



MATERIAL SAFETY DATA SHEET

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

SECTION 1. PRODUCT IDENTIFICATION

PRODUCT NAME: BORON TRIFLUORIDE
CHEMICAL NAME: Boron Trifluoride
FORMULA: Boron Trifluoride = BF₃
SYNONYMS: Boron Fluoride; Trifluoroborane; Boron Trifluoride, compressed
MANUFACTURER: SPECTRA GASES, INC.
ADDRESS: 3434 Route 22 West
 Branchburg, NJ 08876, U.S.A.
PHONE: 908/252-9300
FAX: 908/252-0811
WEB SITE: www.spectra-gases.com
SPECTRA GASES EMERGENCY CONTACT: 800-932-0624 8:30am - 7:00pm
24 HOUR EMERGENCY CONTACT, CHEMTREC: 800/424-9300, 703-527-3887
DATE OF REVISION: May 25, 2004
MSDS NUMBER: 1043
PRODUCT USE: Various

SECTION 2. COMPOSITION and INFORMATION ON INGREDIENTS

COMPOSITION: Boron Trifluoride 100%
CAS NUMBER: Boron Trifluoride 7637-07-2
EINECS NUMBER: Boron Trifluoride 231-569-5
EXPOSURE LIMITS: (10,000 ppm = 1%)

OSHA PELs:	ACGIH TLVs:	NIOSH RELs:
STEL = 1 ppm (ceiling)	STEL = 1 ppm (ceiling)	STEL = 1 ppm (ceiling) IDLH = 25 ppm

SECTION 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 hydrofluoric acid mist. Exposure to this gas can cause severe irritation or burns to exposed tissue, by all routes of exposure. If involved in a fire Boron Trifluoride will decompose to produce hydrogen fluoride (or hydrofluoric acid) and other toxic gases of fluoride compounds. This gas is heavier than air and may accumulate in low-lying areas. Persons who respond to releases of this product must use extreme caution and protect themselves from inhalation of the Boron Trifluoride gas and mists. In a leak situation, all persons must be especially aware of areas which are downwind of the release.

ROUTES OF ENTRY, SYMPTOMS OF ACUTE EXPOSURE: WARNING - If rescue personnel need to enter an area suspected of having a toxic level of Boron Trifluoride, they should be equipped with Self-Contained Breathing Apparatus (SCBA), and, if available, a full-body, chemically resistant suit. Acute overexposure to this gas may cause the following health effects:

EYE CONTACT: Eye contact with this gas can cause severe irritation or burns. Release of a high-pressure gas may result in airborne objects.

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

INHALATION: Boron Trifluoride is corrosive to the respiratory system. Boron Trifluoride is also toxic by inhalation. The concentration of Boron Trifluoride 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 Boron Trifluoride 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 Boron Trifluoride gas may cause an oxygen deficient atmosphere. Exposure to high concentrations may cause unconsciousness, and under some circumstances, death. Effects of exposure by inhalation can be delayed.

SECTION 3. HAZARD IDENTIFICATION (Continued)

SKIN CONTACT: Contact of this gas with the skin can be severely irritating or cause burns. 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. Contact with moist skin can result in formation of hydrofluoric acid. See below for further information.

OTHER HEALTH EFFECTS: It is important to note that Boron Trifluoride may react with water or moist air to generate hydrofluoric acid solution or hydrogen fluoride gas, which can penetrate the skin, causing destruction of the deep tissue layers, including bone tissue. This damage can continue for days, as the fluoride ion reacts with calcium in skin and bone. If 20% or more of the body is contaminated with hydrofluoric acid, hypocalcemia (a life-threatening lowering of serum calcium in the body) may result.

HMIS RATINGS: HEALTH HAZARD: = 4; FLAMMABILITY HAZARD: = 0; PHYSICAL HAZARD: = 1;

ROUTES OF ENTRY, SYMPTOMS OF CHRONIC EXPOSURE:

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

TARGET ORGANS: Skin, respiratory system, eyes, bones, ligaments, liver and kidneys.

