

# MATERIAL SAFETY DATA SHEET

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

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

### 1. PRODUCT IDENTIFICATION

<u>TRADE NAME (AS LABELED):</u>	<b>ALUMINUM BORON ALLOY</b>
<u>CHEMICAL NAME/CLASS:</u>	Aluminum Alloy
<u>SYNONYMS:</u>	Aluminum/Boron Alloy
<u>FORMULA:</u>	AlB <sub>2</sub> and/or AlB <sub>12</sub>
<u>PRODUCT USE:</u>	Various Uses
<u>SUPPLIER/MANUFACTURER'S NAME:</u>	<b>BORON PRODUCTS LLC</b> a Ceradyne Company
<u>ADDRESS:</u>	798 Highway 69A, Quapaw, OK 74363 PO Box 798, Quapaw, OK 74363
<u>EMERGENCY PHONE:</u>	1-918-673-2201
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<u>TECHNICAL CONTACT PHONE:</u>	1-918-673-2201 (8:00 AM to 4:30 PM, Mon.–Fri.)
<u>EMAIL ADDRESS/COMPETENT PERSON FOR MSDS:</u>	inquiry@ceradyneboron.com
<u>DATE OF PREPARATION:</u>	April 22, 2008

ALL WHMIS required information is included in appropriate sections based on the ANSI Z400.1-2004 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. The product is also classified per all applicable EU Directives through EC 1907: 2006

### 2. HAZARD IDENTIFICATION

This product is an aluminum/boron alloy.

EU LABELING AND CLASSIFICATION: This product does not meet the definition of any hazard class, as defined by the European Union Guidelines.

EU CLASSIFICATION: Not applicable.      EU RISK PHRASES: Not applicable.

**EMERGENCY OVERVIEW: Product Description:** Aluminum Boron Alloy is an odorless, silver, metallic solid. **Health Hazards:** As supplied, this material is not anticipated to have significant health effects. If this material is ground into a powder, it can cause mechanical irritation of the nasal mucous membranes, the respiratory tract, and eyes. **Flammability Hazards:** In solid form Aluminum Boron Alloy is not flammable; however, aluminum powder is flammable and so powdered Aluminum Boron Alloy may also be flammable. If involved in a fire, this material will decompose to form aluminum oxides and boron oxides, which may cause adverse effects if inhaled. **Reactivity Hazards:** Aluminum Boron Alloy as a solid is not reactive; however, aluminum powder is flammable and so powdered Aluminum Boron Alloy may also be reactive. **Environmental Hazards:** Release of this material to the environment may harm to plants and animals. **Emergency Recommendations:** Emergency responders must wear personal protective equipment appropriate for the situation to which they are responding and to the chemical hazards of this material. Caution should be used when responding to releases.

### 3. COMPOSITION and INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS #	EINECS #	% w/v	EU CLASSIFICATION FOR COMPONENTS
<b>FORMULATION 1</b>				
Boron	7440-42-8	231-151-2	0.5–1.5	HAZARD CLASSIFICATION: Not applicable. RISK PHRASES: Not applicable.
Aluminum	7429-90-5	231-072-3	Balance	Classification is for Aluminum Powder (Stabilized) HAZARD CLASSIFICATION: F: Flammable RISK PHRASES: R: 10; R: 15
<b>FORMULATION 2</b>				
Boron	7440-42-8	231-151-2	1–5	HAZARD CLASSIFICATION: Not applicable. RISK PHRASES: Not applicable.
Aluminum	7429-90-5	231-072-3	Balance	Classification is for Aluminum Powder (Stabilized) HAZARD CLASSIFICATION: F: Flammable RISK PHRASES: R: 10; R: 15
<b>FORMULATION 3</b>				
Boron	7440-42-8	231-151-2	3–7	HAZARD CLASSIFICATION: Not applicable. RISK PHRASES: Not applicable.
Aluminum	7429-90-5	231-072-3	Balance	Classification is for Aluminum Powder (Stabilized) HAZARD CLASSIFICATION: F: Flammable RISK PHRASES: R: 10; R: 15

See Section 15 for full EU classification information of product and components.

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

**4. FIRST-AID MEASURES**

**RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO THIS MATERIAL WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT.** Victim(s) must be taken for medical attention. Rescuers should be taken for medical attention if necessary. Remove or cover gross contamination to avoid exposure to rescuers. Take copy of label and MSDS to physician or other health professional with victim(s). Consult a physician and/or the nearest Poison Control Center for all exposures except minor instances of skin contact.

**INHALATION:** Remove victim(s) to fresh air as quickly as possible. Only trained personnel should administer supplemental oxygen and/or cardiopulmonary resuscitation if necessary. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Seek immediate medical attention.

**SKIN EXPOSURE:** If this material contaminates the skin, immediately begin decontamination with running water. Minimum flushing is for 15 minutes. Do not interrupt flushing. Remove exposed or contaminated clothing, taking care not to contaminate eyes. Victim must seek immediate medical attention if any adverse effect occurs.

**EYE EXPOSURE:** If this material 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. Seek immediate medical attention.

**MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:** It has been suggested that aluminum exposure is a risk factor for the development or acceleration of onset of Alzheimer's disease in humans. The precise pathogenic role of Aluminum in AD is judged controversial and remains to be defined.

**RECOMMENDATIONS TO PHYSICIANS:** Treat symptoms and eliminate overexposure.

**5. FIRE-FIGHTING MEASURES**

**FLASH POINT:** Not applicable.

**AUTOIGNITION TEMPERATURE:** For Aluminum Powder: 760°C (1400°F)

**FLAMMABLE LIMITS (in air by volume, %):**

Lower: Not applicable. Upper: Not applicable.

**FIRE EXTINGUISHING MATERIALS:** Use extinguishing material suitable to the surrounding fire, including water spray (cooling of containers), ground limestone, dry chemical or 'D' class.

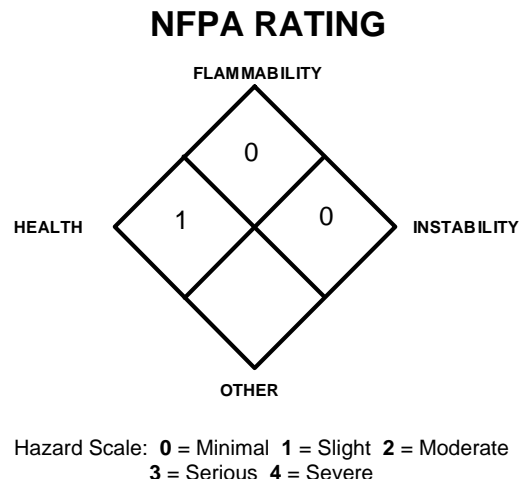
**FIRE EXTINGUISHING MATERIALS NOT TO BE USED:** Halon, carbon dioxide, and foam extinguishers should not be used on fires involving this product.

