SAFETY DATA SHEET

SALEM TUBE

TUBACEX GROUP

Prepared to U.S. OSHA, CMA, ANSI, Canadian WHMIS 2015 (HPR-GHS), Australian Work Health and Safety (Preparation of Safety Data Sheets for Hazardous Chemicals) Code of Practice 2015, European Union CLP EC 1272/2008 & the 8th ATP 2016/918, REACH, the Korean ISHA (Notice 2009-68) & Toxic Chemicals Control Act (TCCA), Singapore SS586 - 2: 2008 and SS 586 - 3: 2008 Standards, Chinese GB 20576 ~ GB 20602-2006, Japanese JIS Z7253, Taiwanese Standards, Mexican NOM-018-STPS-2015 Standard, Standards of *Taiwan, and the Global Harmonization Standard*

1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE

IDENTIFICATION of the SUBSTANCE or PREPARATION:

TRADE NAME (AS LABELED):	**STAINLESS STEEL & NICKEL ALLOYS**
OTHER MEANS OF IDENTIFICATION/SYNONYMS:	None
CHEMICAL NAME/CLASS:	Metal Alloys
RELEVANT USE of the SUBSTANCE:	Various
USES ADVISED AGAINST:	None Identified

COMPANY/UNDERTAKING IDENTIFICATION:

DISTRIBUTOR'S NAME:	**SALEM TUBE, INC.**
ADDRESS:	951 Fourth Street Greenville, PA 16125
BUSINESS PHONE:	01 + 724-646-4301
EMERGENCY PHONE:	United States/Canada: 1-800/424-9300 (Chemtrec) [24-hours] International: +1-703-527-3887 (Chemtrec) [24-hours]
EMAIL:	salemquality@salemtube.com
DATE OF PREPARATION:	February 3, 2008
DATE OF REVISION:	March 23, 2018

2. HAZARD IDENTIFICATION

These products are "Articles" under regulations and standard for the countries listed above. Refer to Section 15 (Regulatory Information) for specific regulatory citations. As articles, these products present negligible health and physical hazards under reasonably anticipated circumstances of use. Subsequently, a Safety Data Sheet is not required for these products under Standards cited above. This document is prepared to provide persons using these products with additional safety information.

GLOBAL HARMONIZATION LABELING AND CLASSIFICATION: These products are articles and are not required to be classified under all jurisdictions.

EMERGENCY OVERVIEW: Product Description: These products are solid metal alloys. **Health Hazards:** During normal use and handling, these products present minimal health hazards. When these alloys are cut or formed, inhalation of dusts may cause irritation of the respiratory system. If heated, fumes may cause metal fume fever. Some components are toxic in dust form; dusts from these products can present a toxicity hazard. Contact with dusts or metal particles may cause mechanical irritation of the eyes. Sharp edges can cause cuts. Components of these alloys are known or suspected carcinogens. The Lead component is a known reproductive toxin. Due to the high level of Nickel, the alloy presents a hazard of skin sensitization and allergic skin reactions in persons susceptible to Nickel. Other components are also skin and/or respiratory sensitizers. **Flammability Hazards:** These alloys are not flammable. **Reactivity Hazards:** These alloys are not reactive. **Environmental Hazards:** Although these alloys present negligible adverse effects to the environment, some components are known to be toxic to marine organisms. **Emergency Recommendations:** Emergency responders must wear the personal protective equipment suitable for the situation to which they are responding.

3. COMPOSITION and INFORMATION ON INGREDIENTS

These products are solid metal alloys. The exposure limits apply to dusts and not to the solid metal form of these products. If these products are cut or otherwise manipulated in such a way that will produce dusts or fumes, exposure to these components is possible.

Hazardous Ingredients:	CAS #	European EINECS #	AICS Inventory Listing	Japanese MITI/ENC Inventory #	Chinese IECSC Inventory	Korean ECL Inventory #	WT %	LABEL ELEMENTS GHS Classification per U.S., Canadian & EU Classification Standards Australian WHS Classification Korean ISHA Classification Hazard Statements
Nickel	7440-02-0	231-111-4	Listed	Excepted as a Mineral	Listed	KE-25818	0.1-99.0	For Powder < 1 mm Particle Size: Harmonized GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Carcinogenicity (Inhalation) Cat. 2, STOT RE Cat. 1, Skin Sensitizer Cat. 1A, Aquatic Chronic Toxicity Cat. 3 Hazard Statement Codes: H351i, H372, H317, H412 Additional ECHA Notified Classification: Classification: Respiratory Sensitization Cat. 1B Hazard Statement Codes: H334
Copper	7440-50-8	231-159-6	Listed	Excepted as a Mineral	Listed	KE-08896	0.1-34.0	Harmonized GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Eye Irritation Cat. 2A, Aquatic Chronic Toxicity Cat. 2 Hazard Statement Codes: H319, H411 Additional ECHA Notified Classification: Classification: Respiratory Acute Oral Toxicity Cat. 4, Aquatic Acute Toxicity Cat. 2 Hazard Statement Codes: H302, H400

See Section 16 for full text of GHS classification

3. COMPOSITION and INFORMATION ON INGREDIENTS (Continued)

Hazardous Ingredients:	CAS #	European EINECS #	AICS Inventory Listing	Japanese MITI/ENC Inventory #	Chinese IECSC Inventory	Korean ECL Inventory #	WT %	LABEL ELEMENTS GHS Classification per U.S., Canadian & EU Classification Standards Australian WHS Classification Korean ISHA Classification Hazard Statements
Molybdenum	7439-98-7	231-107-2	Listed	Excepted as a Mineral	Listed	KE-25427	0.5-17.0	GHS Classification: Not Applicable
Chromium (metal)	7440-47-3	231-157-5	Listed	Excepted as a Mineral	Listed	KE-05970	10.0-30.0	Self-Classification GHS per U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Australian WHS & EU CLP 1272/2008: Classification: Acute Oral Toxicity Cat. 5 Hazard Statement Codes: H303 KOREAN ISHA only Classification: Classification: Not Classified
Cb +Tantalum	7440-25-7	231-135-5	Listed	Excepted as a Mineral	Listed	KE-33006	0.1-4.5	Notified GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Flammable Solid Cat. 1 Hazard Statement Codes: H228 Additional Self-Classification: Classification: Acute Oral Toxicity Cat. 4 Hazard Statement Codes: H302 U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Tungsten	7440-33-7	231-143-9	Listed	Excepted as a Mineral	Listed	KE-35000	0.5-4.5	Notified GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Flammable Solid Cat. 1 Hazard Statement Codes: H228 U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Aluminum (Stabilized)	7429-90-5	231-072-3	Listed	Excepted as a Mineral	Listed	KE-00881	0.1-3.5	Harmonized GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Water Reactive Cat. 2, Flammable Solid Cat. 1 Hazard Statement Codes: H261, H228 U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Manganese	7439-96-5	231-105-1	Listed	Excepted as a Mineral	Listed	KE-22999	0.1-3.0	Self-Classification GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Water Reactive Cat. 2 Hazard Statement Codes: H261 U.S. OSHA only Classification: Classification: Combustible Dust Hazard (moderate hazard)
Cobalt	7440-48-4	231-158-0	Listed	Excepted as a Mineral	Listed	KE-06060	0.0-2.5	Harmonized GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Respiratory Sensitizer Cat. 1, Skin Sensitizer Cat. 1, Aquatic Chronic Toxicity Cat. 4 Hazard Statement Codes: H334, H317, H413 Additional Notified ECHA Classification: Classification: Carcinogenicity (Inhalation) Cat. 1B, Reproductive Toxicity Cat. 2, Acute Inhalation Toxicity Cat. 2, Acute Oral Toxicity Cat. 4, Eye Irritation Cat. 2A, STOT (Inhalation-Lung) RE 2, Aquatic Acute Toxicity Cat. 1, Aquatic Chronic Toxicity Cat. 1 Hazard Statement Codes: H350i, H361fd, H302, H319, H373, H400, H410 U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Iron	7439-89-6	231-096-4	Listed	Excepted as a Mineral	Listed	KE-21059	0.0-2.5	Notified GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Flammable Solid Cat. 1, Self-Heating Cat. 1 Hazard Statement Codes: H228, H251 Additional Self-Classification: Classification: Acute Oral Toxicity Cat. 4 Hazard Statement Codes: H302 U.S. OSHA only Classification: Classification: Combustible Dust Hazard

See Section 16 for full text of GHS classification

3. COMPOSITION and INFORMATION ON INGREDIENTS (Continued)

Hazardous Ingredients:	CAS #	European EINECS #	AICS Inventory Listing	Japanese MITI/ENC Inventory #	Chinese IECSC Inventory	Korean ECL Inventory #	WT %	LABEL ELEMENTS GHS Classification per U.S., Canadian & EU Classification Standards Australian WHS Classification Korean ISHA Classification Hazard Statements
Lead (compounds)	7439-92-1	231-100-4	Listed	Excepted as a Mineral	Listed	KE-21887	0.0-2.5	For Powder ≥ 1 mm Particle Size: Harmonized GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Reproductive Toxicity Cat. 1A, Lactation Hazard Cat. 1 Hazard Statement Codes: H360Df, H362 Additional ECHA Notified Classification: Classification: STOT (Inhalation/Ingestion-Neurological System) RE Cat. 2, Aquatic Acute Toxicity Cat. 1, Aquatic Chronic Toxicity Cat. 1 Hazard Statement Codes: H372, H400, H410 U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Titanium	7440-32-6	231-142-3	Listed	Excepted as a Mineral	Listed	KE-33881	0.10-1.2	U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Silicon	7440-21-3	231-130-8	Listed	Excepted as a Mineral	Listed	KE-31029	0.01-1.0	Self-Classification GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Flammable Solid Cat. 1 Hazard Statement Codes: H228 Additional ECHA Notified Classification (does not apply to Korean ISHA): Classification: Acute Oral Toxicity Cat. 5 Hazard Statement Codes: H303 U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Columbium (Nobium)	7440-03-1	231-113-5	Listed	Excepted as a Mineral	Listed	Not Listed	0.05-0.4	Notified GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Flammable Solid Cat. 1 Hazard Statement Codes: H228 U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Zirconium (powder, non-pyrophoric)	7440-67-7	231-176-9	Listed	Excepted as a Mineral	Listed	KE-35607	0.01-0.10	Harmonized GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Self-Heating Substance Cat. 1, Water Reactive Cat. 1 Hazard Statement Codes: H251, H260 U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Selenium	7782-49-2	231-957-4	Listed	Excepted as a Mineral	Listed	KE-30924	0.01-0.045	Harmonized GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Acute Oral Toxicity Cat. 3, Inhalation Toxicity Cat. 3, STOT (Inhalation) RE Cat. 2, Aquatic Chronic Toxicity Cat. 3 Hazard Statement Codes: H301 + H331, H373, H413 Additional ECHA Notified Classification: Classification: Carcinogenicity Cat. 1B, Reproductive Toxicity Cat. 1A, Lactation Hazard Cat. 1, Skin Sensitization Cat 1B, Aquatic Chronic Cat. 3 Hazard Statement Codes: H351, H360FD, H262, H317, H412
Phosphorous, White	7723-14-0	231-768-7	Listed	Excepted as a Mineral	Listed	KE-28713	0.015-0.04	Harmonized GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Pyrophoric Solid Cat. 1, Acute Oral Toxicity Cat. 2, Acute Inhalation Toxicity Cat. 2, Skin Corrosion Cat. 1B, Aquatic Chronic Toxicity Cat. 3 Hazard Statement Codes: H250. H300 + H330, H314, H412 U.S. OSHA only Classification: Classification: Combustible Dust Hazard