SYMPTOMS: Persistent irritation may result from repeated low-level exposure to this gas. Repeated over-exposure to low levels of Boron Trifluoride for extended periods of time (i.e. years or decades) may lead to a condition called fluorosis, which is a weakening and degeneration of bone structure and can result in emphysema and erosion or mottling of teeth. Chronic exposure can also lead to damage to liver and kidneys.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE: Pre-existing dermatitis, other skin conditions, and respiratory disorders may be aggravated by over-exposure to this gas. Additionally, repeated over-exposure to low levels of Boron Trifluoride for extended periods of time (i.e. years or decades) may aggravate dental problems, heart conditions, bone disorders, and eye problems.

CARCINOGENICITY: Boron Trifluoride is not found on the FEDERAL OSHA Z LIST, NTP, CAL/OSHA, or IARC Carcinogenicity lists and therefore are neither considered to be nor suspected to be cancer-causing agents by these agencies.

SECTION 4. FIRST AID MEASURES

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

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

INHALATION: Remove victim(s) to fresh air, as quickly as possible. Trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation, if necessary. In the event of severe, immediate effects or delayed symptoms that develop after exposure, victim must seek appropriate medical attention.

SKIN CONTACT: If this gas contaminates the skin, immediately begin decontamination with running water. Minimum flushing is for 15 minutes. If necessary, calcium gluconate gel can be applied to affected areas. Remove exposed or contaminated clothing, taking care not to contaminate eyes. Victim should seek appropriate medical attention if symptoms persist. In case of frostbite, place the frostbitten part in warm water. **DO NOT USE HOT WATER.** If warm water is not available, or is impractical to use, wrap the affected parts gently in blankets. Alternatively, if the fingers or hands are frostbitten, place the affected area in the armpit. Encourage victim to gently exercise the affected part while being warmed. Seek immediate medical attention.

NOTES TO PHYSICIANS: Treatment for chemical asphyxiation may be necessary after over-exposure occurs. At high levels of over-exposure and the onset of symptoms of hemolysis, therapeutic intervention may be necessary, including oxygen, methylene blue and exchange transfusion. The occurrence of hemolysis requires careful monitoring for the degree of anemia and the potential for impaired kidney function. Additionally, treatment similar to that for Hydrogen Fluoride over-exposure should be considered. The following information is to assist physicians in the treatment of exposure to fluoride compounds.

For Inhalation Exposure: Administer 100% oxygen at half-hour intervals for three to four hours for victims of minor inhalation exposure. For serious inhalation exposure, 100% oxygen administration should begin immediately, under positive pressure (<4 cm) for half-hour periods for at least six hours until breathing is easy and the color of the skin and mucous membranes is normal.

For Skin Contact: For skin contamination, all areas of exposure should be flushed with copious quantities of water, followed by an iced aqueous or alcoholic solution of 0.13% benzalkonium chloride, iced 70% alcohol, or an ice-cold saturated solution of magnesium sulfate. If the area of burn cannot be drenched or immersed in solution, apply cold compresses containing the materials of the solution. After the iced solution treatment, application of a paste of powdered magnesium oxide and glycerin should be administered. The paste should be applied daily for several days. The prevention of serious burns can be prevented by infiltration of the skin and subcutaneous tissues with a 10% calcium gluconate solution, along with a local anesthetic. Care should be taken to see that all medical personnel providing treatment wear chemically-impervious gloves.

SECTION 4. FIRST AID MEASURES (Continued)

NOTES TO PHYSICIANS - For Skin Contact (continued): 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.

SECTION 5. FIRE FIGHTING MEASURES

FLASH POINT: Not Applicable

AUTOIGNITION: Not Applicable

FLAMMABLE RANGE: Not Applicable

NFPA RATINGS:

HEALTH: = 4 FLAMMABILITY: = 0

INSTABILITY: = 1 SPECIAL: None

EXTINGUISHING MEDIA: This gas is non-flammable; use extinguishing agent appropriate for surrounding materials in a fire.

