2.3 (Toxic Gas); Class 8 (Corrosive)
UN IDENTIFICATION NUMBER: UN 1008
PACKING GROUP: Not Applicable
HAZARD LABEL(S) REQUIRED: Class 2.3 (Toxic Gas); Class 8 (Corrosive)
SPECIAL PROVISIONS: None
EXPLOSIVE LIMIT & LIMITED QUANTITY INDEX: 0
ERAP INDEX: 25
PASSENGER CARRYING SHIP INDEX: Forbidden
PASSENGER CARRYING ROAD OR RAIL VEHICLE INDEX: Forbidden

MARINE POLLUTANT: This gas is not a Marine Pollutant under Transport Canada regulations.

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA): This product is classified, by rules of IATA, as follows:

PROPER SHIPPING NAME: Boron trifluoride, compressed
HAZARD CLASS NUMBER and DESCRIPTION: Class 2.3 (Toxic Gas); Class 8 (Corrosive)
UN IDENTIFICATION NUMBER: UN 1008
PACKING GROUP: Not Applicable
HAZARD LABEL(S) REQUIRED: Class 2.3 (Toxic Gas); Class 8 (Corrosive)
PASSENGER & CARGO AIRCRAFT PACKING INSTRUCTION: None
PASSENGER & CARGO AIRCRAFT MAXIMUM NET QUANTITY/PKG: None
CARGO AIRCRAFT ONLY PACKING INSTRUCTION: Forbidden
CARGO AIRCRAFT ONLY MAXIMUM NET QUANTITY/PKG: Forbidden

SPECIAL PROVISIONS: A2
ERG CODE: 2CP

INTERNATIONAL MARITIME ORGANIZATION (IMO): This product is classified as follows, per rules of the IMO.

UN IDENTIFICATION NUMBER: UN 1008
PROPER SHIPPING NAME: Boron trifluoride, compressed
CLASS: 2.3
SUBSIDIARY RISK: 8
PACKING GROUP: Not Applicable
SPECIAL PROVISIONS: None
HAZARD LABEL(S) REQUIRED: Class 2.3 (Toxic Gas); Class 8 (Corrosive)
LIMITED QUANTITIES: None
PACKING INSTRUCTION: P200

EmS: F-C, S-U

STOWAGE AND SEGREGATION: Category D. Clear of living quarters.

EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD

(ADR): This is classified as follows, per regulations of the U.N. Economic Commission for Europe.

UN NUMBER: UN 1008
NAME AND DESCRIPTION: Boron trifluoride
CLASS: 2
CLASSIFICATION CODE: 1A
PACKING GROUP: Not Applicable
LABELS: 2.3 + 8
SPECIAL PROVISIONS: None
LIMITED QUANTITIES: LQ0
PACKING INSTRUCTION: P200
MIXED PACKING INSTRUCTION: MP9
HAZARD IDENTIFICATION NUMBER: 268

15. REGULATORY INFORMATION

U.S. STATE AND FEDERAL REGULATIONS:

U.S. SARA REPORTING REQUIREMENTS: Borane, Trifluoro- 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)
Boron Trifluoride	Yes	Yes	Yes

U.S. SARA 302 EXTREMELY HAZARDOUS THRESHOLD PLANNING QUANTITY: Boron Trifluoride = 500 lb (270 kg)

U.S. SARA 304 EXTREMELY HAZARDOUS REPORTABLE QUANTITY (RQ): Boron Trifluoride = 500 lb (270 kg)

U.S. CERCLA REPORTABLE QUANTITY (RQ): Boron Trifluoride does not have a specific CERCLA RQ although it is a CERCLA Hazardous Substance.

U.S. TSCA INVENTORY STATUS: Borane, Trifluoro- is produced under a LVE in compliance with TSCA regulations

OTHER U.S. FEDERAL REGULATIONS: Boron Trifluoride is subject to the reporting requirements of Section 112(r) of the Clean Air Act. The Threshold Quantity of Boron Trifluoride is 5000 lb (2270 kg).

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): Borane, Trifluoro- is not on the California Proposition 65 Lists.

ANSI LABELING (Z129.1): POISONOUS, CORROSIVE HIGH PRESSURE GAS. CAN CAUSE EYE, SKIN BURNS, AND RESPIRATORY TRACT BURNS. MAY CAUSE KIDNEY DAMAGE, (based on animal data). Do not breath gas. Store and use with adequate ventilation, and use in closed systems. Do not get in eyes, on skin or clothing. Close valve after each use and when empty. Use with equipment cleaned of compatible materials of construction and rated for cylinder pressure. Use in accordance with the Material Safety Data Sheet. Use in accordance with the Material Safety Data Sheet.



POISON

CALL A PHYSICIAN



FIRST-AID:

IF INHALED, remove to fresh air. If not breathing, give artificial respiration. (Rescuer may receive chemical burns as a result of giving mouth-to-mouth). If breathing is difficult, give oxygen. Call a physician.