See Section 16 for full text of GHS classification

3. COMPOSITION and INFORMATION ON INGREDIENTS (Continued)

Hazardous Ingredients:	CAS #	European EINECS #	AICS Inventory Listing	Japanese MITI/ENC Inventory #	Chinese IECSC Inventory	Korean ECL Inventory #	WT %	LABEL ELEMENTS GHS Classification per U.S., Canadian & EU Classification Standards Australian WHS Classification Korean ISHA Classification Hazard Statements
Vanadium	7440-62-2	231-171-1	Listed	Excepted as a Mineral	Listed	KE-35266	0.04	Self-Classification GHS per U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Australian WHS & EU CLP 1272/2008: Classification: Acute Oral Toxicity Cat. 5 Hazard Statement Codes: H303 Korean ISHA only Classification: Classification: Not Classified U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Sulfur	7704-34-9	231-722-6	Listed	Excepted as a Mineral	Listed	KE-32688	0.001-0.035	Harmonized GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Skin Irritation Cat. 2 Hazard Statement Codes: H315
Tin	7440-31-5	231-141-8	Listed	Excepted as a Mineral	Listed	KE-33838	< 0.01	U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Yttrium	7440-65-5	231-174-8	Listed	Excepted as a Mineral	Listed	KE-35468	0.05-0.12	Notified GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Flammable Solid Cat. 1, Pyrophoric Solid Cat. 1, Acute Oral Toxicity Cat. 4, Acute Dermal Toxicity Cat. 4, Acute Inhalation Toxicity Cat. 4, Acute Chronic Toxicity Cat. 4 Hazard Statement Codes: H228, H250, H302 + H312, H332, H413 U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Zinc (dust, stabilized)	7440-66-6	231-175-3	Listed	Excepted as a Mineral	Listed	KE-35518	< 0.01	Harmonized GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Aquatic Acute Toxicity Cat. 1, Aquatic Chronic Toxicity Cat. 1 Hazard Statement Codes: H400, H410 U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Beryllium	7440-41-7	231-150-7	Listed	Excepted as a Mineral	Listed	KE-02829	0.006	Harmonized GHS Classification per ECHA & U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Carcinogenicity (Inhalation) Cat 1B, Acute Inhalation Toxicity Cat. 2, Acute Oral Toxicity Cat. 3, Skin Irritation Cat. 2, Eye Irritation Cat. 2A, STOT (Inhalation-Respiratory Irritation) SE Cat. 3, Skin Sensitization Cat. 1, STOT (Inhalation) RE Cat. 1 Hazard Statement Codes: H350i, H330, H301, H315, H319, H335, H317, H372 Additional Self Classification: Classification: Flammable Solid Cat. 1 Hazard Statement Codes: H228 U.S. OSHA only Classification: Classification: Combustible Dust Hazard
Boron	7440-42-8	231-151-2	Listed	Excepted as a Mineral	Listed	KE-03518	0.006	Self-Classification GHS per U.S. OSHA HazCom 2012, Canadian WHMIS HPR-2015, Korean ISHA, Australian WHS & EU CLP 1272/2008: Classification: Acute Oral Toxicity Cat. 4 Hazard Statement Codes: H302 U.S. OSHA only Classification: Classification: Combustible Dust Hazard

See Section 16 for full text of GHS classification

4. FIRST-AID MEASURES

WORKPLACE FACILITIES: If handling of these products can result in dusts or particulates, ensure proper decontamination equipment (e.g., eyewash/safety shower stations) are available near areas where these products are handled as necessary.

PROTECTION OF FIRST AID RESPONDERS: Rescuers should be taken for medical attention if necessary.

DESCRIPTION OF FIRST AID MEASURES: Any person suffering injury or adverse effect from these products should seek medical attention. Take a copy of label and SDS to physician or health professional with the contaminated individual.

Skin Exposure: If adverse skin effects occur, discontinue use and flush contaminated area. Seek medical attention if adverse effect occurs after flushing.

Eye Exposure: If dusts or particulates enter the eyes, open the contaminated individual's eyes while under gently running water. Use sufficient force to open eyelids. Have the contaminated individual "roll" eyes. Minimum flushing is for 20 minutes. Contact medical personnel if adverse effect persists after flushing.

Inhalation: If dusts or fumes are inhaled, remove the contaminated individual to fresh air. If necessary, use artificial respiration to support vital functions. Remove or cover gross contamination to avoid exposure to rescuers. The contaminated individual should seek immediate medical attention if any adverse effects occur.

4. FIRST-AID MEASURES (Continued)

DESCRIPTION OF FIRST AID MEASURES (continued):

Ingestion: Ingestion is highly unlikely due to the form of these alloys. If poor hygiene or other conditions lead to ingestion of dusts from product, CALL PHYSICIAN OR POISON CONTROL CENTER FOR MOST CURRENT INFORMATION. If professional advice is not available, do not induce vomiting. Have victim rinse mouth with water or drink several cupfuls of water, if conscious. Never induce vomiting or give a diluent (e.g., water) to someone who is unconscious, having convulsions, or unable to swallow. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration.

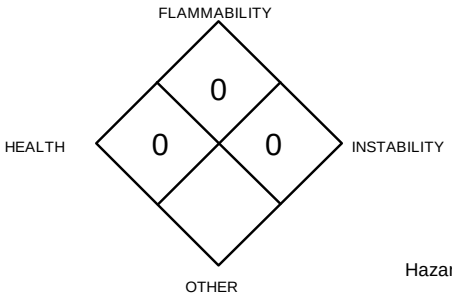
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Preexisting respiratory problems, dermatitis, and other skin disorders may be aggravated by exposure to dusts or fumes from these products.

IMMEDIATE MEDICAL ATTENTION AND SPECIAL TREATMENT NEEDED: Treat symptoms and eliminate exposure.

5. FIRE-FIGHTING MEASURES

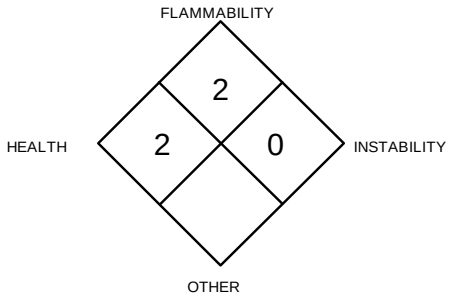
For Solid Metal Alloy

NFPA RATING



For Dusts

NFPA RATING



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

FLASH POINT: Not applicable. AUTOIGNITION TEMPERATURE: Not applicable.

FLAMMABLE LIMITS (in air by volume, %): Not applicable.

FIRE EXTINGUISHING MEDIA: These products are not flammable; use extinguishers appropriate for surrounding materials. In the event of fire involving dusts from the product, special fire-fighting media for metal fires, such as Metal-X, dry sand, talc, dry clay, dry ground limestone, sodium chloride, or approved Class D Extinguishers.

UNSUITABLE FIRE EXTINGUISHING MEDIA: None for alloy. In event of fire involving dusts from the product, and due to the presence of Aluminum and Manganese, DO NOT use carbon dioxide, sodium bicarbonate, halogenated extinguishing agents, foam or water.

UNUSUAL FIRE AND EXPLOSION HAZARDS: These products are not flammable, but will decompose when highly heated, releasing irritating vapors and toxic oxides, including beryllium, boron, cobalt, copper, iron, lead, manganese, molybdenum, niobium, selenium, silicon, sulfur, tin, titanium, tungsten, vanadium, zinc, and zirconium. An accumulation of large amounts of dust from this material in air can cause a severe risk of an air/dust explosion. Long-term storage may result in oxidization and can present a hazard of spontaneous combustion under certain conditions. In addition, due to the high level of aluminum, the Aluminum dust which becomes damp may release some heat. If use of product or manipulation (cutting, etc.) produces dusts, contact of those dusts with water will lead to the formation of hydrogen gas.

Explosion Sensitivity to Mechanical Impact: Not sensitive.

Explosion Sensitivity to Static Discharge: Although these products are 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. Some of the components of these products are flammable metals and dusts can present an extreme air/dust explosion hazard. All equipment in used in the handling of this material should be electrically grounded.

SPECIAL FIRE-FIGHTING PROCEDURES: Structural fire-fighters must wear Self-Contained Breathing Apparatus and full protective equipment. If possible, prevent runoff water from entering storm drains, bodies of water, or other environmentally sensitive areas. Rinse contaminated equipment thoroughly before returning such equipment to service.

6. ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS: Due to the formed nature of these products, no release of any chemical material is possible. If dusts are present, eliminate all sources of ignition before cleanup begins.

PERSONAL PROTECTIVE EQUIPMENT:

Small or Large Spills: Wear gloves (gloves that protect against cuts should be used), eye protection and appropriate body protection (clothing should protect against cuts). Steel-toed boots are recommended.

METHODS FOR CLEAN-UP AND CONTAINMENT: Due to the nature of these products, no special accidental release measures are normally required.

Small Spills: Pick-up spilled product and dispose of or recycle.

Large Spills: Trained personnel following pre-planned procedures should handle non-incidental releases. Pick-up spilled product and dispose of or recycle. Care should be taken if other materials are involved.

All Spills: If product is not recycled, all product to be disposed of should be placed in an appropriate container and sealed. Dispose of in accordance with applicable Federal, State, and local procedures (see Section 13, Disposal Considerations).

ENVIRONMENTAL PRECAUTIONS: None specifically required for release of only of these products. If other materials are involved, avoid release to the environment and consult SDSs for those other materials.

REFERENCE TO OTHER SECTIONS: See information in Section 8 (Exposure Controls – Personal Protection) and Section 13 (Disposal Considerations) for additional information.

7. HANDLING and STORAGE

PRECAUTIONS FOR SAFE HANDLING: All employees who handle these products should be trained to handle it safely Wash thoroughly after handling these products. Do not eat, drink, smoke, or apply cosmetics while handling these products. Avoid breathing fumes generated by these products if heated, or dusts if cut, ground or otherwise manipulated. DO NOT allow dusts from this alloy to accumulate; dusts can pose a serious health hazard and hazard of ignition from air/dust explosion or reaction to other compounds. Work clothing contaminated by dusts from the alloy should not be taken home and must be laundered prior to reuse.

CONDITIONS FOR SAFE STORAGE: . Store product in a cool, dry location, away from direct sunlight, sources of intense heat, or where freezing is possible. Store away from incompatible materials (see Section 10, Stability and Reactivity).

SPECIFIC END USE(S): The alloy is used in many different industries.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Not applicable.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

EXPOSURE LIMITS/CONTROL PARAMETERS:

Safe Work and Hygiene Practices: Do not breathe dusts, particulates or decomposition fumes.

Ventilation and Engineering Controls: Ventilation should be that normally provided in the environment in which these products are used.

Occupational/Workplace Exposure Limits/Guidelines: Due to the form of the product, during normal use and handling, no exposure via inhalation is possible. If dusts or fumes are produced during welding, cutting, forming or sanding of these alloys, the following exposure limits may be applicable.