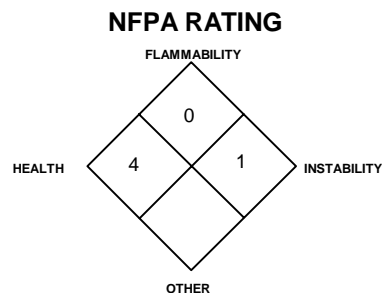
SPECIAL FIRE-FIGHTING PROCEDURES: Non-flammable. In the event of fire, cool containers of this product with water spray to prevent failure. Water should be used with care as contact with water will result in formation of highly toxic hydrogen fluoride gas and hydrofluoric acid.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Releases of Boron Trifluoride presents a severe contact hazard to firefighters. Exposure to high heat, as in a fire situation, can cause the cylinder to rupture. Contact with water can result in formation of hydrogen fluoride or hydrofluoric acid. This reaction can be in the form of a dense, white cloud, which is corrosive and limit visibility.

EXPLOSION SENSITIVITY TO MECHANICAL IMPACT: Not sensitive.

EXPLOSION SENSITIVITY TO STATIC DISCHARGE: Not sensitive.

HAZARDOUS COMBUSTION PRODUCTS: Decomposition of this gas will generate hydrogen fluoride (hydrofluoric acid).



See Section 16 for
Definition of Ratings

SECTION 6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: In the event of a leak of this product, operator should close the gas source if possible to do so safely. Evacuate immediate area. Only trained personnel, wearing Self-Contained Breathing Apparatus (SCBA) and a chemically resistant suit should re-enter a contaminated area.

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

Levels of Boron Trifluoride should be below applicable exposure levels listed in Section 2 (Composition / Information on Ingredients) before personnel can be allowed in the area without SCBA. Detection systems may be considered to monitor for leaks and to measure the level of Boron Trifluoride.

SECTION 7. HANDLING AND STORAGE

STORAGE: Cylinders should be stored upright (with valve protection caps or plugs in place) and firmly secured to prevent falling or being knocked over. Cylinders should be stored in dry, well-ventilated areas. Protect from salt or other corrosive materials. Post "No Smoking or Open Flames" signs in storage or use areas. Cylinders of Boron Trifluoride should be stored away from organic or combustible materials. Storage should be away from heavily traveled areas, walkways, elevators, platform edges or other objects or situations that could damage the cylinder wall. Do not store in a manner that will block emergency exits, fire extinguishers or other safety equipment. Do not allow storage temperature to exceed 125°F (52°C). Use a first-in, first-out inventory system to prevent full containers from being stored for long periods of time. Store empty cylinders away from full cylinders. Consideration should be taken to install leak detection and alarm equipment for storage areas. **NOTE:** Use only DOT or ASME code cylinders designed for compressed gas storage. Cylinders must not be recharged except by or with the consent of owner.

HANDLING: Boron Trifluoride can be dangerous and should only be handled by trained personnel. Spectra Gases, Inc., strongly recommends that this gas only be handled in areas with extensive venting capabilities. Monitoring may be considered for areas in which this gas is used. Detection of Boron Trifluoride odor should trigger immediate response and corrective action. Contaminated clothing should be removed and laundered separately before reuse. **Before using this gas, meticulous leak checking using inert gas is strongly recommended, particularly after new connections are made.** (continued on following page)

SECTION 7. HANDLING AND STORAGE (Continued)

HANDLING (continued): Cylinder valves should be inspected regularly for physical damage or corrosion (apparent by discoloration or rust). Care should be taken to inspect the following valve locations for corrosion: neck (where valve inserts into cylinder); bonnet nut (where handle attaches to valve body). Close valve after each use and when empty. The failure of a valve can result in violent release of the pressurized gas, creating a severe mechanical injury hazard. Use only compatible materials for cylinders, process lines, and other Boron Trifluoride-handling equipment. Do not store cylinders of Boron Trifluoride with materials which could react with Boron Trifluoride or Hydrogen Fluoride: polymerizable materials, water, alkali metals, and all alkaline earth metals except magnesium, strong bases, glass, ceramics, silicon-based compounds.. Lines should be purged with dry nitrogen both before and after maintenance activity. Systems which will operate at elevated temperatures should be passivated prior to introduction of Boron Trifluoride. Passivated systems or components of those systems that have been exposed to moisture should be re-passivated prior to use.

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

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

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Purge gas-handling equipment with inert gas and relieve pressure before attempting repairs.

SPECIAL PRECAUTIONS: Always store and handle compressed gas cylinders in accordance with Compressed Gas Association, Inc. (telephone 703-412-0900) pamphlet CGA P-1, *Safe Handling of Compressed Gases in Containers*. Local regulations may require specific equipment for storage and use.

SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Forced ventilation systems for the general work area should be provided. Spectra Gases, Inc. recommends that cylinders in use be secured within a ventilated enclosure such as a gas cabinet. Ductwork should be constructed of non-metallic material, or should be lined to resist corrosion. Employee exposure should be monitored and reduced to the lowest practical levels using ventilation or other appropriate engineering controls.

RESPIRATORY PROTECTION: Maintain exposure levels of Boron Trifluoride below the levels listed in Section 2 (Composition / Information on Ingredients). Use supplied air respiratory protection if Boron Trifluoride levels exceed exposure limits, or during emergency response to a release of this product. If respiratory protection is required, follow the requirements of the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), or equivalent U.S. State standards, Canadian CSA Standard Z94.4-93 and applicable standards of Canadian Provinces, the European Standard EN149, and EC member states. The following guidelines, based on NIOSH respiratory protection recommendations, are for Boron Trifluoride.

CONCENTRATION RESPIRATORY EQUIPMENT of BORON TRIFLUORIDE

Up to 10 ppm	Supplied Air Respirator (SAR)
Up to 25 ppm	SAR operated in a continuous-flow mode, or full-facepiece Self-Contained Breathing Apparatus (SCBA); or full-facepiece SAR.
Emergency or Planned Entry into Unknown Concentration or IDLH Conditions: an SCBA or positive pressure, full-faced SAR with an auxiliary SCBA.	
Escape	Gas mask with canister to protect against Boron Trifluoride; or escape-type SCBA.

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

SKIN PROTECTION: Work (such as leather) gloves are recommended when handling cylinders of this gas. Use appropriate gloves for spill response. If necessary, refer to U.S. OSHA 29 CFR 1910.138 or appropriate Standards of Canada and those of EC Member States.

OTHER PROTECTIVE EQUIPMENT: Use body protection appropriate for task. Safety shoes are recommended when handling cylinders. Information on general protective measures can be found in U.S. OSHA 29 CFR 1910.136.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

MOLECULAR WEIGHT: 67.805

GAS DENSITY @ 21.1°C (70°F): 3.072 kg/m³ (0.192 lb./ft³)

VAPOR PRESSURE @ 21.1°C (70°F): 19.1

BOILING POINT @ 1 atm: -99.8°C (-147.8°F)

FREEZING/MELTING POINT @ 1 atm: -128°C (-198.4°F)

SPECIFIC GRAVITY (air = 1): 2.380

SOLUBILITY IN WATER: Very soluble in cold water.

SPECIFIC VOLUME: 5.6lb/ft³

CRITICAL PRESSURE: 723.0 psia

CRITICAL TEMPERATURE: -12.2°C (10.04°F)

COEFFICIENT WATER/OIL DISTRIBUTION: Not available.

ODOR THRESHOLD: 1.5 ppm

APPEARANCE, ODOR AND STATE: Boron Trifluoride is a pungent-smelling, toxic, corrosive gas having a suffocating odor.

WARNING PROPERTIES FOR THIS GAS: The odor and dense, white appearance of this gas are distinctive warning properties associated with Boron Trifluoride.

SECTION 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Boron Trifluoride is stable at normal temperature and pressure. This gas hydrolyzes in moist air to form hydrogen fluoride (hydrofluoric acid).