**UNUSUAL FIRE AND EXPLOSION HAZARDS:** Aluminum Boron Alloy as a solid is not flammable; however, aluminum powder and boron powder are both flammable and so powdered Aluminum Boron Alloy may also be flammable. If involved in a fire, this material will decompose to form aluminum oxides and boron oxides, which may cause adverse effects if inhaled. This product may react with strong acids and strong alkalis to release flammable hydrogen gas.

**Explosion Sensitivity to Mechanical Impact:** Not applicable.

**Explosion Sensitivity to Static Discharge:** Although this material is not sensitive to static discharge, dusts of this material can be ignited by static discharge, especially if large amounts of dusts are allowed to accumulate. All equipment used in the handling of this material should be electrically grounded.

**SPECIAL FIRE-FIGHTING PROCEDURES:** Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. Move containers from fire area if it can be done without risk to personnel. If possible, prevent runoff water from entering storm drains, bodies of water, or other environmentally sensitive areas. Rinse contaminated equipment thoroughly with sodium bicarbonate solution (or another neutralizer for acids) before returning such equipment to service.



**6. ACCIDENTAL RELEASE MEASURES**

**SPILL RESPONSE:** The atmosphere must have levels of the components of this product lower than those listed in Section 8, (Exposure Limits and Personal Protection) and at least 19.5 percent oxygen before personnel can be allowed into the area without Self-Contained Breathing Apparatus (SCBA).

**Small Spills:** Wipe up spilled solid with damp sponge or sweep up spilled material or vacuum with explosion-proof vacuum, avoiding generation of dusts, wearing gloves, goggles and apron. Place spilled material in appropriate container for disposal, sealing tightly. Clean spill area with soap and water.

**Large Spills:** Trained personnel using pre-planned procedures should respond to uncontrolled releases. Proper protective equipment should be used. In case of a spill, clear the affected area, protect people, and respond with trained personnel.

**6. ACCIDENTAL RELEASE MEASURES (Continued)**
**SPILL RESPONSE (continued):**

**Large Spills (continued):** Minimum Personal Protective Equipment should be the following: **triple-gloves (rubber gloves and nitrile gloves over latex gloves), chemical resistant suit and boots, hard hat, and Self-Contained Breathing Apparatus.** Monitor the surrounding area for oxygen levels. The atmosphere must have at least 19.5 % oxygen before personnel can be allowed in the area without Self-Contained Breathing Apparatus. Access to the spill area should be restricted. Spread should be limited by gently covering the spill with damp cloths or towels. Sweep up or vacuum spilled solid (an explosion-proof vacuum should be used), avoiding the generation of airborne dusts. The dispersal of particles into surrounding air must be avoided. Decontaminate the area thoroughly. All contaminated absorbents and other materials should be placed in an appropriate container and sealed.

Place all spill residue in a double plastic bag or other containment and seal. Decontaminate the area thoroughly. Do not mix with wastes from other materials. Dispose of in accordance with applicable Federal, State, and local procedures (see Section 13, Disposal Considerations). For spills on water, contain, minimize dispersion and collect. Dispose of recovered material and report spill per regulatory requirements.

**PART III** *How can I prevent hazardous situations from occurring?*
**7. HANDLING and STORAGE**

**WORK AND HYGIENE PRACTICES:** As with all chemicals, avoid getting this product ON YOU or IN YOU. Wash thoroughly after handling this product. Do not eat, drink, smoke, or apply cosmetics while handling this product. Avoid breathing dusts, particulates, or fumes generated by this product. Use in a well-ventilated location. Wipe down area routinely to avoid the accumulation of dusts of this product. Remove contaminated clothing immediately.

**STORAGE AND HANDLING PRACTICES:** All employees who handle this material should be trained to handle it safely. Keep container tightly closed when not in use. Store containers in a cool, dry location, away from direct sunlight, or sources of intense heat. Material should be stored in secondary containers or in a diked area, as appropriate. Store containers away from incompatible chemicals (see Section 10, Stability and Reactivity). Post warning and "NO SMOKING" signs in storage and use areas as appropriate. Empty containers may contain residual particulates; therefore, empty containers should be handled with care. Never store food, feed, or drinking water in containers which held this product.

**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 dispose of according to applicable U.S. Federal, State, or local procedures and appropriate Canadian standards and those of EU Member States.

**8. EXPOSURE CONTROLS - PERSONAL PROTECTION**

**VENTILATION AND ENGINEERING CONTROLS:** Use with adequate ventilation to ensure exposure levels are maintained below the limits provided below if applicable. Ensure eyewash/safety shower stations are available near areas where this product is used.

**EXPOSURE LIMITS:**

CHEMICAL NAME	CAS #	EXPOSURE LIMITS IN AIR							
		ACGIH-TLV		OSHA-PEL		NIOSH-RELS		NIOSH	OTHER
		TWA mg/m <sup>3</sup>	STEL mg/m <sup>3</sup>	TWA mg/m <sup>3</sup>	STEL mg/m <sup>3</sup>	TWA mg/m <sup>3</sup>	STEL mg/m <sup>3</sup>	IDLH mg/m <sup>3</sup>	
Aluminum (exposure limits are for Aluminum Metal Dust)	7429-90-5	10	NE	15 (Total dust), 5 (Resp. fraction)	NE	10 (Total dust), 5 (Resp. fraction)	NE	NE	DFG MAK: TWA = 1.5 (Respirable fraction of the aerosol)
Boron (exposure limits are for Boron Oxide)	7440-42-8	10	NE	15 (Total dust) 10 (Total dust) [vacated 1989 PEL]	NE	10 (Total dust)	NE	NE	Carcinogen: EPA-I

NE = Not Established.

**INTERNATIONAL EXPOSURE LIMITS FOR COMPONENTS:** Currently, there are no international exposure limits established for this compound.

*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), equivalent standards of Canada (including CSA Standard Z94.4-02 and CSA Standard Z94.3-02), standards of EU member states (including EN 529:2005 for respiratory PPE, CEN/TR 15419:2006 for hand protection, and CR 13464:1999 for face/eye protection. Please reference applicable regulations and standards for relevant details.*

**RESPIRATORY PROTECTION:** Maintain airborne contaminant concentrations below exposure limits listed above if applicable. If necessary, refer to U.S. OSHA 29 CFR 1910.133, the European Standard CR 13464:1999 and the Canadian CSA Standard Z94.3-M1982, *Industrial Eye and Face Protectors* for further information. Use of a NIOSH-approved respirator with a protection factor of 50 or greater with P100 or more is micron size is less than 10 microns or use of a category 21-C air-purifying respirator with P100 cartridge is recommended. 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).