CHEMICAL NAME	CAS #	EXPOSURE LIMITS IN AIR							
		ACGIH-TLVs		OSHA-PELs		NIOSH-RELs		NIOSH	OTHER
		TWA mg/m³	STEL mg/m³	TWA mg/m³	STEL mg/m³	TWA mg/m³	STEL mg/m³	IDLH mg/m³	mg/m³
Aluminum Exposure limits given are for aluminum metal and fume	7429-90-5	1 (resp. fract.)	NE	15 (total dust), 5 (resp. fract.)	NE	10 (total dust), 5 (resp. fract.); Fume: 5	NE	NE	DFG MAKs: TWA = 4 (inhalable fraction); 1.5 (respirable fraction) DFG MAK Pregnancy Risk Classification: D Carcinogen: TLV-A4
Beryllium Exposure limits are for beryllium and compounds	7440-41-7	0.00005 (inhal. frac.) RSEN	0.0002 (inhal. frac.)	0.002 (30-min. peak per 8-hr shift); 0.005 (ceiling)	0.0025 (30 min. peak per 8-hr shift); 0.005 (ceiling)	NE See Pocket Guide Appendix A	0.0005 (ceiling)	4, as Be	DFG MAK: Danger of Sensitization of the Airways and Skin United Kingdom TWA: EH 40 WEL: 0.002 Carcinogen: EPA-B1, EPA-L (inhaled), EPA-CBD (ingested); IARC-1, MAK-1, NIOSH-Ca, NTP-K, TLV-A1
Boron	7440-42-8	NE	NE	NE	NE	NE	NE	NE	Carcinogen: EPA-I
Carbon	7440-44-0	NE	NE	NE	NE	NE	NE	NE	NE
Chromium Metal	7440-47-3	0.5	NE	1	NE	0.5 See Pocket Guide Appendix C	NE	250, as Cr	Carcinogen: Inhalation: EPA-A, EPA-K, Oral: EPA-D, EPA-CBD, IARC-3, TLV-A4
Cobalt Exposure limits are for Cobalt and inorganic compounds, as Co	7440-48-4	0.02	NE	0.1 (for metal dust & fume, as Co) 0.05 (for metal dust & fume-vacated 1989 PEL)	NE	0.05 (for metal dust & fume, as Co)	NE	20, as Co	DG MAK: Danger of Sensitization of Airways and Skin (as inhalable fraction) DFG MAK Germ Cell Mutagen Category: 3A Carcinogen: IARC-2B, MAK-2
Columbium (niobium)	7440-03-1	NE	NE	NE	NE	NE	NE	NE	NE
Copper Exposure limits are for copper, dusts, and mists, and copper fume, as Cu	7440-50-8	Dust & Mist: 1 Fume: 0.2	Fume: 0.1	Dust & Mist: 1 Fume: 0.1	NE	Dust & Mist: 1 Fume: 0.1 (resp. fract.)	NE	100 (dusts, mists, fume)	DFG MAK: PEAK Fume: = 2•MAK 15 min. average value, 1-hr interval Carcinogen: Dust & Fume: EPA-D
Iron Exposure limits are for iron oxide, dust & fume, as Fe	7439-89-6	5 (resp. fract.)	NE	Fume:10	NE	Dust & Fume: 5, as Fe	NE	NE	DFG MAK: TWA = 1.5 (resp. fraction) Carcinogen: IARC-3, MAK-3B, TLV-A4
Lead Exposure limits are for lead and inorganic compounds, as Pb	7439-92-1	0.05	NE	0.05 See 29 CFR 1910.1025	NE	0.05 (8-hr TWA) See Pocket Guide Appendix C	NE	100	DFG MAKs: As inhalable fraction DFG MAK Germ Cell Mutagen Category: 3A United Kingdom Ceiling: EH 40 WEL: 0.15 Carcinogen: EPA-B2, IARC-2A, MAK-2, NTP-R, TLV-A3
Manganese Exposure limits are for fume, as Mn	7439-96-5	0.2 (resp. fract.), 0.1 (inhal. fract.)	NE	1 (vacated 1989 PEL)	5 (ceiling)	1	3	500, as Mn	DFG MAKs: TWA: 0.2 (inhalable fraction), 0.02 (respirable fraction) PEAK = 8•MAK 15 min. average value, 1-hr interval DFG MAK Pregnancy Risk Classification: C United Kingdom TWA: EH 40 WEL: 0.5 Carcinogen: EPA-D

NE = Not Established. RSEN: Respiratory Sensitizer See Section 16 for Definitions of Terms Used.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION (Continued)

EXPOSURE LIMITS/CONTROL PARAMETERS (continued):

Occupational/Workplace Exposure Limits/Guidelines (continued):

CHEMICAL NAME	CAS #	EXPOSURE LIMITS IN AIR							
		ACGIH-TLVs		OSHA-PELs		NIOSH-RELs		NIOSH	OTHER
		TWA mg/m³	STEL mg/m³	TWA mg/m³	STEL mg/m³	TWA mg/m³	STEL mg/m³	IDLH mg/m³	mg/m³
Molybdenum Exposure limits are for Molybdenum & insoluble compounds, as Mo	7439-38-2	10 (inhal. fract.); 3 (resp. fract.)	NE	15 (total dust) 10 (vacated 1989 PEL)	NE	NE	NE	NE	NE
Nickel, Elemental	7440-02-0	1.5 (inhal. frac.)	NE	1	NE	0.015 See Pocket Guide Appendix A	NE	10, as Ni	DFG MAK: Inhalable Fraction: Danger of sensitization of airways (as inhalable dusts/aerosols) Carcinogen: IARC-2B, MAK-1, NTP-K, NIOSH-Ca, TLV-A5
Phosphorous, White	7723-14-0	NE	NE	NE	NE	0.1	NE	NE	DFG MAKs: TWA = 0.01 (inhalable fraction) PEAK = 2•MAK 15 min. average value, 1-hr interval, 4 per shift DFG MAK Pregnancy Risk Classification: C United Kingdom TWA: EH 40 WEL: 0.1 STEL: EH 40 WEL: 0.3 Carcinogen: EPA-D
Selenium, metal	7782-49-2	0.2	NE	NE	NE	0.2	NE	1, as Se	DFG MAKs: TWA = 0.02 (inhalable fraction), skin PEAK = 8•MAK 15 min. average value, 1-hr interval, 4 per shift, skin DFG MAK Pregnancy Risk Classification: C United Kingdom TWA: EH 40 WEL: 0.1 Carcinogen: EPA-B2, IARC-3, MAK-3B, NTP-R
Silicon	7440-21-3	NE	NE	15 (total dust), 5 (resp. fract.) 10 (total dust) [vacated 1989 PEL]	10 (total dust), 5 (resp. fract.)	NE	NE	NE	United Kingdom TWA: EH 40 WEL: 10
Sulfur	7704-34-9	NE	NE	NE	NE	NE	NE	NE	NE
Tantalum Exposure limits are for tantalum, metal and tantalum oxides and dusts, as Ta	7440-25-7	NE	NE	5	NE	5	10	2500, as Ta	DFG MAK: TWA Metal: = 4 (inhalable fraction); 1.5 (respirable fraction) DFG MAK Pregnancy Risk Classification: C
Tin, metal	7440-31-5	2	NE	2	NE	2	NE	100, as Sn	United Kingdom TWA: EH 40 WEL: 2 STEL: EH 40 WEL: 4
Titanium	7440-32-6	NE	NE	NE	NE	NE	NE	NE	NE
Tungsten Exposure limits are for tungsten and insoluble compounds, as W	7440-33-7	3 (resp. fract.)	NE	5 (vacated 1989 PEL)	10 (vacated 1989 PEL)	5	10	NE	United Kingdom TWA: EH 40 WEL: 0.1 STEL: EH 40 WEL: 0.3
Vanadium Exposure limits are for Vanadium and inorganic compounds	7440-62-2	NE	NE	NE	NE	NE	NE	35, as V	DFG MAK: Inhalable fraction DFG MAK Germ Cell Mutagen Category 2 Carcinogen: MAK-2
Yttrium Exposure limits are for yttrium and compounds, as Y	7440-65-5	1	NE	1	NE	1	NE	500, as Y	United Kingdom TWA: EH 40 WEL: 0.1 STEL: EH 40 WEL: 0.3
Zinc	7440-66-6	NE	NE	NE	NE	NE	NE	NE	DFG MAKs: TWA = 0.1 mg/m³ (respirable fraction); 2 (inhalable fraction) PEAK = Respirable Fraction: 4•MAK 15 min., average value, 1 hour interval, 4 per shift; Inhalable Fraction: 2•MAK 15 min., average value, 1 hour interval, 4 per shift Carcinogen: EPA-D, EPA-I, EPA-II
Zirconium, Elemental	7440-67-7	5	10	5	10 (vacated 1989 PEL)	NE	NE	50, as Zr	DFG MAKs: TWA = 1 (inhalable fraction) PEAK = 1•MAK 15 min. average value, 1-hr interval, 4 per shift Danger of Sensitization of the Airways and the Skin United Kingdom TWA: EH 40 WEL: 5 STEL: EH 40 WEL: 10 Carcinogen: TLV-A4

NE = Not Established. See Section 16 for Definitions of Terms Used.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION (Continued)

International Occupational Exposure Limits: In addition to the exposure limit values cited in this section, other exposure limits have been established by various countries for the components of these products.

ALUMINUM:
Australia: TWA = 10 mg/m^3 (metal dust), JUL 2008
Australia: TWA = 2 mg(Al)/m^3, JUL 2008
Australia: TWA = 5 mg/m^3 (pyro powders), JUL 2008
Australia: TWA = 5 mg/m^3 (welding fumes), JUL 2008
Austria: TMW = 10 mg/m^3; KZW = 20 mg/m^3, inhal, 2007
Belgium: TWA = 10 mg/m^3, MAR2002
Belgium: TWA = 5 mg/m^3 (pyro powders), MAR 2002
Belgium: TWA = 5 mg/m^3 (welding fumes), MAR 2002
Denmark: TWA = 5 mg/m^3, MAY 2011
Finland: TWA = 1.5 mg/m^3 (welding fumes), NOV 2011
France: VME = 10 mg/m^3, 5 mg/m^3 (fume, resp. dust), FEB 2006
Germany: MAK = 1.5 mg/m^3 (respirable), 2005
Hungary: TWA = 6 mg/m^3 (resp), SEP 2000
Iceland: TWA = 10 mg/m^3, STEL = 5 mg/m^3, dust, NOV 2011
Japan: OEL = 0.5 mg/m^3 (resp. dust), 2 mg/m^3 (total dust), MAY 2012
Korea: TWA = 10 mg/m^3 (metal dust), 2006
Korea: TWA = 5 mg/m^3 (pyro powders), 2006
Korea: TWA = 5 mg/m^3 (welding fumes), 2006
México: TWA = 10 mg/m^3; STEL = 20 mg/m^3, 2004
México: TWA = 5 mg(Al)/m^3, 2004
México: TWA = 5 mg(Al)/m^3 (pyro powders), 2004
The Netherlands: MAC-TGG = 10 mg/m^3, 2003
New Zealand: TWA = 10 ppm (metal dust), JAN 2002
New Zealand: TWA = 5 ppm (fumes), JAN 2002
New Zealand: TWA = 5 ppm (pyro powders), JAN 2002
Norway: TWA = 5 mg/m^3, JAN 1999
Peru: TWA = 10 mg/m^3, JUL 2005
Russia: STEL = 2 mg/m^3, JUN 2003
Sweden: TWA = 5 mg/m^3 (total dust); TWA = 2 mg/m^3 (resp. dust), JUN 2005
Switzerland: MAK-W = 3 mg/m^3, DEC 2006
United Kingdom: TWA = 10 mg/m^3 (inhal. dust), OCT 2007
United Kingdom: TWA = 4 mg/m3 (resp. dust), OCT 2007
In Argentina, Bulgaria, Colombia, Jordan, Singapore, Vietnam check ACGIH TLV