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

MATERIALS WITH WHICH GAS IS INCOMPATIBLE: Boron Trifluoride reacts with incandescence when heated with alkali metals or alkaline earth metals, except magnesium. Ethyl, isopropyl, butyl, benzyl, and triphenylmethyl nitrates in contact with Boron Trifluoride interact violently (after an induction period of up to several hours) with gas evolution. The reaction of calcium oxide and Boron Trifluoride forms a fused mass after warming. Contact anhydrous calcium oxide or magnesium oxide, the metal fluoride and the volatile boron oxyfluoride are formed. Boron Trifluoride hydrolyzes to produce boric acid, hydrofluoric acid, and fluoboric acid. Boron Trifluoride is a catalyst for many polymerization reactions. Boron Trifluoride upon contact with water or steam, will produce toxic and corrosive fumes of hydrogen fluoride. Aluminum chloride or aluminum bromide react with Boron Trifluoride when gently heated to yield boron halide and aluminum fluoride. Boron Trifluoride, (electrophilic), acts as an acid catalyst for esterification, nitrations, oxidations, reductions, and halogenations. Alkali and alkaline earth metals reduce Boron Trifluoride to elemental boron and the metal fluoride. Boron Trifluoride reacts with slaked lime; calcium borate and fluoroborate are formed with evolution of heat. Mono- and di- hydroxyfluoroboric acids are formed very rapidly when Boron Trifluoride contacts water contained in a vessel. Interaction of hexafluoroisopropylideneaminolithium with a range of chloro- and fluoro-derivatives of boron during warming to 25°C tend to be violently exothermic in absence of solvent. The trihalides react with water, lower alcohols, hydrogen sulfide, alkyl mercaptans, ammonia, primary and secondary amines, phosphine, and arsine, liberating hydrogen halide in each case. Boron halides such Boron Trifluoride as react violently with water, and, particularly if there is a deficiency of water, a violent explosion may result.

REACTIVITY:

A) HAZARDOUS DECOMPOSITION PRODUCTS: Boron Trifluoride decomposes to form hydrogen fluoride (hydrofluoric acid).

B) HAZARDOUS POLYMERIZATION: Will not occur; however Boron Trifluoride can act as a catalyst for other polymerizable materials.

SECTION 11. TOXICOLOGICAL INFORMATION

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

DOT LC₅₀ = 806 ppm

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

LC₅₀ (Inhalation-Rat) 1180 mg/m³: Sense Organs and Special Senses (Eye): lachrymation; 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): lachrymation; 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

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

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

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

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

SECTION 11. TOXICOLOGICAL INFORMATION (Continued)

TOXICITY DATA (continued):

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

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

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

TCLo (Inhalation-Guinea Pig) 12,800 ppb/7 hours/65 days-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 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) 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

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 days-intermittent: Lungs, Thorax, or Respiration: other changes; Liver: liver function tests impaired; Blood: changes in leukocyte (WBC) count

CARCINOGENICITY: Boron Trifluoride has not been found to be carcinogenic.

IRRITANCY OF PRODUCT: Boron Trifluoride is corrosive to contaminated tissue.

SENSITIZATION OF PRODUCT: Boron Trifluoride has not been found to be a human skin or respiratory sensitizer.

REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the Boron Trifluoride on the human reproductive system.

Mutagenicity: No human mutagenic effects have been described for Boron Trifluoride.

Embryotoxicity: No human embryotoxic effects have been described for Boron Trifluoride.

Teratogenicity: No human teratogenic effects have been described for Boron Trifluoride.

Reproductive Toxicity: No human reproductive effects have been described for Boron Trifluoride.

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

BIOLOGICAL EXPOSURE INDICES (BEIs): Biological Exposure Indices (BEIs) are applicable for Boron Trifluoride (as a fluoride compound), as follows.

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

SECTION 12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: In natural waters containing calcium and other alkali and alkaline earth metals, Boron Trifluoride will precipitate out as calcium fluoride and other fluoride salts, and thus will naturally neutralize.

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

EFFECT OF CHEMICAL ON AQUATIC LIFE: Boron Trifluoride can be detrimental to aquatic life. If a large release this gas occurs near a river or other body of water, there is a potential for fish and other aquatic life to be harmed or killed.

MOBILITY: Currently, there are no data on the mobility of Boron Trifluoride.

PERSISTENCE AND BIODEGRADABILITY: Persistence: Currently, there are no data on the persistence of Boron Trifluoride. Biodegradation: Currently, there are no data available on the biodegradation of Boron Trifluoride.

POTENTIAL TO BIOACCUMULATE: No data are currently available on the bioaccumulation of Boron Trifluoride.

OZONE-DEPLETION POTENTIAL: Boron Trifluoride is not a Class I or Class II ozone depleting chemical (40 CFR Part 82).

SECTION 13. DISPOSAL CONSIDERATIONS

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

DISPOSAL INFORMATION: Residual product in system can be neutralized using various caustic systems (e.g., activated alumina or soda lime). Neutralization should only be done by appropriately trained and experienced personnel. Disposal shall be done in accordance with U.S. Federal, State and local regulations, regulations of the provinces of Canada or EC member states.