## 8. EXPOSURE CONTROLS - PERSONAL PROTECTION (Continued)

**EYE PROTECTION:** Splash goggles or safety glasses. If necessary, refer to U.S. OSHA 29 CFR 1910.133, the European Standard CR 13464:1999 and the Canadian CSA Standard Z94.3-M1982, *Industrial Eye and Face Protectors* for further information.

**HAND PROTECTION:** Wear puncture resistant gloves when using this material. Lightweight nitrile or natural rubber gloves are not recommended. Check gloves for leaks prior to use. If necessary, refer to U.S. OSHA 29 CFR 1910.138, the European Standard DIN EN 374, the European Standard CEN/TR 15419:2006 and Standards of Canada for further information.

**BODY PROTECTION:** Use body protection appropriate for task. If necessary, refer to appropriate Standards of Canada or the European DIN EN 465 for other requirements. If necessary, refer to the OSHA Technical Manual (Section VII: Personal Protective Equipment) or appropriate Standards of Canada. If a hazard of injury to the feet exists due to falling objects, rolling objects, where objects may pierce the soles of the feet or where employee's feet may be exposed to electrical hazards, use foot protection, as described in U.S. OSHA 29 CFR 1910.136 and the Canadian CSA Standard Z195-M1984, *Protective Footwear*.

## 9. PHYSICAL and CHEMICAL PROPERTIES

**RELATIVE VAPOR DENSITY (air = 1):** Not available.

**SPECIFIC GRAVITY:** Not established.

**SOLUBILITY IN WATER:** Insoluble.

**EXPANSION RATIO:** Not established.

**ODOR THRESHOLD:** Odorless.

**COEFFICIENT WATER/OIL DISTRIBUTION:** Not applicable.

**BOILING POINT:** Not available.

**APPEARANCE, ODOR AND COLOR:** Aluminum Boron Alloy is an odorless, silver, metallic solid.

**HOW TO DETECT THIS SUBSTANCE (warning properties):** The appearance of this material may be a warning property in event of a release of this product.

**EVAPORATION RATE (nBuAc = 1):** Not applicable.

**MELTING/FREEZING POINT:** 600°C (1112°F)

**VAPOR PRESSURE:** Not established.

**pH:** Not applicable.

**VAPOR PRESSURE:** Not available.

**SPECIFIC VOLUME (ft<sup>3</sup>/lb):** Not available.

**MOLECULAR FORMULA:** AIB<sub>2</sub> and/or AIB<sub>12</sub>

## 10. STABILITY and REACTIVITY

**STABILITY:** Stable at standard temperatures and pressures.

**DECOMPOSITION PRODUCTS:** Products of thermal decomposition include aluminum oxides and boron oxides.

**MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE:** This material may react with oxidizing materials, acid chlorides, and metal salts. This material may react with strong acids and strong alkalies to release flammable hydrogen gas.

**HAZARDOUS POLYMERIZATION:** Will not occur.

**CONDITIONS TO AVOID:** Avoid exposure to high temperatures. Avoid spark or open flame when powdered material is thoroughly dispersed (suspended) in air. Avoid exposure to incompatible chemicals.

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

### 11. TOXICOLOGICAL INFORMATION

**SYMPTOMS OF OVEREXPOSURE BY ROUTE OF EXPOSURE:** Contact with this material may be irritating. The symptoms of overexposure to this product, via route of exposure are as follows:

**INHALATION:** Inhalation of dusts or particulates of Aluminum Boron Alloy may irritate the nose, lungs, and other respiratory tissues and cause coughing, difficulty breathing and sneezing. Inhalation of aluminum fumes that may be generated by thermal decomposition of this product may cause impairment of cognitive function, motor dysfunction and peripheral neuropathy. Inhalation of boron oxide that may be generated by thermal decomposition of this product may cause eye irritation; dry mouth, nose, or throat; sore throat; and productive cough.

**CONTACT WITH SKIN or EYES:** Skin contact with filings, particulates, or dusts of Aluminum Boron Alloy may irritate or abrade the skin. Eye contact with filings, particulates, or dusts of this product will cause irritation, pain and tearing by mechanical irritation. Eye contact with boron oxides that may be generated by thermal decomposition of this material can cause inflammation of the inner surface of the eyelid and the exposed surface of the eyeball.

**SKIN ABSORPTION:** This product is not known to be absorbed via abraded or damaged skin.

**INGESTION:** Ingestion is not anticipated to be a significant route of occupational overexposure. If large amounts of this product are ingested, they may cause nausea, vomiting and diarrhea.

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

Hazard Scale: 0 = Minimal 1 = Slight 2 = Moderate  
3 = Serious 4 = Severe \* = Chronic hazard

## 11. TOXICOLOGICAL INFORMATION (Continued)

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

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

**ACUTE:** Acute exposure by all routes (especially if material is in filing, particulate, or dust form) may irritate exposed tissues.

**CHRONIC:** Chronic exposure to Aluminum Boron Alloy is not known to cause adverse symptoms.

**TARGET ORGANS:** ACUTE: Skin, eyes. CHRONIC: None currently known.

**TOXICITY DATA:** Currently, there are no specific toxicology data currently available for this alloy. The following are toxicity data for elemental Aluminum and elemental Boron.

### ALUMINUM:

TCLo (inhalation, man) = 4 mg/m<sup>3</sup>/1 year-intermittent: Lungs, Thorax, or Respiration: cough; Lungs, Thorax, or Respiration: dyspnea; Nutritional and Gross Metabolic: weight loss or decreased weight gain

TCLo (inhalation, rat) = 206 mg/m<sup>3</sup>/5 hours/30 days-intermittent: Lungs, Thorax, or Respiration: fibrosis (interstitial); Endocrine: hypoglycemia; Blood: changes in serum composition (e.g. TP, bilirubin, cholesterol)

TDLo (oral, rat) = 1260 mg/kg: Multigeneration: Reproductive: Effects on Newborn: behavioral, physical, other postnatal measures or effects

TDLo (Unreported-Rat) 67.5 mg/kg: female 2-27 day(s) after conception: Reproductive: Effects on Newborn: behavioral, Effects on Newborn: delayed effects

### ALUMINUM (continued):

Rats injected with 100 mg aluminum powder directly into the trachea showed scarring in the lungs. Animals given about 1400 ppm aluminum in the diet had decreased phosphorus in the blood and bone. Aluminum particles implanted in rabbit eyes caused slight inflammation.