BERYLLIUM:
ARAB Republic of Egypt: TWA = 0.002 mg/m^3, JAN 1993
Australia: TWA = 0.002 mg/m^3, Carcinogen, JUL 2008
Austria: TRK-TMW = 0.005 mg/m^3; KZW = 0.02 mg/m^3, polishing, inhal, sen, 2007
Austria: TRK-TMW = 0.002 mg/m^3; KZW = 0.008 mg/m^3, inhal, sen, 2007
Belgium: TWA = 0.002 mg/m^3, Carcinogen, MAR 2002
Denmark: TWA = 0.001 mg/m^3 (dust), carc, MAY 2011
Finland: TWA = 0.001 mg/m^3, NOV 2011
Hungary: CL = 0.002 mg/m^3, Carcinogen, SEP 2000
India: TWA = 0.002 mg/m^3, Carcinogen, JAN 1993
Iceland: TWA = 0.001 mg(Be)/m^3 (dust), carc, sen, NOV 2011
Japan: OEL = 0.002 mg/m^3, 2A carc, A1 sen, S2 sen, MAY 2012
Korea: TWA = 0.002 mg/m^3, 2006
México: TWA = 0.002 mg/m^3, 2004
New Zealand: TWA = 0.002 mg/m^3, carcinogen, JAN 2002
Norway: TWA = 0.001 mg/m^3, JAN 1999
Peru: TWA = 0.002 mg/m^3, JUL 2005
The Philippines: TWA = 0.002 mg/m^3, JAN 1993
Poland: MAC(TWA) = 0.001 mg/m^3, MAC(STEL) = 0.003 mg/m^3, JAN 1999
Russia: TWA = 0.001 mg/m^3, STEL 0.003 mg/m^3, Carcinogen, JUN 2003
Sweden: TWA = 0.002 mg/m^3, Carcinogen, Sen, JUN 2005
Switzerland: MAK-W = 0.002 mg/m^3, Switzerland: MAK-W = 0.002 mg/m^3, carc 1, inhal, sen, JAN 2011
Thailand: TWA = 0.002 mg/m^3, STEL = 0.005 mg/m^3, JAN 1993
Turkey: TWA = 0.002 mg/m^3, JAN 1993
United Kingdom: TWA = 0.002 mg/m^3, carc, OCT 2007
In Argentina, Bulgaria, Colombia, Jordan, Singapore, Vietnam check ACGIH TLV

CHROMIUM:
ARAB Republic of Egypt: TWA = 0.05 mg/m^3, JAN 1993
Australia: TWA = 0.5 mg/m^3, JUL 2008
Belgium: TWA = 0.5 mg/m^3, MAR 2002
Denmark: TWA = 0.5 mg/m^3 (dust), MAY 2011
EC: TWA = 2 mg/m^3, FEB 2006
Finland: TWA = 0.5 mg/m^3, NOV 2011
France: VME = 0.5 mg/m^3, FEB 2006

CHROMIUM (continued):
Iceland: TWA = 0.5 mg/m^3, dust, NOV 2011
Japan: OEL = 0.5 mg/m^3, a2 sen, s1 sen, MAY 2012
Mexico: TWA = 0.5 mg/m^3, 2004
The Netherlands: MAC-TGG = 0.5 mg/m^3, 2003
New Zealand: TWA = 0.5 mg/m^3, JAN 2002
The Philippines: TWA = 1 mg/m^3, JAN 1993
Poland: TWA = 0.5 mg/m^3, JAN 1999
Sweden: TWA = 0.5 mg(Cr)/m^3, JUN 2005
Switzerland: MAK-W = 0.5 mg/m^3, inhal, sen, JAN 2011
United Kingdom: TWA = 0.5 mg/m^3, OCT2007
In Argentina, Bulgaria, Colombia, Jordan, Singapore, Vietnam check ACGIH TLV

COBALT:
ARAB Republic of Egypt: TWA = 0.1 mg/m^3, JAN 1993
Australia: TWA = 0.05 mg/m^3, JUL 2008
Austria: TRK-TMW = 0.5 mg/m^3 ;KZW = 2 mg/m^3, inhal, sen, 2007
Austria: TRK-TMW = 0.1 mg/m^3; KZW = 0.4 mg/m^3, inhal, sen, 2007
Belgium: TWA = 0.02 mg/m^3 (fume, dust), MAR 2002
Denmark: TWA = 0.01 mg(Co)/m^3 (fume, dust), carc, MAY 2011
Finland: TWA = 0.02 mg/m^3, NOV 2011
Hungary: TWA = 0.1 mg/m^3, STEL = 0.4 mg/m^{33}, SEP 2000
Iceland: TWA = 0.02 mg(Co)/m^3 (dust, fume), sen, NOV 2011
Japan: OEL = 0.05 mg/m^3, 2B carc, a1 sen, s2 sen, MAY 2012
Mexico: TWA = 0.1 mg(Co)/m^3, 2004
The Netherlands: MAC-TGG = 0.02 mg/m^3, 2003
New Zealand: TWA = 0.05 mg/m^3 (dust and fume), JAN2002
Norway: TWA = Norway: TWA = 0.05 mg/m^3, JAN 1999
Peru: TWA = 0.02 mg/m^3, JUL 2005
The Philippines: TWA = 0.1 mg/m^3, JAN 1993
Poland: MAC(TWA) = 0.05 mg/m^3, MAC(STEL) = 0.2 mg/m3, JAN 1999
Russia: STEL = 0.5 mg/m^3, JUN2003
Sweden: TWA = 0.05 mg/m^3, Sen, JUN2005
Switzerland: MAK-W = 0.05 mg/m^3, carc 2, inhal, skin, sen, JAN2011
United Kingdom: TWA = 0.1 mg/m^3, sen, OCT 2007
In Argentina, Bulgaria, Colombia, Jordan, Singapore, Vietnam check ACGIH TLV

COLUMBIUM (NIOBIUM):
Austria: MAK-TMW = 0.5 mg/m^3; KZW = 1 mg/m^3, resp, 2007
Austria: MAK-TMW = 5 mg/m^3; KZW = 10 mg/m^3, inhal, 2007
Denmark: TWA = 0.5 mg/m^3 (fume), MAY 2011
Denmark: TWA = 5 mg(Nb)/m^3 (dust), MAY 2011
Iceland: TWA = 5 mg/m^3, NOV 2011
Russia: TWA = 10 mg/m^3, JUN 2003

COPPER:
ARAB Republic of Egypt: TWA = 0.1 mg/m^3 (fume), JAN 1993
Australia: TWA = 0.2 mg/m^3 (fume), JUL 2008
Australia: TWA = 1 mg/m^3 (dust and mist), JUL 2008
Belgium: TWA = 0.2 mg/m^3 (fume), MAR 2002
Belgium: TWA = 1 mg/m^3 (dust, aerosol), MAR 2002
Finland: TWA = 0.1 mg/m^3, resp. dust, NOV 2011
Finland: TWA = 1 mg/m^3, NOV 2011
France: VME = 1 mg/m^3 (dust), 0.2 mg/m^3 (fume), FEB 2006
Hungary: TWA = 0.1 mg/m^3 (fume), STEL = 0.4 mg/m^3 (fume), SEP 2000
Hungary: TWA = 1 mg(Cu)/m^3, STEL = 4 mg(Cu)/m^3, SEP 2000
Hungary: TWA = 1 mg/m^3, STEL = 4 mg/m^3, SEP 2000
India: TWA = 0.2 mg/m^3 (fume), JAN 1993
Iceland: TWA = 0.1 mg(Cu)/m^3 (resp. dust), NOV 2011
Korea: TWA = 0.1 mg/m^3 (fume), 2006
Korea: TWA = 1 mg/m^3 (dust and mist), 2006
The Netherlands: MAC-TGG = 0.2 mg/m^3 (fume), 2003
The Netherlands: MAC-TGG = 1 mg/m^3 (dust), 2003
New Zealand: TWA = 0.2 mg/m^3 (fume), JAN 2002
New Zealand: TWA = 1 mg/m^3 (dust and mist), JAN 2002
Norway: TWA = 0.05 mg(Co)/m^3, JAN 1999
Norway: TWA = 0.1 mg/m^3, fume, JAN 1999
Peru: TWA = 0.2 mg/m^3, JUL 2005
The Philippines: TWA = 1.0 mg/m^3 (fume), JAN 1993
Poland: MAC(TWA) fume = 0.1 mg/m^3, MAC(STEL) fume = 0.3 mg/m^3, JAN 1999
Poland: MAC(TWA) dust = 1 mg/m^3, MAC(STEL) dust = 2 mg/m^3, JAN 1999
Russia: TWA = OEL-RUSSIA: TWA 0.5 mg/m^3, STEL 1 mg/m^3, JUN 2003

COPPER (continued):
Sweden: TWA = 1 mg/m^3; TWA = .2 mg/m^3 (resp. dust), JUN 2005
Switzerland: MAK-W = 0.1 mg/m3, KZG-W= 0.2 mg/m^3, inhal, JAN 2011
Thailand: TWA = 0.1 mg/m^3 (fume), JAN 1993
Thailand: TWA = 1 mg/m^3, JAN 1993
United Kingdom: TWA = 0.2 mg/m^3 (fume), OCT 2007
United Kingdom: TWA = 1 mg/m^3; STEL= 2 mg/m^3 (dusts and mists), OCT 2007
In Argentina, Bulgaria, Colombia, Jordan, Singapore, Vietnam check ACGIH TLV

IRON:
Russia: STEL = 10 mg/m^3, Skin, JUN 2003

LEAD:
Australia: TWA = 0.15 mg/m^3 (dust, fume), JUL 2008
Austria: MAK-TMW = 0.1 mg/m^3; KZW = 0.4 mg/m^3, inhal, 2007
Belgium: TWA = 0.15 mg/m^3 (dust, fume), MAR 2002
Denmark: TWA = 0.05 mg(Pb)/m^3 (fume, dust), MAY 2011
France: VME = 0.1 mg/m^3, FEB 2006
Hungary: TWA = 0.05 mg/m^3 (resp), STEL = 0.2 mg/m^3 (resp), SEP 2000
Hungary: TWA = 0.15 mg/m^3, STEL = 0.6 mg/m^3, SEP 2000
Iceland: TWA = 0.05 mg(Pb)/m^3 (dust, fume), NOV 2011
Japan: OEL = 0.1 mg/m^3, 2B carcinogen, MAY 2012
Korea: TWA =0.05 mg/m^3, 2006
México: TWA = 0.15 mg/m^3, 2004
The Netherlands: MAC-TGG = 0.15 mg/m^3, 2003
New Zealand: TWA = 0.1 mg(Pb)/m^3 (dust and fume), JAN 2002
Norway: TWA = 0.05 mg/m^3, JAN 1999
Peru: TWA = 0,05 mg/m^3, JUL 2005
Poland: MAC(TWA) = 0.05 mg/m^3, JAN 1999
Russia: TWA = 0.05 mg/m^3, JUN 2003
Sweden: TWA = 0.1 mg/m^3 (total dust); TWA = 0.5 mg/m^3 (resp. dust), JUN 2005
Switzerland: MAK-W = 0.1 mg/m^3; KZG-W = 0.8 mg/m^3, carc 3, inhal, JAN 2011