IN CASE OF CONTACT, immediately flush eyes or skin with water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash clothing before reuse. (Discard contaminated shoes).

DO NOT REMOVE THIS PRODUCT LABEL.

ADDITIONAL CANADIAN REGULATIONS:

CANADIAN DSL/NDL INVENTORY: Boron Trifluoride is listed on the DSL Inventory.

OTHER CANADIAN REGULATIONS: Not applicable.

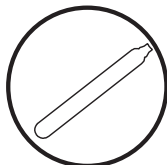
CANADIAN ENVIRONMENTAL PROTECTION AGENCY (CEPA) PRIORITY SUBSTANCES LISTS: This material is on the CEPA Priorities Substances Lists, as a fluoride compound, and is considered "Toxic" and on the First Priorities Substance List.

CANADIAN WHMIS CLASSIFICATION and SYMBOLS:

Class A: Compressed Gases

Class D1A: Toxic Material/Immediate and Serious Effects

Class E: Corrosive



ADDITIONAL EUROPEAN COMMUNITY INFORMATION:

EUROPEAN COMMUNITY REGULATIONS:

EC LABELING AND CLASSIFICATION: Boron Trifluoride is listed as follows:

EC CLASSIFICATION: T+ [Very Toxic]; C [Corrosive]

EC RISK PHRASES: [R: 26]: Very toxic by inhalation. [R: 35]: Cause severe burns.

15. REGULATORY INFORMATION (Continued)

ADDITIONAL EUROPEAN COMMUNITY INFORMATION (continued):

EUROPEAN COMMUNITY REGULATIONS (continued):

EC SAFETY PHRASES: [S: 21/2]: Keep locked up and out of reach of children. (This safety phrase can be omitted from the label when the substance or preparation is sold for industrial use only.) [S: 9]: Keep container in a well-ventilated. [S: 26]: In case of contact with the eyes, rinse immediately with plenty of water. [S: 36/37/39]: Wear suitable protective clothing, gloves and eye/face protection. [S: 45]: In case of accident or if you feel unwell, seek medical advice immediately (show label where possible).

EC CLASSIFICATION SYMBOLS:



ADDITIONAL JAPANESE REGULATIONS:

JAPANESE ENCS: This gas is on the ENCS Inventory.

16. OTHER INFORMATION

The information contained herein is furnished without warranty of any kind. Persons using this product should consider these data only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use and disposal of this material, the safety of health of employees and customers and the protection of the environment.

DEFINITIONS OF TERMS

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

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

EXPOSURE LIMITS IN AIR:

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

LOQ: Limit of Quantitation.

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

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

NIC: Notice of Intended Change.

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

NIOSH RELs: NIOSH's Recommended Exposure Limits.

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

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

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

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

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

EXPOSURE LIMITS IN AIR (continued):

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

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS: This rating system was developed by the National Paint and Coating Association and has been adopted by industry to identify the degree of chemical hazards.

HEALTH HAZARD:

0 (Minimal Hazard): No significant health risk, irritation of skin or eyes not anticipated. *Skin Irritation:* Essentially non-irritating. PII or Draize = "0".

Eye Irritation: Essentially non-irritating, or minimal effects which clear in < 24 hours [e.g. mechanical irritation]. Draize = "0". *Oral Toxicity LD₅₀ Rat:* < 5000 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit:* < 2000 mg/kg. *Inhalation Toxicity 4-hrs LC₅₀ Rat:* < 20 mg/L.; **1 (Slight Hazard: Minor reversible Injury)** may occur; slightly or mildly irritating. *Skin Irritation:* Slightly or mildly irritating. *Eye Irritation:* Slightly or mildly irritating. *Oral Toxicity LD₅₀ Rat:* > 500-5000 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit:* > 1000-2000 mg/kg. *Inhalation Toxicity LC₅₀ 4-hrs Rat:* > 2-20 mg/L.; **2 (Moderate Hazard):**

Temporary or transitory injury may occur. *Skin Irritation:* Moderately irritating; primary irritant; sensitizer. PII or Draize > 0, < 5. *Eye Irritation:* Moderately to severely irritating and/or corrosive; reversible corneal opacity; corneal involvement or irritation clearing in 8-21 days. Draize > 0, ≤ 25. *Oral Toxicity LD₅₀ Rat:* > 50-500 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit:* > 200-1000 mg/kg. *Inhalation Toxicity LC₅₀ 4-hrs Rat:* > 0.5-2 mg/L.); **3 (Serious Hazard: Major injury likely unless prompt action is taken and medical treatment is given; high level of toxicity; corrosive.)** *Skin Irritation:* Severely irritating and/or corrosive; may destroy dermal tissue, cause skin burns, dermal necrosis. PII or Draize > 5-8 with destruction of tissue. *Eye Irritation:* Corrosive, irreversible destruction of ocular tissue; corneal involvement or irritation persisting for more than 21 days. Draize > 80 with effects irreversible in 21 days. *Oral Toxicity LD₅₀ Rat:* > 1-50 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit:* > 20-200 mg/kg. *Inhalation Toxicity LC₅₀ 4-hrs Rat:* > 0.05-0.5 mg/L.);