### BORON:

LD<sub>50</sub> (oral, rat) = 650 mg/kg

LD<sub>50</sub> (oral, mouse) = 560 mg/kg

LD<sub>50</sub> (oral, dog) = 310 mg/kg

LD<sub>50</sub> (oral, cat) = 250 mg/kg

LD<sub>50</sub> (oral, rabbit) = 310 mg/kg

LD<sub>50</sub> (oral, guinea pig) = 310 mg/kg

LD<sub>50</sub> (oral, mammal) = 300 mg/kg

LD<sub>50</sub> (intraperitoneal, rat) = 7 gm/kg

LD<sub>50</sub> (intraperitoneal, mouse) = 11 gm/kg

### BORON (continued):

TDLo (oral, rat) = 32 gm/kg/30 days-intermittent: Brain and Coverings: other degenerative changes; Cardiac: other changes; Liver: liver function tests impaired

TDLo (oral, rat) = 4.95 mg/kg: female 1-22 day(s) after conception: Reproductive: Effects on Embryo or Fetus: fetotoxicity (except death, e.g., stunted fetus), fetal death

TDLo (oral, rabbit) = 2821 mg/kg/13 weeks-intermittent: Biochemical: Enzyme inhibition, induction, or change in blood or tissue levels: dehydrogenases, transaminases, other transferases

TCLo (inhalation, rat) = 10,560 µg/m<sup>3</sup>/4 hours/17 weeks-intermittent: Lungs, Thorax, or Respiration: other changes; Nutritional and Gross Metabolic: weight loss or decreased weight gain

**GENERAL TOXICITY INFORMATION:** Inhalation of fumes of Aluminum Boron Alloy may cause impairment of cognitive function; motor dysfunction; peripheral neuropathy; eye irritation; dry mouth, nose, or throat; sore throat; and productive cough.

**CARCINOGENIC POTENTIAL:** The Boron component of this material is listed by agencies tracking carcinogenic potential, as follows:

EPA-I (Data are inadequate for an assessment of Human Carcinogenic Potential)

**IRRITANCY OF PRODUCT:** Acute exposure by all routes (especially if material is in filings, particulates, or dusts form) may irritate exposed tissues.

**SENSITIZATION TO THE PRODUCT:** Aluminum Boron Alloy is not known to be a human skin or respiratory sensitizer.

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

**Mutagenicity:** The components of this product are not reported to cause reproductive effects in humans.

**Embryotoxicity:** The components of this product are not reported to produce embryotoxic effects in humans.

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

**Reproductive Toxicity:** The components of this product are not reported to cause reproductive effects in humans. For elemental boron, data regarding developmental and reproductive toxicity show that lower fetal body weight in rats is the critical effect. As dose level increases, the effects seen include: further rib effects and testicular pathology in the rat, decreased fetal body weight and increased fetal cardiovascular malformations in the rabbit, and severe testicular pathology in the rat; testicular atrophy and sterility in the rat; reduced fetal body weight in the mouse.

*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 EXPOSURES INDICES (BEIs):** Currently, there are no Biological Exposure Indices (BEIs) determined for the components of this product.

## 12. ECOLOGICAL INFORMATION

ALL WORK PRACTICES MUST BE AIMED AT ELIMINATING ENVIRONMENTAL CONTAMINATION.

**MOBILITY:** This product is a metal solid; only degradation of the alloy could lead to potential mobility of components in the soil. Information on components is available as follows.

### ALUMINUM:

Soil Adsorption/Mobility: In general, decreasing pH results in an increase in mobility for monomeric forms of aluminum. The mobility of aluminum ions in soil is of concern in areas where acid rain is deposited and of acid mine drainage. In addition to the effect of pH on mobility, the type of acid entering environmental systems may also be important. Nitric acid was found to leach more aluminum from soil columns representative of high elevation forest floor soils than sulfuric acid. This is due to the higher solubility of aluminum nitrate than aluminum sulfate. However, in mineral horizons below the forest floor, concentrations of aluminum leached by these acids did not differ from concentrations of aluminum leached by distilled, deionized water at pH of 5.7. Soluble constituents from the forest floor affected the aluminum solubility in the underlying mineral horizons under the leaching conditions used. These constituents may have included natural buffering agents which resist changes in pH and, therefore, mediate the effect of the acid.

### BORON:

Soil Adsorption/Mobility: Boron compounds in water may be adsorbed by soils and sediments. The extent of boron adsorption depends on the chemical composition of the soil, pH, salinity, organic matter content, iron and aluminum oxide content, iron- and aluminum-hydroxy content, and clay content. The adsorption of boron to soils can be variable and range from being fully reversible to irreversible. The adsorption of boron is expected to be most significant for soils that contain high concentrations of amorphous aluminum and iron oxides and hydroxides. Log Kd values were measured in 11 soils for various elements; values ranged from no sorption to 0.925 for boron, (BO<sub>3</sub>)<sup>3-</sup> was the initial species. Boron was reported to be highly mobile in sandy loam and in sandy soil; Kd values ranged from 0-10.

**PERSISTENCE AND BIODEGRADABILITY:** This product is a metal solid that will persist for a long period under ambient environmental conditions. Information on components is available as follows.

**ALUMINUM:**

**Persistence and Biodegradability:** Aluminum compounds enter environmental media naturally through the weathering of rocks and minerals. Anthropogenic releases of aluminum compounds are in the form of air emissions, waste water effluents, and solid waste primarily associated with industrial processes, such as aluminum metal production. Because aluminum compounds are a major constituent of the earth's crust, natural weathering processes far exceed the contribution of releases to air, water, and land associated with anthropogenic activities. The behavior of aluminum ions and compounds in the environment depends upon their coordination chemistry and the characteristics of the local environment such as pH. The major features of the biogeochemical cycle of aluminum include: leaching of aluminum ions from soil and minerals into aqueous environments; adsorption and/or precipitation of aluminum ions and compounds onto soil or sediment; and wet and dry deposition aluminum-containing dust particulates from the air to land or surface water. Aluminum ions and compounds will not bioconcentrate in aquatic organisms to any significant degree. Volatilization of aluminum compounds from moist soil surfaces is not an important fate process because these compounds are ionic and will not volatilize.