MANGANESE:
ARAB Republic of Egypt: TWA = 5 mg/m^3, JAN 1993
Australia: TWA = 1 mg/m^3 (dust), JUL2008
Australia: TWA = 1 mg/m^3, STEL = 3 mg/m^3 (fume), JUL2008
Belgium: TWA = 0.2 mg/m^3, MAR 2002
Denmark: TWA = 0.2 mg(Mn)/m^3 (fume), MAY 2011
Denmark: TWA = 0.2 mg/m^3 (dust), MAY 2011
Denmark: TWA = 0.1 mg/m^3 (respirable), MAY 2011
Denmark: TWA = 0.1 mg/m^3, MAY 2011
Finland: TWA = 0.2 mg/m^3, inhal. dust, NOV 2011
Finland: TWA = 0.1 mg/m^3, resp. dust, NOV 2011
France: VME = 1 mg/m^3 (fume), JAN 1999
Germany: MAK = 0.02 mg(Mn)/m^3 (resp), 0.2 mg(Mn)/m^3 (inhal), 2011
Hungary: TWA = 5 mg/m^3, STEL 20 mg/m^3, SEP 2000
Iceland: TWA = 1 mg/m^3 (resp. dust), NOV2011
Japan: OEL = 0.2 mg/m^3, MAY 2012
Korea: TWA = 1 mg/m^3, STEL 3 mg/m^3 (fume), 2006
Korea: TWA = 5 mg/m^3 (dust), 2006
México: TWA = 0.2 mg(Mn)/m^3, 2004
México: TWA = 0.2 mg(Mn)/m^3; STEL = 3 mg(Mn)/m^3, 2004
México: TWA = 0.2 mg/m^3, 2004
México: TWA = 1 mg(Mn)/m^3 (fume), 2004
The Netherlands: MAC-TGG = 1 mg/m^3, 2003
New Zealand: TWA = 1 mg/m^3 (dust), JAN 2002
New Zealand: TWA = 1 mg/m^3; STEL = 3 mg/m^3 (fume), JAN 2002
Norway: TWA = 1 mg/m^3, JAN 1999
Peru: TWA = 0,2 mg/m^3, JUL2005
The Philippines: TWA = 5 mg/m^3, JAN 1993
Russia: TWA = 0.1 mg/m^3, STEL = 0.6 mg/m^3, JUN 2003
Sweden: TWA = 0.2 mg/m^3, (total dust); TWA = 0.1 mg/m^3, (resp. dust), JUN 2005
Switzerland: MAK-W = 0.5 mg/m^3, inhal, JAN2011
Thailand: TWA = 5 mg/m^3, JAN 1993
Turkey: TWA = 5 mg/m^3 (fume), JAN 1993
United Kingdom: TWA = 0.5 mg/m^3, OCT 2007
In Argentina, Bulgaria, Colombia, Jordan, Korea, New Zealand, Singapore, Vietnam check ACGIH TLV

MOLYBDENUM:
Australia: TWA = 10 mg(Mo)/m^3, JUL 2008
Austria: MAK-TMW 10 mg/m^3; KZW 20 mg/m^3, inhal, 2007
Belgium: TWA = 10 mg/m^3, MAR 2002
Korea: TWA = 10 mg/m^3, 2006
New Zealand: TWA = 5 mg/m^3, JAN 2002
Russia: TWA = 0.5 mg/m^3, STEL = 3 mg/m^3, JUN 2003

8. EXPOSURE CONTROLS - PERSONAL PROTECTION (Continued)

EXPOSURE LIMITS/CONTROL PARAMETERS (continued):

International Occupational Exposure Limits (continued):

MOLYBDENUM (continued):
Sweden: TWA = 10 mg/m^3 (total dust); TWA = 5 mg/m^3 (resp. dust), JUN 2005
Switzerland: MAK-W = 10 mg/m^3, DEC 2006
NICKEL:
ARAB Republic of Egypt: TWA = 0.1 mg/m^3, JAN 1993
Australia: TWA = 1 mg/m^3, JUL 2008
Austria: TRK-TMW = 0.5 mg/m^3; KZW = 2 mg/m^3, inhal, sen, 2007
Belgium: TWA = 1 mg/m^3, MAR 2002
Finland: TWA = 1 mg/m^3, NOV 2011
France: VME = 1 mg/m^3, C^3 Carcinogen, FEB 2006
Hungary: TWA = 0.1 mg/m^3, STEL = 0.1 mg/m^3, SEP 2000
Iceland: TWA = 0.05 mg/m^3 (dust), carc, sen, NOV 2011
Japan: OEL = 1 mg/m^3, 2B carcinogen, sen, MAY 2009
Japan: Group 2B occupational carcinogen, MAY 2009
OEL-KOREA: TWA 1 mg/m3, 2006
Korea: TWA = 1 mg/m^3, 2006
The Netherlands: MAC-TGG = 1 mg/m^3, 2003
New Zealand: TWA = 1 mg/m^3, sen, JAN 2002
Peru: TWA = 1,5 mg/m^3, JUL 2005
The Philippines: TWA = 1 mg/m^3, JAN 1993
Poland: MAC(TWA) = 0.25 mg/m^3, JAN 1999
Russia: STEL = 0.05 mg/m^3, Carcinogen, JUN 2003
Sweden: TWA = 0.5 mg/m^3 (total dust), Sen, JUN 2005
Switzerland: MAK-W = 0.5 mg/m^3, carc 3, inhal, sen, JAN 2011
Thailand: TWA = 1 mg/m^3, JAN 1993
United Kingdom: TWA = 0.5 mg(Ni)/m^3, skin, OCT 2007
In Argentina, Bulgaria, Colombia, Jordan, Singapore, Vietnam check ACGIH TLV
SELENIUM:
Arab Republic of Egypt: TWA = 0.2 mg/m^3, JAN 1993
Australia: TWA = 0.1 mg/m^3, JUL 2008
Austria: MAK-TMW = 0.1 mg/m^3; KZW = 0.3 mg/m^3, inhal, 2007
Belgium: TWA = 0.2 mg/m^3, MAR 2002
Denmark: TWA = 0.1 mg(Se)/m^3, MAY 2011
Germany: MAK = 0.02 mg/m^3, inhal, skin, 2011
OEL-HUNGARY: TWA 0.1 mg/m3, STEL 0.4 mg/m3, SEP2000
OEL-ICELAND: TWA 0.1 mg/m3, NOV2011 Hungary: TWA = 0.1 mg/m^3, STEL = 0.4 mg/m^3, SEP 2000
Iceland: TWA = 0.1 mg/m^3, NOV 2011
Japan: OEL = 0.1 mg/m^3, MAY 2012
Korea: TWA = 0.2 mg/m^3, 2006
México: TWA = 0.2 mg/m^3, 2004
The Netherlands: MAC-TGG = 0.1 mg(Se)/m^3, 2003
New Zealand: TWA = 0.1 mg/m^3, JAN 2002
Peru: TWA = 0,2 mg/m^3, JUL 2005
The Philippines: TWA = 0.2 mg/m^3, JAN 1993
Poland: MAC(TWA) = 0.1 mg/m^3, MAC(STEL) = 0.3 mg/m^3, JAN 1999
Russia: TWA = 2 mg/m^3, JUN 2003
Sweden: TWA = 0.1 mg/m^3 (total dust), JUN 2005
Switzerland: MAK-W = 0.02 mg/m^3, KZG-W = 0.16 mg/m3, inhal, skin, JAN2011
Turkey: TWA = 0.2 mg/m^3, JAN 1993
United Kingdom: TWA = 0.1 mg/m^3, OCT2007
In Argentina, Bulgaria, Colombia, Jordan, Singapore, Vietnam check ACGIH TLV
SILICON:
Belgium: TWA = 10 mg/m^3, MAR 2002
Denmark: TWA = 10 mg/m^3, MAY 2011
France: VME = 10 mg/m^3, FEB 2006
Iceland: TWA = 0.5 ppm (0.7 mg/m^3), NOV 2011
Korea: TWA = 10 mg/m^3, 2006
Mexico: TWA = 10 mg/m^3; STEL = 20 mg/m^3 (inhalable), 2004
The Netherlands: MAC-TGG = 10 mg/m^3, 2003
New Zealand: TWA = 10 mg/m^3 (inspirable dust), JAN 2002
Norway: TWA = 10 mg/m^3, JAN 1999
SILICON (continued):
Peru: TWA = 10 mg/m^3 (inhal), 4 mg/m^3 (resp), JUL 2005
Switzerland: MAK-W = 3 mg/m3, resp, JAN 2011
United Kingdom: TWA = 10 mg/m^3 (inhal. dust), OCT2007
United Kingdom: TWA = 4 mg/m^3 (resp. dust), OCT2007
In Argentina, Bulgaria, Colombia, Jordan, Singapore, Vietnam check ACGIH TLV
SULFUR:
Russia: TWA = 6 mg/m^3, JUN 2003
TANTALUM:
Arab Republic of Egypt: TWA = 0.1 mg/m^3, JAN 1993
Australia: TWA = 5 mg/m^3 (dust), JUL 2008
Austria: MAK-TMW = 5 mg/m^3, inhal, 2007
Belgium: TWA = 5 mg/m^3, MAR 2002
Denmark: TWA = 5 mg(Ta)/m^3, MAY 2011
France: VME = 5 mg/m^3, FEB 2006
Germany: MAK = 1.5 mg/m^3, resp, 2011
Germany: MAK = 4 mg/m^3, inhal, 2011
Iceland: TWA = 5 mg/m^3, dust, NOV 2011
México: TWA = 5 mg/m^3; STEL = 10 mg/m^3, 2004
The Netherlands: MAC-TGG = 5 mg/m^3, 2003
New Zealand: TWA = 5 mg/m3, JAN 2002
Peru: TWA = 5 mg/m^3, JUL 2005
The Philippines: TWA = 5 mg/m^3, JAN 1993
Poland: MAC(TWA) = 5 mg/m^3, JAN 1999
Russia: TWA = 10 mg/m^3, JUN 2003
Switzerland: MAK-W = 5 mg/m^{33}, inhal, JAN 2011
United Kingdom: TWA = 5 mg/m^3; STEL = 10 mg/m^3, OCT 2007
In Argentina, Bulgaria, Colombia, Jordan, Singapore, Vietnam check ACGIH TLV
TIN:
Australia: TWA = Australia: TWA = 2 mg/m^3, JUL2008
Austria: MAK-TMW = 2 mg/m^3; KZW = 4 mg/m^3, inhal, 2007
Belgium: TWA = = 2 mg/m^3, Skin, MAR 2002
Hungary: TWA = Hungary: TWA = = 2 mg/m^3, STEL = 8 mg/m^3, Skin, SEP 2000
Korea: TWA = 2 mg/m3, 2006
The Netherlands: MAC-TGG = 2 mg/m^3, 2003
New Zealand: TWA = 2 mg/m^3, JAN 2002
Norway: TWA = 1 mg/m^3, JAN 1999
Peru: TWA = 2 mg/m^3, JUL 2005
The Philippines: TWA = 2 mg/m^3, JAN 1993
Poland: TWA = 2 mg/m^3, JAN 1999
Switzerland: MAK-W = 2 mg/m^3, KZG-W = 4 mg/m^3, inhal, JAN 2011
Thailand: TWA = 2 mg/m^3, JAN 1993
In Argentina, Bulgaria, Colombia, Jordan, Korea, New Zealand, Singapore, Vietnam, New Zealand, Singapore, Vietnam check ACGIH TLV
TITANIUM:
Russia: STEL = 10 mg/m^3, JUN 2003
TUNGSTEN:
Austria: MAK-TMW = 5 mg/m^3; KZW = 10 mg/m^3, inhal, 2007
Belgium: TWA = 5 mg/m^3, STEL = 10 mg/m^3, MAR 2002
Denmark: TWA = 5 mg(W)/m^3 (dust), MAY 2011
Iceland: TWA = 5 mg/m^3, dust, NOV 2011
México: TWA = 5 mg(W)/m^3; STEL = 10 mg(W)/m^3, 2004
New Zealand: TWA = 1 mg(W)/m^3, JAN 2002
Norway: TWA = 5 mg/m^3, JAN 1999
Poland: MAC(TWA) fume and dust = 5 mg/m^3, JAN 1999
Russia: TWA = 6 mg/m^3, JUN 2003
Sweden: TWA = 5 mg/m^3, JUN 2005
Switzerland: MAK-W = 5 mg/m^3, DEC 2006
United Kingdom: TWA = 5 mg/m^3; STEL = 10 mg/m^3, OCT 2007
WHITE PHOSPHOROUS:
ARAB Republic of Egypt: TWA = 0.1 mg/m^3, JAN 1993
Australia: TWA = 0.1 mg/m^3, JUL 2008
Austria: MAK-TMW = 0.1 mg/m^3; KZW = 0.2 mg/m^3, inhal, 2007
Belgium: TWA = 0.02 ppm (0.1 mg/m^3), MAR 2002
WHITE PHOSPHOROUS (continued):
Denmark: TWA = 0.1 mg/m^3, MAY 2011
Finland: STEL = 0.1 mg/m^3, NOV 2011
France: VME = 0.1 mg/m^3, VLE = 0.3 mg/m^3, FEB 2006
Germany: MAK = 0.01 mg/m^3, inhal, 2011
Hungary: TWA = 0.1 mg/m^3, STEL = 0.1 mg/m^3, SEP 2000
Iceland: TWA = 0.1 mg/m^3, NOV 2011
Japan: OEL = 0.1 mg/m^3, MAY 2012
Korea: TWA = 0.1 mg/m^3, 2006
México: TWA = 0.1 mg/m^3; STEL = 0.3 mg/m^3, 2004
The Netherlands: MAC-TGG = 0.1 mg/m^3, 2003
New Zealand: TWA = 0.1 mg/m^3, JAN 2002
The Philippines: TWA = 0.1 mg/m^3, JAN 1993
Poland: MAC(TWA) = 0.3 mg/m^3, JAN 1993
Russia: 0.03 mg/m^3, STEL = 0.1 mg/m^3, JUN 2003
Switzerland: MAK-W = 0.05 mg/m^3, KZG-W = 0.1 mg/m^3, inhal, JAN 2011
Thailand: TWA = 0.1 mg/m^3, JAN 1993
Turkey: TWA = 0.1 mg/m^3, JAN 1993
United Kingdom: TWA = 0.1 mg/m^3; STEL = 0.3 mg/m^3, OCT,2007
In Argentina, Bulgaria, Colombia, Jordan, Korea, New Zealand, Singapore, Vietnam check ACGIH TLV
VANADIUM:
Austria: MAK-TMW = 0.5 mg/m3; KZW = 1 mg/m^3, inhal, 2007
The Netherlands: MAC-TGG = 0.5 mg(V)/m^3, 2003
YTTRIUM:
Australia: TWA = 1 mg/m^3, JUL 2008
Austria: MAK-TMW = 1 mg/m^3; KZW = 10 mg/m^3, resp, 2007
Belgium: TWA = 1 mg/m^3, MAR 2002
Denmark: TWA = 1 mg(Y)/m^3 (dust), MAY 2011
France: VME = 1 mg/m^3, FEB 2006
Iceland: TWA = 1 mg/m^3, dust, NOV 2011
The Netherlands: MAC-TGG = 1 mg/m^3, 2003
New Zealand: TWA = 1 mg/m^3, JAN 2002
Peru: TWA = 1 mg/m^3, JUL 2005
The Philippines: TWA = 5 ppm (25 mg/m^3), JAN 1993
Poland: MAC(TWA) = 1 mg/m^3, JAN 1999
United Kingdom: TWA = 1 mg/m^3; STEL = 3 mg/m^3, skin, OCT 2007
In Argentina, Bulgaria, Colombia, Jordan, Singapore, Vietnam check ACGIH TLV
ZINC (POWDER):
ARAB Republic of Egypt: TWA = 0.1 mg/m^3, JAN 1993
Germany: MAK = 0.1 mg/m^3, resp, 2011
Germany: MAK = 2 mg/m^3, inhal, 2011
Switzerland: MAK-W = 0.1 mg/m^3, KZG-W = 0.4 mg/m^3, resp, JAN 2011
Switzerland: MAK-W = 2 mg/m^3, KZG-W = 4 mg/m3, inhal, JAN 2011
ZIRCONIUM:
ARAB Republic of Egypt: TWA = 5 mg/m^3, JAN 1993
Australia: TWA = 5 mg/m^3, STEL = 10 mg/m^3 (powder), JUL 2008
Austria: MAK-TMW = 5 mg/m^3, inhal, sen, 2007
Belgium: TWA = 5 mg/m^3, STEL = 10 mg/m^3, MAR 2002
Denmark: TWA = 5 mg(Zr)/m^3, MAY 2011
Hungary: STEL = 5 mg(Zr)/m^3, STEL = 20 mg(Zr)/m^3, SEP 2000
Iceland: TWA = 5 mg/m^3, NOV 2011
The Netherlands: MAC-TGG = 5 mg/m^3, 2003
New Zealand: TWA = 5 mg/m^3, STEL = 10 mg/m^3, JAN 2002
Peru: TWA = 5 mg/m^3; STEL = 10 mg/m^3, JUL 2005
Poland: MAC(TWA) = 5 mg/m^3, MAC(STEL) = 10 mg/m^3, JAN 1999
Russia: STEL = 6 mg/m^3, JUN 2003
Switzerland: MAK-W = 5 mg/m^3, inhal, JAN 2011
In Argentina, Bulgaria, Colombia, Jordan, Korea, New Zealand, Singapore, Vietnam, New Zealand, Singapore, Vietnam check ACGIH TLV