SECTION 14. TRANSPORT INFORMATION

U.S. SHIPPING INFORMATION:

U.S. DOT PROPER SHIPPING NAME: Boron Trifluoride
HAZARD CLASS NUMBER and DESCRIPTION: 2.3 (Toxic Gas)
UN IDENTIFICATION NUMBER: UN 1008
U.S. DOT SHIPPING LABEL(S) REQUIRED: Class 2.3 (Toxic Gas)
PLACARD (When required): 2.3 (Toxic Gas)
PACKING GROUP: Not Applicable
HAZARD ZONE: ZONE B

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure position. Ensure cylinder valve is properly closed, valve outlet cap has been reinstalled, and valve protection cap is secured before shipping cylinder.

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

NAERG (NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK) #: 125

CANADIAN SHIPPING INFORMATION:

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

PROPER SHIPPING NAME: Boron Trifluoride
HAZARD CLASS NUMBER and DESCRIPTION: 2.3 (Toxic Gas), 8 (Corrosive)
UN IDENTIFICATION NUMBER: UN 1008
PACKING GROUP: Not Applicable
HAZARD SHIPPING 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

INTERNATIONAL AIR TRANSPORT ASSOCIATION SHIPPING INFORMATION (IATA):

IATA DESIGNATION: Boron Trifluoride is considered as dangerous goods, per the International Air Transport Association.

PROPER SHIPPING NAME: Boron Trifluoride
HAZARD CLASS NUMBER and DESCRIPTION: 2.3 (Toxic Gas), 8 (Corrosive)
UN IDENTIFICATION NUMBER: UN 1008
HAZARD SHIPPING LABEL(S) REQUIRED: Class 2.3 (Toxic Gas), Class 8 (Corrosive)
ERG CODE: 2CP

The following Packaging Information is applicable to this product:

PASSENGER AND CARGO AIRCRAFT				CARGO AIRCRAFT ONLY	
Limited Quantity		Packing Instruction	Max. Qty per Pkg	Packing Instruction	Max. Qty per Pkg
Packing Instruction	Max. Qty per Pkg				
////	////	Forbidden	Forbidden	Forbidden	Forbidden

SECTION 14. TRANSPORT INFORMATION (Continued)
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INTERNATIONAL MARITIME ORGANIZATION SHIPPING INFORMATION (IMO):

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

PROPER SHIPPING NAME: Boron Trifluoride

HAZARD CLASS NUMBER and DESCRIPTION: 2.3 (Toxic Gas), 8 (Corrosive)

UN IDENTIFICATION NUMBER: UN 1008

HAZARD LABEL(S) REQUIRED: Class 2.3 (Toxic Gas), 8 (Corrosive)

SPECIAL PROVISIONS: None

LIMITED QUANTITIES: None

EmS: F-D, S-U

STOWAGE CATEGORY: Category D - Clear of living quarters.

MARINE POLLUTANT: Silane is not designated by the IMO to be a Marine Pollutant.

EUROPEAN SHIPPING INFORMATION:

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

UN NUMBER: 1008

NAME and DESCRIPTION: Boron Trifluoride

CLASS: 2

CLASSIFICATION CODE: 2TC

PACKING GROUP: Not Applicable

LABELS: 2.3 + 8

SPECIAL PROVISIONS: None

LIMITED QUANTITIES: LQ0

PACKING INSTRUCTIONS: P200

MIXED PACKING INSTRUCTIONS: MP9

HAZARD IDENTIFICATION NUMBER: 268

SECTION 15. REGULATORY INFORMATION

U.S. FEDERAL REGULATIONS:**EPA - ENVIRONMENTAL PROTECTION AGENCY:**

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

Reportable Quantity (RQ): Not applicable.

SARA TITLE III: Superfund Amendment and Reauthorization Act

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

Section 302 Extremely Hazardous Substances (TPQ): Boron Trifluoride is listed. TPQ = 500 lb (227 kg)

Section 304 Extremely Hazardous Reportable Quantity (RQ): Boron Trifluoride is listed. RQ = 500 lb (227 kg)

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

IMMEDIATE HEALTH: Yes PRESSURE: Yes

DELAYED HEALTH: Yes REACTIVITY: No

FIRE: No

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

Releases of Boron Trifluoride require reporting under Section 313.