**BORON:**

**Persistence and Biodegradability:** Inorganic boron compounds (with the exception of hydroboranes) are expected to be nonvolatile and will exist solely in the particulate phase in the ambient atmosphere. Particulate-phase boron compounds will be removed from the atmosphere by wet and dry deposition. While some organoboron compounds and boron halide compounds are volatile, they are expected to be rapidly hydrolyzed and will not persist in the environment. The chemistry of boron is dominated by its tendency to form stable bonds with electronegative atoms, especially oxygen. Reduced boron compounds (halides, hydrides, alkyls and aryls) tend to oxidize and hydrolyze readily, and would be expected to be converted into various boron-oxide compounds in the environment. The extent of boron adsorption depends on the chemical composition of the soil, pH, salinity, organic matter content, iron and aluminum oxide content, iron- and aluminum-hydroxy content, and clay content. The adsorption of boron to soils can be variable and range from being fully reversible to irreversible. The adsorption of boron is expected to be most significant for soils that contain high concentrations of amorphous aluminum and iron oxides and hydroxides. Inorganic boron compounds are nonvolatile and would not be expected to volatilize from moist or dry soil surfaces. No biotransformation processes have been reported for boron compounds. In aqueous solution, boron is normally present as boric acid and borate ions, with the dominant form of inorganic boron as undissociated boric acid in natural aqueous systems. In aqueous solution, boric acid acts as an electron acceptor (Lewis acid), accepting hydroxide from water to form (B(OH)<sub>4</sub>)<sup>-</sup> ion. In concentrated solutions (>0.1 M boric acid) polymeric species are formed. Boron compounds in water may be adsorbed by soils and sediments. The extent of boron adsorption depends on the pH of the water. The greatest adsorption is observed at pH 7.5-9.0. Since the adsorption of boron is expected to be most significant for soils that contain high concentrations of amorphous aluminum and iron oxides and hydroxides, sediments with these characteristics may also strongly adsorb boron compounds.

**BIO-ACCUMULATION POTENTIAL:** This product has not been tested for bio-accumulation potential. Information on components is available as follows.

**ALUMINUM:**

**Bioconcentration:** Aluminum is not bio-accumulated to a large degree (BCF < 300) in most fish and shellfish. Brook trout have been shown to accumulate slightly more aluminum (measured as whole-body residues) at pH 5.6-5.7 than at pH 6.5-6.6. The estimated steady-state BCF values for aluminum in brook trout, (which were inversely related to pH), were 215 at pH 5.3, 123 at pH 6.1, and 36 at pH 7.2. The maximum BCFs were 232 at pH 5.3, 153 at pH 6.1, and 46 at pH 7.2. When transferred to water of the same pH without added aluminum, brook trout eliminated aluminum from tissues more rapidly at pH 5.3 than at pH 6.1 and 7.2. In tissues of smallmouth bass, aluminum concentrations were higher and more variable in gill tissue than in other tissues. Aluminum concentrations in rainbow trout from an alum treated lake, an untreated lake, and a hatchery were highest in gill tissue and lowest in muscle. Aluminum residue analyses in brook trout have shown that whole-body aluminum content decreases as the fish advance from larvae to juveniles. These result simply that the aging larvae begin to decrease their rate of aluminum uptake, to eliminate aluminum at a rate that exceeds uptake, or to maintain approximately the same amount of aluminum while the body mass increases. The decline in whole-body aluminum residues in juvenile brook trout may be related to growth and dilution by edible muscle tissue that accumulated less aluminum than did the other tissues. Concentrations of aluminum in whole-body tissue of the Atlantic salmon exposed to high concentrations of aluminum ranging from 3 µg/g (for fish exposed to 33 µg/liter) to 96 µg/g (for fish exposed to 264 µg/liter) at pH 5.5. After 60 days of exposure, BCFs ranged from 76 to 190 and were directly related to the aluminum exposure concentration.

**BORON:**

**Bioconcentration:** BCF values ranging for boron (in compounds) from 0.3 to 198 have been measured in fish. According to a classification scheme, BCF values of zero to 30 are low and from 100 to 1,000 are high.

**ECOTOXICITY:** This product has not been tested for aquatic or animal toxicity. All release to terrestrial, atmospheric and aquatic environments should be avoided.

**OTHER ADVERSE EFFECTS:** This compound is not listed as having ozone depletion potential.

**EFFECT OF MATERIAL ON PLANTS or ANIMALS:** There are currently no data on the effects of this product on plants and animals in the environment.

**EFFECT OF CHEMICAL ON AQUATIC LIFE:** There are no data on the effects of this product in an aquatic environment; however, as an insoluble compound, no significant effects are anticipated. The following aquatic toxicity data are available for components of this product.

**ALUMINUM:**

LC<sub>50</sub> (*Psidium casertanum*) 96 hours = > 1.0 mg/L; static, 20-25 deg C, pH 3.5  
 LC<sub>50</sub> (*Psidium casertanum*) 96 hours = > 0.4 mg/L; static, 20-25 deg C, pH 4.5  
 LC<sub>50</sub> (*Psidium compressum*) 96 hours = > 0.4 mg/L; static, 20-25 deg C, pH 4.5  
 LC<sub>50</sub> (*Psidium compressum*) 96 hours = > 1.0 mg/L; static, 20-25 deg C, pH 3.5  
 LC<sub>50</sub> (*Psidium compressum* Ridged-beak peaclam) 96 hours = > 0.40 mg/L; static  
 LC<sub>50</sub> (*Amnicola limosa* Snail) 96 hours = > 1.0 mg/L; static, 20-25 deg C, pH 3.5  
 LC<sub>50</sub> (*Amnicola limosa* Snail) 96 hours = > 0.4 mg/L; static, 20-25 deg C, pH 4.5  
 LC<sub>50</sub> (*Salmo trutta* Brown trout, alevins) 28 hours = 19 µg/L; field study in upland Welsh streams /Conditions of bioassay not specified in source examined/ /Total monomeric aluminum  
 LC<sub>50</sub> (*Salmo trutta* Brown trout, alevins) 42 hours = 15 µg/L; field study in upland Welsh streams /Conditions of bioassay not specified in source examined/ /Total monomeric aluminum  
 LC<sub>50</sub> (*Salmo trutta* Brown trout, alevins) 28 hours = 79 µg/L; field study in upland Welsh streams /Conditions of bioassay not specified in source examined/ /0.45 µm filterable aluminum  
 LC<sub>50</sub> (*Salmo trutta* Brown trout, alevins) 42 days = 72 µg/L; field study in upland Welsh streams /Conditions of bioassay not specified in source examined/ /0.45 µm filterable aluminum