Australian Hazardous Chemical Information System (HMIS) Exposure Standards:

CHEMICAL NAME	CAS #	EXPOSURE LIMITS IN AIR				
		TWA mg/m^3	STEL mg/m^3	Advisory Carcinogen Category	Other Advisory Information	Notes
Aluminum (metal dust)	7429-90-5	10	NE	NE	NE	NE
Beryllium Compounds	7440-41-7	0.002	NE	See Notes	NE	Some compounds in these groups are classified as carcinogenic or as sensitisers. Check individual classification details on the safety data sheet for information on classification.
Chromium metal	7440-47-3	0.5	NE	NE	NE	NE

NE = Not Established.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION (Continued)

EXPOSURE LIMITS/CONTROL PARAMETERS (continued):

Australian Hazardous Chemical Information System (HMIS) Exposure Standards:

CHEMICAL NAME	CAS #	EXPOSURE LIMITS IN AIR				
		TWA mg/m^3	STEL mg/m^3	Advisory Carcinogen Category	Other Advisory Information	Notes
Cobalt metal dust & fume (as Co)	7440-48-4	0.05	NE	NE	SEN	NE
Copper fume, dusts & mists (as Cu)	7440-50-8	Fume: 0.2 Dust: 0.05	NE	NE	NE	NE
Lead Lead inorganic, dusts & fume (as Pb)	7439-92-1	0.15	NE	NE	NE	Exposure standard is under review
Manganese dust & compounds (as Mn)	7439-96-5	1	NE	NE	NE	NE
Molybdenum insoluble compounds (as Mo)	7439-38-1	10	NE	NE	NE	NE
Nickel Metal and powder	7440-02-0	1	NE	Carcinogen 2	Metal: SEN	NE
Selenium compounds (as Se)	7782-49-2	0.1	NE	NE	NE	NE
Silicon	7440-21-3	10	NE	NE	NE	This value is for inhalable dust containing no asbestos and < 1% crystalline silica.
Tantalum metal & oxide dusts	7440-25-4	5	NE	NE	NE	NE
Tin metal	740-31-5	2	NE	NE	NE	NE
Tungsten insoluble compounds (as W)	7440-33-7	5	10	NE	NE	NE
Vanadium (as V_2O_5) dust & fume	7440-62-2	0.5	NE	NE	NE	NE
Yttrium metal & compounds (as Y)	7440-65-5	1	NE	NE	NE	NE
Zirconium compounds (as Zr)	7440-66-6	5	10	NE	NE	NE

NE = Not Established.

UK Minimum Exposure Limits:

CHEMICAL NAME	CAS #	WORKPLACE EXPOSURE LIMIT				
		Long-Term Exposure Limit (8-Hrs TWA Reference Period)		Short-Term Exposure Limit (15-minute Reference Period)		Comments
		ppm	$mg.m^{-3}$	ppm	$mg.m^{-3}$	The Carcin, Sen and Skin notations are not exhaustive. Notations have been applied to substances identified in IOELV Directives
Aluminum Metal Inhalable Dusts Respirable Dusts	7429-90-5	NE	 10 4	NE	NE	NE
Beryllium and beryllium compounds, as Be	7440-41-7	NE	0.002	NE	NE	Carcinogen
Chromium	7440-47-3	NE	0.5	NE	NE	NE
Cobalt and cobalt compounds as Co	7440-03-1	NE	0.1	NE	NE	SEN
Copper fume & dusts, as Cu	7440-50-8	NE	Fume: 0.2 Dusts: 1	NE	Dusts: 2	NE
Manganese and its inorganic compounds, as Mn	7439-96-5	NE	0.5	NE	NE	NE
Molybdenum compounds as Mo Soluble Compounds Insoluble Compounds	7439-38-3	NE	 5 10	NE	 10 20	NE
Nickel and its inorganic compounds Insoluble Compounds	7440-02-0	NE	 0.5	NE	NE	Skin, Carc
Selenium and compounds as Se	7782-49-2	NE	0.1	NE	NE	NE
Silicon Inhalable Dusts Respirable Dusts	7440-21-3	NE	 10 4	NE	NE	NE
Tantalum	7440-25-4	NE	5	NE	10	NE
Tin compounds, inorganic as Sn	7440-31-5	NE	2	NE	4	NE

NE = Not Established.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION (Continued)

EXPOSURE LIMITS/CONTROL PARAMETERS (continued):

UK Minimum Exposure Limits (continued):

CHEMICAL NAME	CAS #	WORKPLACE EXPOSURE LIMIT				
		Long-Term Exposure Limit (8-Hrs TWA Reference Period)		Short-Term Exposure Limit (15-minute Reference Period)		Comments
		ppm	$mg.m^{-3}$	ppm	$mg.m^{-3}$	The Carcin, Sen and Skin notations are not exhaustive. Notations have been applied to substances identified in IOELV Directives
Tungsten and compounds as W Insoluble Compounds	7440-33-7	NE	5	NE	10	NE
Yttrium	7440-65-5	NE	1	NE	3	NE
Zirconium compounds, as Zr	7440-67-7	NE	5	NE	10	NE

NE = Not Established.

ACGIH Biological Exposure Indices (BEIs): Currently, the following ACGIH Biological Exposure Indices (BEIs) have been determined for some the components of these products.

CHEMICAL: DETERMINANT	SAMPLING TIME	BEI
Cobalt • Cobalt in urine	• End of shift at end of workweek	• 15 µg/L
Lead • Lead in blood	• Not critical	• 200 µg/L
Note: Women of child-bearing potential whose blood Pb exceeds 10 µg/dL are at risk of delivering a child with a blood Pb over the current Centers for Disease Control guidance of 10 µg/dL.		

UK Biological Monitoring Guidance Values (BMGVs): Currently, no BMGVs have been established for components.