CLEAN AIR ACT:

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

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

TSCA: Toxic Substances Control Act

Boron Trifluoride is listed on the TSCA Inventory.

OSHA - OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION:

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

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

U.S. STATE REGULATORY INFORMATION:

CALIFORNIA PROPOSITION 65: Boron Trifluoride is not a listed substance for which the State of California requires warning under this statute.

OTHER STATE REGULATIONS: Boron Trifluoride is covered under the following specific State regulations (more specific regulations exist in some States):

Alaska - Designated Toxic and Hazardous Substances: Boron Trifluoride.
California - Permissible Exposure Limits for Chemical Contaminants: Boron Trifluoride.
Florida - Substance List: Boron Trifluoride.
Illinois - Toxic Substance List: Boron Trifluoride.
Kansas - Section 302/313 List: No.
Massachusetts - Substance List: Boron Trifluoride.

Michigan - Critical Materials Register: No.
Minnesota - List of Hazardous Substances: Boron Trifluoride.
Missouri - Employer Information/Toxic Substance List: Boron Trifluoride.
New Jersey - Right to Know Hazardous Substance List: Boron Trifluoride.
North Dakota - List of Hazardous Chemicals, Reportable Quantities: No.

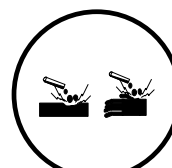
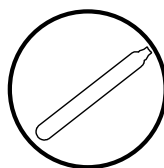
Pennsylvania - Hazardous Substance List: No.
Rhode Island - Hazardous Substance List: Boron Trifluoride.
Texas - Hazardous Substance List: Boron Trifluoride.
West Virginia - Hazardous Substance List: Boron Trifluoride.
Wisconsin - Toxic and Hazardous Substances: Boron Trifluoride.

CANADIAN FEDERAL REGULATIONS:

CANADIAN DSL INVENTORY STATUS: Boron Trifluoride is listed on the Canadian DSL Inventory.

OTHER CANADIAN REGULATIONS: Boron Trifluoride would be categorized as a Controlled Product, Hazard Classes A, D1A, and E, as per the Controlled Product Regulations. Boron Trifluoride is on the CEPA Priorities Substances Lists. Boron Trifluoride(as an Inorganic Fluoride compound) would be on the First Priorities Substances List (Toxic).

CANADIAN WHMIS SYMBOLS: **Class A:** Compressed Gas
Class D1A: Toxic Material/Immediate and Serious Effects
Class E: Corrosive Material



EUROPEAN ECONOMIC COMMUNITY REGULATIONS:

BORON TRIFLUORIDE:

EC EINECS/ELINCS NUMBER: 231-569-5

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

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

EC SAFETY PHRASES: [S: 2 ½]: Keep locked up and out of the reach of children.* **This safety phrase can be omitted from the label when the substance or preparation is sold for industrial use only.* [S: 9]: Keep container tightly closed and in a well ventilated place. [S: 26]: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. [S: 28]: After contact with skin, wash immediately with plenty of water and seek medical advice. [S: 36/37/38]: 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).

EUROPEAN COMMUNITY ANNEX II HAZARD SYMBOLS:



SECTION 16. OTHER INFORMATION

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

SECTION 16. OTHER INFORMATION (Continued)

Further information about compressed gases can be found in the following pamphlets published by: Compressed Gas Association Inc. (CGA), 4221 Wainey Road, 5th Floor, Chantilly, VA 20151-2923 Telephone: (703) 788-2700.

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

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

5/04 Revision: New Format, general re-write

DEFINITIONS OF TERMS

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

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

EXPOSURE LIMITS IN AIR:

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

LOQ: Limit of Quantitation.

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

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

NIC: Notice of Intended Change.

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

NIOSH RELs: NIOSH's Recommended Exposure Limits.

PEL-Permissible Exposure Limit: OSHA's Permissible Exposure Limits. This exposure value means exactly the same as a TLV, except that it is enforceable by OSHA.

The OSHA Permissible Exposure Limits are based in the 1989 PELs and the June, 1993 Air Contaminants Rule (Federal Register: 58: 35338-35351 and 58: 40191). Both the current PELs and the vacated PELs are indicated. The phrase, "Vacated 1989 PEL," is placed next to the PEL that was vacated by Court Order.