**ALUMINUM (continued):**

LC<sub>50</sub> (*Salmo trutta* Brown trout, parr about 3 months) 21 days = 84 µg/L; field study in upland Welsh streams /Conditions of bioassay not specified in source examined/ /0.45 µm filterable aluminum  
 LC<sub>50</sub> (*Salmo trutta* Brown trout, parr about 3 months) 21 hours = 105 µg/L; field study in upland Welsh streams /Conditions of bioassay not specified in source examined/ /0.45 µm filterable aluminum  
 LC<sub>50</sub> (*Brachionus calyciflorus* Rotifer) 24 hours = > 3000 µg/L; static /technical product  
 LC<sub>50</sub> (*Ctenopharyngodon idella* Grass carp, white amur) 96 hours = 260 µg/L (95% confidence interval: 210-310 µg/L); static  
 LC<sub>50</sub> (*Daphnia magna* Water flea) 6 hours = 9.5 mg/L/Conditions of bioassay not specified in source examined/ /formulated product  
 LC<sub>50</sub> (*Daphnia magna* Water flea) 24 hours = 2.6 mg/L/Conditions of bioassay not specified in source examined/ /formulated product  
 LC<sub>50</sub> (*Enallagma* sp. Damselfly) 96 hours = > 0.40 mg/L; static  
 LC<sub>50</sub> (*Hyallela azteca* Scud) 96 hours = > 0.40 mg/L; static  
 LC<sub>50</sub> (*Oncorhynchus mykiss* Rainbow trout) 96 hours = 120 µg/L; static  
**BORON:**  
 EC<sub>50</sub> (Lemna minor Duckweed; growth inhibition) 4 days = > 60 mg/L; static

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

**13. DISPOSAL CONSIDERATIONS**

**DISPOSAL METHODS:** It is the responsibility of the generator to determine at the time of disposal whether the product meets the criteria of a hazardous waste per regulations of the area in which the waste is generated and/or disposed of. 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 hazardous waste regulatory authority. Shipment of wastes must be done with appropriately permitted and registered transporters.

**13. DISPOSAL CONSIDERATIONS (Continued)**

DISPOSAL CONTAINERS: Waste materials must be placed in and shipped in appropriate 5-gallon or 55 gallon poly or metal waste pails or drums. Permeable cardboard containers are not appropriate and should not be used. Ensure that any required marking or labeling of the containers be done to all applicable regulations.

PRECAUTIONS TO BE FOLLOWED DURING WASTE HANDLING: Wear proper protective equipment when handling waste materials. Dispose of in accordance with applicable Federal, State, and local procedures and standards.

U.S. EPA WASTE NUMBER: Not applicable.

EUROPEAN WC WASTE CODE: 16 01 99 (Wastes Not Otherwise Specified)

**14. TRANSPORTATION INFORMATION**

U.S. DEPARTMENT OF TRANSPORTATION REGULATIONS: This product is NOT classified as dangerous goods, per U.S. DOT regulations, under 49 CFR 172.101.

TRANSPORT CANADA, TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: This product is NOT classified as dangerous goods, per regulations of Transport Canada.

INTERNATIONAL AIR TRANSPORT ASSOCIATION SHIPPING INFORMATION (IATA): This product is NOT classified as dangerous goods, per the International Air Transport Association. Heated product is forbidden to be shipped via aircraft.

INTERNATIONAL MARITIME ORGANIZATION SHIPPING INFORMATION (IMO): This product is NOT classified as dangerous goods, under rules of the IMO.

EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR): This product is NOT classified as dangerous goods by the United Nations Economic Commission for Europe.

**15. REGULATORY INFORMATION**

**U.S. STATE AND FEDERAL REGULATIONS:**

U.S. SARA REPORTING REQUIREMENTS: The Aluminum component of this product 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)
Aluminum (fume or dust)	No	No	Yes

U.S. SARA THRESHOLD PLANNING QUANTITY: There are no specific Threshold Planning Quantities for any component of this product. The default Federal MSDS submission and inventory requirement filing threshold of 10,000 lb (4,540 kg) therefore applies, per 40 CFR 370.20.

U.S. SARA 302 EXTREMELY HAZARDOUS THRESHOLD PLANNING QUANTITY: Not applicable.

U.S. SARA 304 EXTREMELY HAZARDOUS REPORTABLE QUANTITY (RQ): Not applicable.

U.S. CERCLA REPORTABLE QUANTITY (RQ): Not applicable.

U.S. TSCA INVENTORY STATUS: The components of this alloy are on the TSCA Chemical Inventory.

OTHER U.S. FEDERAL REGULATIONS: Not applicable.

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): The components of this alloy are not on the California Proposition 65 Lists.

ANSI LABELING (Z129.1; Provided to Summarize Occupational Hazard Information): **CAUTION! DUSTS AND FUMES MAY CAUSE IRRITATION BY ALL ROUTES OF EXPOSURE. CONTACT WITH HOT PRODUCT WILL CAUSE THERMAL BURNS. SHARP EDGES ON PRODUCT CAN CAUSE CUTS.** Do not taste or swallow. Do not get on skin, in eyes, or on clothes. Do not breathe dusts, particulates, or fumes. Keep container closed. Use only with adequate ventilation. Wash thoroughly after handling. Wear gloves and goggles. In case of fire, smother with dry sand, or Class D fire extinguishing agents. Carefully shovel or sweep up spilled material and place in suitable container. Avoid generating dust. Use appropriate Personal Protective Equipment (PPE). Use in accordance with the Material Safety Data Sheet.

**FIRST-AID:** **IF DUSTS OR FUMES FROM PRODUCT ARE INHALED,** remove to fresh air. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, give oxygen. Call a physician.

**IN CASE OF CONTACT:** In event of irritation, 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).

**ADDITIONAL CANADIAN REGULATIONS:**

CANADIAN DSL/NDL INVENTORY: The components of this alloy are listed on the DSL Inventory.

OTHER CANADIAN REGULATIONS: Not applicable.

CANADIAN ENVIRONMENTAL PROTECTION AGENCY (CEPA) PRIORITY SUBSTANCES LISTS: The components of this product are not on the CEPA priority substances lists.

CANADIAN WHMIS CLASSIFICATION and SYMBOLS: Not applicable.



**EUROPEAN UNION INFORMATION FOR PRODUCT:**

**EU LABELING AND CLASSIFICATION:** This product does not meet the definition of any, as defined by the European Economic Community Guidelines.

**EU CLASSIFICATION:** Not applicable.

**EU RISK PHRASES:** Not applicable.

**EU SAFETY PHRASES:** Not applicable.

**EUROPEAN UNION ANNEX II HAZARD SYMBOLS:** Not applicable.

The following is classification information for components of this product.

**Aluminum Powder:**

EU EINECS/ELINCS NUMBER: 231-072-8

EU HAZARD CLASSIFICATION: [F] Flammable

EU RISK PHRASES: [R: 10]: Flammable. [R: 15]: Contact with water liberates extremely flammable gases.

EU SAFETY PHRASES: [S: 2½-]: Keep 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: 7/8]: Keep container tightly closed and dry. [S: 43]: In case of fire never use water.

**16. OTHER INFORMATION****PREPARED BY:**

CHEMICAL SAFETY ASSOCIATES, INC.  
PO Box 3519, La Mesa, CA 91944-3519  
(800) 441-3365 • (619) 670-0609

REVISION INFORMATION: February 29, 2008. Revise format for current EU standards.