PROTECTIVE EQUIPMENT: 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), U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), 29 CFR 1910.133 for eye protection, 29 CFR 1910.138 for hand protection, 29 CFR 1910.136 for foot protection, equivalent standards of Canada (including CSA Standard Z94.4-02, CSA Standard Z94.3-02, CSA Standard Z94.4-93 for respiratory protection, CSA Standard Z94.3-M1982, *Industrial Eye and Face Protectors and* CSA Standard Z195-M1984, *Protective Footwear*), or 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);or, for the AS/NZS 1336:1997: Recommended practices for occupational eye protection; AS/NZS 1337 part 1-6: Eye protectors for industrial applications; AS/NZS 1715:2009: Selection, use and maintenance of respiratory protective devices; AS/NZS 1716:2003: Respiratory protective devices; AS/NZS 2161 Set: 2008: Occupational protective gloves; AS/NZS 2210.1:2010: Safety, protective and occupational footwear - Guide to selection, care and use; AS/NZS 2210.2:2009: Occupational protective footwear - Test methods; AS/NZS 4503 part 1-3: Protective clothing - Protection against liquid chemicals - Test method: Resistance of materials to permeation by liquids and standards of Mexico. Please reference applicable regulations and standards for relevant details.

Respiratory Protection: None needed under normal conditions of use and handling. Maintain airborne contaminant concentrations below exposure limits listed above. For materials without listed exposure limits, minimize respiratory exposure. If necessary, use only respiratory protection authorized under appropriate regulations. Oxygen levels below 19.5% are considered IDLH by U.S. 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 U.S. OSHA's Respiratory Protection Standard (1910.134-1998). The following NIOSH personal protective equipment guidelines are available for components that may produce significant health hazards. This information is provided in the event of possible dusts or fumes being produced during use.

BERYLLIUM and NICKEL

CONCENTRATION	RESPIRATORY PROTECTION
Based on NIOSH REL at Concentrations Above the NIOSH REL, or Where There is No REL, at Any Detectable Concentration:	Any Self-Contained Breathing Apparatus (SCBA) that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, or any Supplied-Air Respirator (SAR) that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode.
Escape:	Any Air-Purifying, Full-Facepiece Respirator with a high-efficiency particulate filter, or any appropriate escape-type, SCBA.

CHROMIUM

CONCENTRATION	**RESPIRATORY PROTECTION**
Up to 2.5 mg/m^3:	Any Dust and Mist respirator.
Up to 5 mg/m^3:	Any Dust and Mist respirator except single-use and quarter-mask respirators, or any Supplied-Air Respirator (SAR).
Up to 12.5 mg/m^3:	Any SAR operated in a continuous-flow mode, or any Powered, Air-Purifying Respirator (PAPR) with a dust and mist filter.
Up to 25 mg/m^3:	Any Air-Purifying, Full-Facepiece Respirator with a high-efficiency particulate filter, or any Powered, Air-Purifying Respirator (PAPR) with a tight-fitting facepiece and a high-efficiency particulate filter, or any Self-Contained Breathing Apparatus (SCBA) with a full facepiece, or any SAR with a full facepiece.
Up to 250 mg/m^3:	Any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode.
Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions:	Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, or any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode.
Escape:	Any Air-Purifying, Full-Facepiece Respirator with a high-efficiency particulate filter, or any appropriate escape-type, SCBA.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION (Continued)

PROTECTIVE EQUIPMENT (continued):

Respiratory Protection (continued):

COBALT

CONCENTRATION	RESPIRATORY PROTECTION
Up to 0.25 mg/m^3:	Any Quarter-Mask Respirator.
Up to 0.5 mg/m^3:	Any Particulate Respirator Equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators, or any Supplied-Air Respirator (SAR).
Up to 1.25 mg/m^3:	Any SAR in a continuous-flow mode, or any Powered Air-Purifying Respirator (PAPR) with a high-efficiency particulate filter.
Up to 2.5 mg/m^3:	Any Air-Purifying, Full-Facepiece Respirator with an N100, R100, or P100 filter, or any Self-Contained Breathing Apparatus (SCBA) with a full facepiece, or any SAR with a full facepiece.
Up to 20 mg/m^3:	Any SAR that has a full facepiece and is operated in a pressure-demand or other positive pressure mode.
Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions:	Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, or any SAR that has a full-facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode.
Escape:	Any Air-Purifying, Full-Facepiece Respirator with an N100, R100, or P100 filter or any appropriate escape-type, SCBA.

COPPER (DUSTS & MISTS, METAL FUME)

CONCENTRATION	**RESPIRATORY PROTECTION**
Up to 5 mg/m^3:	Any Dust and Mist Respirator.
Up to 10 mg/m^3:	Any Dust and Mist Respirator except single-use and quarter-mask respirators, or any Supplied-Air Respirator (SAR).
Up to 25 mg/m^3:	Any SAR operated in a continuous-flow mode, or any Powered, Air-Purifying Respirator (PAPR) with a dust and mist filter.
Up to 50 mg/m^3:	Any Air-Purifying, Full-Facepiece Respirator with a high-efficiency particulate filter, or any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter, or Self-Contained Breathing Apparatus with a full facepiece, or any SAR with a full facepiece.
Up to 100 mg/m^3:	Any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode.

COPPER (DUSTS & MISTS, METAL FUME)

CONCENTRATION	**RESPIRATORY PROTECTION**
Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions:	Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, or any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode.
Escape:	Any Air-Purifying, Full-Facepiece Respirator with a high-efficiency particulate filter, or any appropriate escape-type, SCBA.

LEAD

CONCENTRATION	RESPIRATORY PROTECTION
Up to 0.5 mg/m^3:	Any Air-Purifying Respirator with a high-efficiency particulate filter, or any Supplied-Air Respirator (SAR).
Up to 1.25 mg/m^3:	Any SAR operated in a continuous-flow mode, or any Powered, Air-Purifying Respirator with a high-efficiency particulate filter.
Up to 2.5 mg/m^3:	Any Air-Purifying, Full-Facepiece Respirator with a high-efficiency particulate filter, or any SAR that has a tight-fitting facepiece and is operated in a continuous-flow mode, or any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter, or any Self-contained breathing apparatus with a full facepiece, or any SAR with a full facepiece.
Up to 50 mg/m^3:	Any SAR operated in a pressure-demand or other positive-pressure mode.
Up to 100 mg/m^3:	Any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode.
Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions:	Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, or any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode.
Escape:	Any Air-Purifying, Full-Facepiece Respirator with a high-efficiency particulate filter, or any appropriate escape-type, SCBA.

MANGANESE

CONCENTRATION	RESPIRATORY PROTECTION
Up to 10 mg/m^3:	Any Particulate Respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators, or any Supplied-Air Respirator (SAR).
Up to 25 mg/m^3:	Any SAR operated in a continuous-flow mode, or any Powered Air-Purifying Respirator with a high-efficiency particulate filter.
Up to 50 mg/m^3:	Any Air-Purifying, Full-Facepiece Respirator with an N100, R100, or P100 filter, or any SAR that has a tight-fitting facepiece and is operated in a continuous-flow mode, or any Powered Air-Purifying Respirator (PAPR) with a tight-fitting facepiece and a high-efficiency particulate filter, or any Self-Contained Breathing Apparatus (SCBA) with a full facepiece, or any SAR with a full facepiece.
Up to 500 mg/m^3:	Any SAR operated in a pressure-demand or other positive-pressure mode.
Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions:	Emergency or planned entry into unknown concentrations or IDLH conditions: Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, or any SAR that has a full-facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode.
Escape:	Any Air-Purifying, Full-Facepiece Respirator with an N100, R100, or P100 filter, or any appropriate escape-type, SCBA.

PHOSPHOROUS

CONCENTRATION	RESPIRATORY PROTECTION
Up to 1 mg/m^3:	Any Supplied-Air Respirator (SAR).
Up to 2.5 mg/m^3:	Any SAR operated in a continuous-flow mode.
Up to 5 mg/m^3:	Any Self-Contained Breathing Apparatus (SCBA) with a full facepiece, or any SAR with a full facepiece.
Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions:	Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, or any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode.
Escape:	Any appropriate escape-type, SCBA.

SELENIUM

CONCENTRATION	RESPIRATORY PROTECTION
Up to 1 mg/m^3:	Any Dust and Mist respirator (IF NOT present as a fume), or any Dust, Mist, and Fume respirator, or any Air-Purifying, Full-Facepiece Respirator with a high-efficiency particulate filter, or any Powered, Air-Purifying Respirator (PAPR) with a dust and mist filter (IF NOT present as a fume), or any PAPR with a Dust, Mist, and Fume filter, or any Supplied-Air Respirator (SAR), or any Self-Contained Breathing Apparatus (SCBA) with a full facepiece.
Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions:	Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, or any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode.
Escape:	Any Air-Purifying, Full-Facepiece Respirator with a high-efficiency particulate filter, or any appropriate escape-type, SCBA.

VANADIUM FUME/DUST

CONCENTRATION	RESPIRATORY PROTECTION
Up to 0.5 mg/m^3:	Any Air-Purifying Respirator with a high-efficiency particulate filter, or any Supplied-Air Respirator (SAR).
Up to 1.25 mg/m^3:	Any SAR operated in a continuous-flow mode, or any Powered, Air-Purifying Respirator (PAPR) with a high-efficiency particulate filter.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION (Continued)

PROTECTIVE EQUIPMENT (continued):

Respiratory Protection (continued):

VANADIUM FUME/DUST (continued)

CONCENTRATION	RESPIRATORY PROTECTION
Up to 2.5 mg/m^3:	Any Air-Purifying, Full-Facepiece Respirator with a high-efficiency particulate filter, or any PAPR with a tight-fitting facepiece and a high-efficiency particulate filter, or any Self-Contained Breathing Apparatus (SCBA) with a full facepiece, or any SAR with a full facepiece.
Up to 35 mg/m^3:	Any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode.
Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions:	Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, or any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode.
Escape:	Any Air-Purifying, Full-Facepiece Respirator with a high-efficiency particulate filter, or any appropriate escape-type, SCBA.

ZIRCONIUM

CONCENTRATION	RESPIRATORY PROTECTION
Up to 25 mg/m^3:	Any Dust and Mist Respirator.
Up to 50 mg/m^3:	Any dust and mist respirator except single-use and quarter-mask respirators, or any Powered, Air-Purifying Respirator (PAPR) with a dust and mist filter, or any Air-Purifying, Full-Facepiece Respirator with a high-efficiency particulate filter, or any Supplied-Air Respirator (SAR); Self-Contained Breathing Apparatus (SAR) with a full facepiece.
Emergency or Planned Entry into Unknown Concentrations or IDLH Conditions:	Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, or any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode.
Escape:	Any Air-Purifying, Full-Facepiece Respirator with a high-efficiency particulate filter, or any appropriate escape-type, SCBA.

EYE PROTECTION: None needed under normal use and handling. Wear safety goggles if dusts or other particulates are present or other eye protection normally used in the environment that these products are used. If necessary, refer to appropriate regulations.

HAND PROTECTION: Wear appropriate glove for work being done. Resistance of specific materials can vary from product to product. Evaluate resistance under conditions of use and maintain gloves carefully. If necessary, refer to appropriate regulations.

BODY PROTECTION: Use body protection appropriate for task. If a hazard of injury to the feet exists due to falling objects, rolling objects, where objects may pierce the soles of the feet or where employee's feet may be exposed to electrical hazards, use foot protection, as described in U.S. OSHA 29 CFR 1910.136 and the Canadian CSA Standard Z195-02, *Protective Footwear*. If necessary, refer to appropriate regulations.