DEFINITIONS OF TERMS (Continued)

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS (continued):

HEALTH HAZARD (continued):

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

FLAMMABILITY HAZARD:

0 (Minimal Hazard-Materials that will not burn in air when exposure to a temperature of 815.5 °C [1500 °F] for a period of 5 minutes.); **1** (Slight Hazard-Materials that must be pre-heated before ignition can occur. Material require considerable pre-heating, under all ambient temperature conditions before ignition and combustion can occur, including: Materials that will burn in air when exposed to a temperature of 815.5°C (1500°F) for a period of 5 minutes or less; Liquids, solids and semisolids having a flash point at or above 93.3 °C [200 °F] (e.g. OSHA Class III-B, or; Most ordinary combustible materials [e.g. wood, paper, etc.]; **2** (Moderate Hazard-Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not, under normal conditions, form hazardous atmospheres in air, but under high ambient temperatures or moderate heating may release vapor in sufficient quantities to produce hazardous atmospheres in air, including: Liquids having a flash-point at or above 37.8°C [100°F]; Solid materials in the form of course dusts that may burn rapidly but that generally do not form explosive atmospheres; Solid materials in 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.);

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS (continued):

PHYSICAL HAZARD (continued):

2 (*Water Reactivity*: Materials that may react violently with water. *Organic Peroxides*: Materials that, in themselves, are normally unstable and will readily undergo violent chemical change, but will not detonate. These materials may also react violently with water. *Explosives*: Division 1.4 – Explosive substances where the explosive effect are largely confined to the package and no projection of fragments of appreciable size or range are expected. An external fire must not cause virtually instantaneous explosion of almost the entire contents of the package. *Compressed Gases*: Pressurized and meet OSHA definition but < 514.7 psi absolute at 21.1 °C (70°F) [500 psig]. *Pyrophorics*: No Rating. *Oxidizers*: Packing Group II *Solids*: any material that, either in concentration tested, exhibits a mean burning time of less than or equal to the mean burning time of a 2:3 potassium bromate/cellulose mixture and the criteria for Packing Group I are not met. *Liquids*: any material that exhibits a mean pressure rise time less than or equal to the pressure rise of a 1:1 aqueous sodium chlorate solution (40%)/cellulose mixture and the criteria for Packing Group I are not met. *Unstable Reactives*: Substances that may polymerize, decompose, condense, or self-react at ambient temperature and/or pressure, but have a low potential for significant heat generation or explosion. Substances that readily form peroxides upon exposure to air or oxygen at room temperature); **3** (*Water Reactivity*: Materials that may form explosive reactions with water. *Organic Peroxides*: Materials that are capable of detonation or explosive reaction, but require a strong initiating source, or must be heated under confinement before initiation; or material 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. *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 (material that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials); **1** (materials that on exposure under fire conditions could cause irritation or minor residual injury); **2** (materials that on intense or continued exposure under fire conditions could cause temporary incapacitation or possible residual injury); **3** (materials that can on short exposure could cause serious temporary or residual injury); **4** (materials that under very short exposure could cause death or major residual injury).

FLAMMABILITY HAZARD: 0 Materials that will not burn under typical fire conditions, including intrinsically noncombustible materials such as concrete, stone, and sand. **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. **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.

DEFINITIONS OF TERMS (Continued)

NATIONAL FIRE PROTECTION ASSOCIATION HAZARD RATINGS (continued):

FLAMMABILITY HAZARD (continued): **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. **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.

INSTABILITY HAZARD: **0** Materials that in themselves are normally stable, even under fire conditions. **1** Materials that in themselves are normally stable, but that can become unstable at elevated temperatures and pressures. **2** Materials that readily undergo violent chemical change at elevated temperatures and pressures. **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. **4** Materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction 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**, **TC_o**, **LCL_o**, and **LCo**, the lowest dose (or concentration) to cause lethal or toxic effects. **Cancer Information:** The sources are: **IARC** - the International Agency for Research on Cancer; **NTP** - the National Toxicology Program, **RTECS** - the Registry of Toxic Effects of Chemical Substances, **OSHA** and **CAL/OSHA**. IARC and NTP rate chemicals on a scale of decreasing potential to cause human cancer with rankings from 1 to 4. Subrankings (2A, 2B, etc.) are also used. **Other Information:** **BEI** - ACGIH Biological Exposure Indices, represent the levels of determinants which are most likely to be observed in specimens collected from a healthy worker who has been exposed to chemicals to the same extent as a worker with inhalation exposure to the TLV.

ECOLOGICAL INFORMATION:

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

REGULATORY INFORMATION:**U.S. and CANADA:**

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

EUROPEAN and INTERNATIONAL:

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