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.

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

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

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

**LOQ:** Limit of Quantitation.

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

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

**NIC:** Notice of Intended Change.

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

**NIOSH RELS:** NIOSH's Recommended Exposure Limits.

**EXPOSURE LIMITS IN AIR (continued):**

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

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

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

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

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

**HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD**

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

**HEALTH HAZARD:**

**0 (Minimal Hazard):** No significant health risk, irritation of skin or eyes not anticipated. *Skin Irritation:* Essentially non-irritating. PII or Draize = "0". *Eye Irritation:* Essentially non-irritating, or minimal effects which clear in < 24 hours [e.g. mechanical irritation]. Draize = "0". *Oral Toxicity LD<sub>50</sub> Rat:* < 5000 mg/kg. *Dermal Toxicity LD<sub>50</sub> Rat or Rabbit:* < 2000 mg/kg. *Inhalation Toxicity 4-hrs LC<sub>50</sub> 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 LD<sub>50</sub> Rat:* > 500-5000 mg/kg. *Dermal Toxicity LD<sub>50</sub> Rat or Rabbit:* > 1000-2000 mg/kg. *Inhalation Toxicity LC<sub>50</sub> 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 LD<sub>50</sub> Rat:* > 50-500 mg/kg. *Dermal Toxicity LD<sub>50</sub> Rat or Rabbit:* > 200-1000 mg/kg. *Inhalation Toxicity LC<sub>50</sub> 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 LD<sub>50</sub> Rat:* > 1-50 mg/kg. *Dermal Toxicity LD<sub>50</sub> Rat or Rabbit:* > 20-200 mg/kg. *Inhalation Toxicity LC<sub>50</sub> 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 LD<sub>50</sub> Rat:* ≤ 1 mg/kg. *Dermal Toxicity LD<sub>50</sub> Rat or Rabbit:* ≤ 20 mg/kg. *Inhalation Toxicity LC<sub>50</sub> 4-hrs Rat:* ≤ 0.05 mg/L).

HAZARDOUS  
MATERIALS

## IDENTIFICATION SYSTEM HAZARD RATINGS (continued):

**FLAMMABILITY HAZARD:**

**0** (Minimal Hazard-Materials that will not burn in air when exposure to a temperature of 815.5°C [1500°F] for a period of 5 minutes.); **1** (Slight Hazard-Materials that must be pre-heated before ignition can occur. Material require considerable pre-heating, under all ambient temperature conditions before ignition and combustion can occur, including: Materials that will burn in air when exposed to a temperature of 815.5°C (1500°F) for a period of 5 minutes or less; Liquids, solids and semisolids having a flash point at or above 93.3°C [200°F] (e.g. OSHA Class IIIB, or; Most ordinary combustible materials [e.g. wood, paper, etc.]; **2** (Moderate Hazard-Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not, under normal conditions, form hazardous atmospheres in air, but under high ambient temperatures or moderate heating may release vapor in sufficient quantities to produce hazardous atmospheres in air, including: Liquids having a flash-point at or above 37.8°C [100°F]; Solid materials in the form of course dusts that may burn rapidly but that generally do not form explosive atmospheres; Solid materials in a fibrous or shredded form that may burn rapidly and create flash fire hazards (e.g. cotton, sisal, hemp; Solids and semisolids that readily give off flammable vapors.); **3** (Serious Hazard- Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials in this degree produce hazardous atmospheres with air under almost all ambient temperatures, or, unaffected by ambient temperature, are readily ignited under almost all conditions, including: Liquids having a flash point below 22.8°C [73°F] and having a boiling point at or above 38°C [100°F] and below 37.8°C [100°F] [e.g. OSHA Class IB and IC]; Materials that on account of their physical form or environmental conditions can form explosive mixtures with air and are readily dispersed in air [e.g., dusts of combustible solids, mists or droplets of flammable liquids]; Materials that burn extremely rapidly, usually by reason of self-contained oxygen [e.g. dry nitrocellulose and many organic peroxides]); **4** (Severe Hazard-Materials that will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or that are readily dispersed in air, and which will burn readily, including: Flammable gases; Flammable cryogenic materials; Any liquid or gaseous material that is liquid while under pressure and has a flash point below 22.8°C [73°F] and a boiling point below 37.8°C [100°F] [e.g. OSHA Class IA; Material that ignite spontaneously when exposed to air at a temperature of 54.4°C [130°F] or below [e.g. pyrophoric]).

**PHYSICAL HAZARD:**

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

## HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS (continued):

**PHYSICAL HAZARD (continued):**

**3 (continued):** *Liquids*: Any material that spontaneously ignites when mixed with cellulose in a 1:1 ratio, or which exhibits a mean pressure rise time less than the pressure rise time of a 1:1 perchloric acid (50%)/cellulose mixture. *Unstable Reactives*: Substances that may polymerize, decompose, condense or self-react at ambient temperature and/or pressure and have a moderate potential to cause significant heat generation or explosion.; **4** *Water Reactivity*: Materials that react explosively with water without requiring heat or confinement. *Organic Peroxides*: Materials that are readily capable of detonation or explosive decomposition at normal temperature and pressures. *Explosives*: Division 1.1 & 1.2-explosive substances that have a mass explosion hazard or have a projection hazard. A mass explosion is one that affects almost the entire load instantaneously. *Compressed Gases*: No Rating. *Pyrophorics*: Add to the definition of Flammability "4". *Oxidizers*: No "4" rating. *Unstable Reactives*: Substances that may polymerize, decompose, condense or self-react at ambient temperature and/or pressure and have a high potential to cause significant heat generation or explosion.

## NATIONAL FIRE PROTECTION ASSOCIATION HAZARD RATINGS:

**HEALTH HAZARD: 0** (materials that, under emergency conditions, would offer no hazard beyond that of ordinary combustible materials): Gases and vapors whose LC<sub>50</sub> for acute inhalation toxicity is greater than 10,000 ppm. Dusts and mists whose LC<sub>50</sub> for acute inhalation toxicity is greater than 200 mg/L. Materials whose LD<sub>50</sub> for acute dermal toxicity is greater than 2000 mg/kg. Materials whose LD<sub>50</sub> for acute oral toxicity is greater than 2000 mg/kg. Materials that are essentially non-irritating to the respiratory tract, eyes and skin. **1** (materials that, under emergency conditions, can cause significant irritation): Gases and vapors whose LC<sub>50</sub> for acute inhalation toxicity is greater than 5,000 ppm but less than or equal to 10,000 ppm. Dusts and mists whose LC<sub>50</sub> for acute inhalation toxicity is greater than 10 mg/L but less than or equal to 200 mg/L. Materials whose LD<sub>50</sub> for acute dermal toxicity is greater than 1000 mg/kg but less than or equal to 2000 mg/kg. Materials whose LD<sub>50</sub> for acute oral toxicity is greater than 500 mg/kg but less than or equal to 2000 mg/kg. Materials that cause slight to moderate irritation to the respiratory tract, eyes and skin.