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

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

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

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

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

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM

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

HEALTH HAZARD:

0 (Minimal Hazard): No significant health risk, irritation of skin or eyes not anticipated. *Skin Irritation:* Essentially non-irritating. PII or Draize = "0". *Eye Irritation:* Essentially non-irritating, or minimal effects which clear in < 24 hours [e.g. mechanical irritation]. Draize = "0". *Oral Toxicity LD₅₀ Rat.* < 5000 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit.* < 2000 mg/kg. *Inhalation Toxicity 4-hrs LC₅₀ Rat.* < 20 mg/L.; **1 (Slight Hazard):** Minor reversible injury may occur; slightly or mildly irritating. *Skin Irritation:* Slightly or mildly irritating. *Eye Irritation:* Slightly or mildly irritating. *Oral Toxicity LD₅₀ Rat.* > 500-5000 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit.* > 1000-2000 mg/kg. *Inhalation Toxicity LC₅₀ 4-hrs Rat.* > 2-20 mg/L);

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS (continued):

HEALTH HAZARD (continued):

2 (Moderate Hazard): Temporary or transitory injury may occur. *Skin Irritation:* Moderately irritating; primary irritant; sensitizer. PII or Draize > 0, < 5. *Eye Irritation:* Moderately to severely irritating and/or corrosive; reversible corneal opacity; corneal involvement or irritation clearing in 8-21 days. Draize > 0, < 25. *Oral Toxicity LD₅₀ Rat.* > 50-500 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit.* > 200-1000 mg/kg. *Inhalation Toxicity LC₅₀ 4-hrs Rat.* > 0.5-2 mg/L.; **3 (Serious Hazard):** Major injury likely unless prompt action is taken and medical treatment is given; high level of toxicity; corrosive. *Skin Irritation:* Severely irritating and/or corrosive; may destroy dermal tissue, cause skin burns, dermal necrosis. PII or Draize > 5-8 with destruction of tissue. *Eye Irritation:* Corrosive, irreversible destruction of ocular tissue; corneal involvement or irritation persisting for more than 21 days. Draize > 80 with effects irreversible in 21 days. *Oral Toxicity LD₅₀ Rat.* > 1-50 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit.* > 20-200 mg/kg. *Inhalation Toxicity LC₅₀ 4-hrs Rat.* > 0.05-0.5 mg/L.; **4 (Severe Hazard):** Life-threatening; major or permanent damage may result from single or repeated exposure. *Skin Irritation:* Not appropriate. Do not rate as a "4", based on skin irritation alone. *Eye Irritation:* Not appropriate. Do not rate as a "4", based on eye irritation alone. *Oral Toxicity LD₅₀ Rat.* ≤ 1 mg/kg. *Dermal Toxicity LD₅₀Rat or Rabbit.* ≤ 20 mg/kg. *Inhalation Toxicity LC₅₀ 4-hrs Rat.* ≤ 0.05 mg/L).

FLAMMABILITY HAZARD:

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

DEFINITIONS OF TERMS (Continued)

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS (continued):**FLAMMABILITY HAZARD (continued):**

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 \geq 514.7 psi absolute at 21.1°C (70°F) [500 psig]. *Pyrophorics*: No Rating. *Oxidizers*: Packing Group I *Solids*: any material that, in either concentration tested, exhibits a mean burning time less than the mean burning time of a 3:2 potassium bromate/cellulose mixture. *Liquids*: Any material that spontaneously ignites when mixed with cellulose in a 1:1 ratio, or which exhibits a mean pressure rise time less than the pressure rise time of a 1:1 perchloric acid (50%)/cellulose mixture.

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS (continued):**PHYSICAL HAZARD (continued):**

3 (continued): *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. **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.

DEFINITIONS OF TERMS (Continued)

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/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: **EC** is the European Community (formerly known as the **EEC**, European Economic Community). **EINECS:** This the European Inventory of Now-Existing Chemical Substances. The **ARD** is the European Agreement Concerning the International Carriage of Dangerous Goods by Road and the **RID** are the International Regulations Concerning the Carriage of Dangerous Goods by Rail.