## NATIONAL FIRE PROTECTION ASSOCIATION HAZARD RATINGS (continued):

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

**FLAMMABILITY HAZARD: 0** Materials that will not burn under typical fire conditions, including intrinsically noncombustible materials such as concrete, stone, and sand: Materials that will not burn in air when exposed to a temperature of 816°C (1500°F) for a period of 5 minutes in accordance with Annex D. **1** Materials that must be preheated before ignition can occur. Materials in this degree require considerable preheating, under all ambient temperature conditions, before ignition and combustion can occur. Materials that will burn in air when exposed to a temperature of 816°C (1500°F) for a period of 5 minutes in accordance with Annex D.

## NATIONAL FIRE

## PROTECTION ASSOCIATION HAZARD RATINGS (continued):

**FLAMMABILITY HAZARD (continued): 1 (continued):** Liquids, solids and semisolids having a flash point at or above 93.4°C (200°F) (i.e. Class IIIB liquids). Liquids with a flash point greater than 35°C (95°F) that do not sustain combustion when tested using the Method of Testing for Sustained Combustibility, per 49 CFR 173, Appendix H or the UN Recommendation on the Transport of Dangerous Goods, Model Regulations (current edition) and the related Manual of Tests and Criteria (current edition). Liquids with a flash point greater than 35°C (95°F) in a water-miscible solution or dispersion with a water non-combustible liquid/solid content of more than 85 percent by weight. Liquids that have no fire point when tested by ASTM D 92 Standard Test Method for Flash and Fire Points by Cleveland Open Cup, up to a boiling point of the liquid or up to a temperature at which the sample being tested shows an obvious physical change. Combustible pellets with a representative diameter of greater than 2 mm (10 mesh). Solids containing greater than 0.5 percent by weight of a flammable or combustible solvent are rated by the closed up flash point of the solvent. Most ordinary combustible materials. **2** Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating could release vapor in sufficient quantities to produce hazardous atmospheres with air: Liquids having a flash point at or above 37.8°C (100°F) and below 93.4°C (200°F) (i.e. Class II and Class IIIA liquids.) Solid materials in the form of powders or coarse dusts of representative diameter between 420 microns (40 mesh) and 2 mm (10 mesh) that burn rapidly but that generally do not form explosive mixtures in air. Solid materials in fibrous or shredded form that burn rapidly and create flash fire hazards, such as cotton, sisal and hemp. Solids and semisolids that readily give off flammable vapors. Solids containing greater than 0.5 percent by weight of a flammable or combustible solvent are rated by the closed cup flash point of the solvent. **3** Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials in this degree produce hazardous atmospheres with air under almost all ambient temperatures or, though unaffected by ambient temperatures, are readily ignited under almost all conditions: Liquids having a flash point below 22.8°C (73°F) and having a boiling point at or above 37.8°C (100°F) and those liquids having a flash point at or above 22.8°C (73°F) and below 37.8°C (73°F) and below 37.8°C (100°F) (i.e. Class IB and IC liquids). Materials that, on account of their physical form or environmental conditions, can form explosive mixtures with air and are readily dispersed in air. Flammable or combustible dusts with a representative diameter less than 420 microns (40 mesh). Materials that burn with extreme rapidity, usually by reason of self-contained oxygen (e.g. dry nitrocellulose and many organic peroxides). Solids containing greater than 0.5 percent by weight of a flammable or combustible solvent are rated by the closed cup flash point of the solvent. **4** Materials that will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or that are readily dispersed in air and will burn readily: Flammable gases. Flammable cryogenic materials. Any liquid or gaseous materials that is liquid while under pressure and has a flash point below 22.8°C (73°F) and a boiling point below 37.8°C (100°F) (i.e. Class IA liquids). Materials that ignite when exposed to air. Solids containing greater than 0.5 percent by weight of a flammable or combustible solvent are rated by the closed cup flash point of the solvent.

**INSTABILITY HAZARD: 0** Materials that in themselves are normally stable, even under fire conditions: Materials that have an estimated instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) below 0.01 W/mL. Materials that do not exhibit an exotherm at temperatures less than or equal to 500°C (932°F) when tested by differential scanning calorimetry. **1** Materials that in themselves are normally stable, but that can become unstable at elevated temperatures and pressures: Materials that have an estimated instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) at or above 0.01 W/mL and below 10 W/mL. **2** Materials that readily undergo violent chemical change at elevated temperatures and pressures: Materials that have an estimated instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) at or above 10 W/mL and below 100W/mL. **3** Materials that in themselves are capable of detonation or explosive decomposition or explosive reaction, but that require a strong initiating source or that must be heated under confinement before initiation: Materials that have an estimated instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) at or above 100 W/mL and below 1000 W/mL. Materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures. **4** Materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures: Materials that have an estimated instantaneous power density (product of heat of reaction and reaction rate) at 250°C (482°F) of 1000 W/mL or greater. Materials that are sensitive to localized thermal or mechanical shock at normal temperatures and pressures.

## 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: **LD<sub>50</sub>** - Lethal Dose (solids & liquids) which kills 50% of the exposed animals; **LC<sub>50</sub>** - 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/m<sup>3</sup>** concentration expressed in weight of substance per volume of air; **mg/kg** quantity of material, by weight, administered to a test subject, based on their body weight in kg. Other measures of toxicity include **TDLo**, the lowest dose to cause a symptom and **TCLo** the lowest concentration to cause a symptom; **TDo**, **LDLo**, and **LDo**, or **TC**, **TCo**, **LCLo**, and **LCo**, the lowest dose (or concentration) to cause lethal or toxic effects. **Cancer Information:** The sources are: **IARC** - the International Agency for Research on Cancer; **NTP** - the National Toxicology Program, **RTECS** - the Registry of Toxic Effects of Chemical Substances, **OSHA** and **CAL/OSHA**. IARC and NTP rate chemicals on a scale of decreasing potential to cause human cancer with rankings from 1 to 4. Subrankings (2A, 2B, etc.) are also used. **Other Information:** **BEI** - ACGIH Biological Exposure Indices, represent the levels of determinants which are most likely to be observed in specimens collected from a healthy worker who has been exposed to chemicals to the same extent as a worker with inhalation exposure to the TLV.

## ECOLOGICAL INFORMATION:

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

## REGULATORY INFORMATION:

## U.S. and CANADA:

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

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

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