9. PHYSICAL and CHEMICAL PROPERTIES

FORM: Solid metal.
COLOR: Silver-grey.
MOLECULAR FORMULA: Mixture.
MOLECULAR WEIGHT: Mixture.
ODOR: Metallic.
ODOR THRESHOLD: Not applicable.
RELATIVE VAPOR DENSITY (air = 1): Not applicable.
EVAPORATION RATE (n-BuAc = 1): Not applicable.
SPECIFIC GRAVITY (water = 1): Not available.
MELTING/FREEZING POINT: > 1400°C (> 2500°F)
SOLUBILITY IN WATER: None.
BOILING POINT: Not applicable.
OTHER SOLUBILITIES: Not soluble.
pH: Not applicable.
VAPOR PRESSURE @ 20°C: Not applicable.
VISCOSITY: Not applicable.
DECOMPOSITION TEMPERATURE: Not available.
FLASH POINT: Not applicable.
EXPLOSIVE PROPERTIES: Not applicable.
OXIDIZER PROPERTIES: Not applicable.
HOW TO DETECT THIS SUBSTANCE IN EVENT OF ACCIDENTAL SPILL (warning properties): Not applicable (product cannot be 'spilled' or 'released'.)

10. STABILITY and REACTIVITY

CHEMICAL STABILITY: Stable.

DECOMPOSITION PRODUCTS: *Combustion:* When heated to 1400°C (2500°F) the product can melt, producing metal oxides. *Hydrolysis:* Not applicable.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: None. Powders of components of the alloy have a wide ride range of incompatible materials; some produce highly hazardous reactions or can ignite. Refer to SDSs for these compounds for additional information.

POSSIBILITY OF HAZARDOUS REACTIONS/POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Avoid exposure to or extreme temperatures, including high heat and freezing. Avoid accumulation of dusts.

11. TOXICOLOGICAL INFORMATION

SYMPTOMS OF EXPOSURE BY ROUTE OF EXPOSURE: These products present limited health hazards due to their solid form. The symptoms of exposure are from dusts from if the alloy is cut or ground.

INHALATION: As a formed metal product, the alloy pose no hazard of inhalation. If dusts or particulates from these products are inhaled, moderate irritation to the nose, throat, and lungs can occur. Symptoms may include sneezing, coughing, nasal congestion, and difficulty breathing. Symptoms are generally alleviated upon exposure to fresh air. Chronic inhalation of dusts or fumes may cause poor wound healing, due to presence of White Phosphorous. Chronic exposure to fumes from these products may cause metal fume fever. Symptoms of metal fume fever occur about 4 to 12 hours after exposure and usually last about 24 hours. Recovery is complete with no apparent permanent disability. Symptoms of metal fume fever resemble the "flu" and include: sweating, shivering, headache, fever, chills, thirst, muscle aches, nausea, vomiting, weakness, and tiredness. A metallic or sweet taste in the mouth, dryness or irritation of the throat, and coughing may occur at the time of exposure to the metal fumes. Some workers may develop a short-term resistance so that repeated exposure to metal oxide fumes does not cause metal fume fever. This immunity is quickly lost after short absences from work (weekends or vacations). Inhalation of iron oxide fume or dust is cause of pulmonary roentgenographic appearance called siderosis, or an accumulation of iron that leads to reduced lung capacity. Due to the trace Beryllium component, chronic inhalation of dust may cause serious and potentially fatal progressive inflammatory lung disease caused by an immune response to Beryllium. Chronic inhalation exposure may also cause manganese toxicity. Refer to 'Other Potential Health Effects' for additional information.

11. TOXICOLOGICAL INFORMATION

For Solid Metal Alloy

HAZARDOUS MATERIAL IDENTIFICATION SYSTEM		
HEALTH HAZARD	(BLUE)	0
FLAMMABILITY HAZARD	(RED)	0
PHYSICAL HAZARD	(ORANGE)	0

PROTECTIVE EQUIPMENT			
EYES	RESPIRATORY	HANDS	BODY
	SEE SECTION 8		SEE SECTION 8

For Routine Industrial Use and Handling Applications

For Fumes (Health Hazard only) and Dusts

HAZARDOUS MATERIAL IDENTIFICATION SYSTEM		
HEALTH HAZARD	(BLUE)	2
FLAMMABILITY HAZARD	(RED)	3
PHYSICAL HAZARD	(ORANGE)	0

PROTECTIVE EQUIPMENT			
EYES	RESPIRATORY	HANDS	BODY
	SEE SECTION 8		SEE SECTION 8

For Routine Industrial Use and Handling Applications

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

CONTACT WITH SKIN or EYES: As a formed metal product, these products pose minimal hazard by skin or eye contact. Cuts or abrasions may occur from contact with sharp edges. If Beryllium particles penetrate injured skin, they can cause ulcers and granulomas (a mass of inflamed tissue). Exposure to Beryllium dust has been associated with a skin disease characterized by poor wound healing, ulcers, and wart-like bumps. Components of the alloy are known skin sensitizers; contact with dusts or prolonged contact with the alloy may cause sensitization and allergic skin reactions. Although not expected to occur, rare cases of allergic contact dermatitis have been reported in people working with copper dust. If during forming, cutting, grinding or heating, dusts and fumes can be produced, which can be irritating to the eyes, including mechanical irritation. Repeated contact of iron dusts with the eyes can cause conjunctivitis, or can cause discoloration of the eyes.

SKIN ABSORPTION: Not applicable.

INGESTION: Ingestion is an unlikely route of occupational exposure to these products. In the unlikely event that dusts from the product are ingested, nausea, vomiting, and diarrhea may result. Repeated ingestion of iron compounds can cause vomiting, diarrhea, pink urine, black stool, and liver or kidney damage. Repeated ingestion of iron compounds can also cause siderosis, which is an accumulation of iron in tissues, leading to yellowing of the skin.

INJECTION: Injection of metal slivers under the skin can lead to infections and allergic skin reactions.

OTHER HEALTH EFFECTS: Although in trace amount in the alloy, acute and chronic exposure to low levels of Beryllium dusts can cause serious health effects from Beryllium toxicity. Repeated inhalation exposure can lead to chronic Beryllium disease, a progressive inflammatory lung disease characterized by the formation of granulomas and scarring. This condition is caused by an immune response to beryllium. In people who develop chronic beryllium disease, the progression is as follows: 1) development of an immune response to beryllium; 2) gradual development of a chronic inflammatory response; 3) measurable loss of lung function; 4) disability and death. In the early stages, there may be no symptoms or symptoms may consist of a mild cough and labored breathing from mild exertion, followed by to chest pain, weakness, fatigue, labored breathing at rest, reduced appetite (anorexia) and weight loss, and constant hacking cough. Blue discoloration of the hands and fingers, and heart enlargement and disease may also be seen. Some information indicates chronic skin contact with dusts may also contribute to development of Beryllium disease.

Manganese toxicity following chronic exposure to manganese through inhalation of dusts or fumes for periods of from 6 months to 2 years results in "manganism", a disease of central nervous system involving psychic and neurological disorders. This toxicity is reversible if recognized early and exposure is eliminated.

Long-term occupational exposure to inorganic lead compounds has caused dose-related harmful effects to the central and peripheral nervous systems, the kidneys, and the blood system. Some of these effects are irreversible. Several studies also suggest that increased inorganic lead exposure is associated with small to moderate increases in blood pressure, and that moderate to high exposures may cause harmful effects to the immune system. Inorganic lead compounds are not known to be respiratory or skin sensitizers. Long-term lead toxicity is commonly referred to as "plumbism".

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in **Lay Terms**. In the event of exposure, the following symptoms may be observed:

ACUTE: Due to their form, these products present limited acute health hazards as a formed metal product. Sharp edges may cause cuts and abrasions. If heated, inhalation of fumes may cause metal fume fever. Inhalation of dusts from cutting, grinding or other forming can cause irritation the respiratory system and other adverse effects described earlier in this Section. Dusts may cause mechanical irritation to the eyes.

CHRONIC: Rare cases of allergic contact dermatitis have been reported in people working with copper dust. These products contain Nickel, Lead, Chromium and Beryllium, which are known human carcinogens and several other suspected human carcinogens. These products contain Lead, a known human mutagen and reproductive toxin and Cobalt, a known mutagen.

11. TOXICOLOGICAL INFORMATION

TARGET ORGANS: Dusts: *Acute*: Eyes, respiratory system. *Chronic*: Respiratory system, skin, immune system, reproductive system. Fumes: *Acute*: Central nervous system, muscles, respiratory system, eyes, reproductive system. *Chronic*: Respiratory system, central nervous system, heart, kidneys, liver, immune system.

TOXICITY DATA: Although there are toxicity data for many components, none are presented in this SDS due to the form of the product.

CARCINOGENIC POTENTIAL OF COMPONENTS: The components of the alloys are listed by agencies tracking the carcinogenic potential of chemical compounds, as follows:

ALUMINUM (dust): ACGIH-TLV-A4 (Not Classifiable as a Human Carcinogen)

BERYLLIUM: ACGIH TLV-A1 (Confirmed Human Carcinogen); EPA-B1 (Limited Evidence of Carcinogenicity from Epidemiologic Studies); Inhalation: EPA-L (Likely to be Carcinogenic to Humans); EPA-L (Likely to be Carcinogenic to Humans); Ingestion: EPA-CBD (Cannot Be Determined); IARC-1 (Carcinogenic to Humans), NIOSH-Ca (Potential Occupational Carcinogen with No Further Categorization), NTP-K (Known to Be a Human Carcinogen)

BORON: EPA-I (Data are Inadequate for an Assessment of Human Carcinogenic Potential)

CHROMIUM (metal): ACGIH-TLV-A4 (Not Classifiable as a Human Carcinogen); EPA-A (Human Carcinogen); EPA-K(Known Human Carcinogen); Oral: EPA-D (Not Classifiable as to Human Carcinogenicity); EPA-CBD (Cannot Be Determined); IARC-3 (Unclassifiable as to Human Carcinogenicity)

COBALT: IARC-2B (Possibly Carcinogenic to Humans); MAK-2 (Substances that are Considered to be Carcinogenic for Man Because Sufficient Data from Long-Term Animal Studies or Limited Evidence from Animal Studies Substantiated by Evidence from Epidemiological Studies Indicate that They Can Make a Significant Contribution to Cancer Risk),

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

IRON: ACGIH-TLV-A4 (Not Classifiable as a Human Carcinogen), IARC-3 (Unclassifiable as to Human Carcinogenicity)

LEAD: ACGIH-TLV-A3 (Confirmed Animal Carcinogen), EPA-B2 (Probable Human Carcinogen-Sufficient Evidence from Animal Studies; Inadequate Evidence or No Data from Epidemiologic Studies), IARC-2A (Probably Carcinogenic to Humans), MAK-2 (Substances that are Considered to be Carcinogenic for Man Because Sufficient Data from Long-Term Animal Studies or Limited Evidence from Animal Studies Substantiated by Evidence from Epidemiological Studies Indicate that They Can Make a Significant Contribution to Cancer Risk) NTP-R (Reasonably Anticipated to Be a Human Carcinogen)

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

NICKEL: IARC-1 (Carcinogenic to Humans), MAK-1 (Substances that Cause Cancer in Man and Can Be Assumed to Make a Significant Contribution to Cancer Risk), NIOSH-Ca (Potential Occupational Carcinogen with No Further Categorization), NTP-K (Known to Be a Human Carcinogen)

VANADIUM: MAK-2 (Substances that are Considered to be Carcinogenic for Man Because Sufficient Data from Long-Term Animal Studies or Limited Evidence from Animal Studies Substantiated by Evidence from Epidemiological Studies Indicate that They Can Make a Significant Contribution to Cancer Risk),

ZINC: EPA-D (Not Classifiable as to Human Carcinogenicity); EPA-I (Data are Inadequate for an Assessment of Human Carcinogenic Potential); EPA-II (Inadequate Information to Assess Carcinogenic Potential)

ZIRCONIUM: ACGIH-TLV-A4 (Not Classifiable as a Human Carcinogen)

IRRITANCY OF PRODUCT: Inhalation of dusts or fumes may cause respiratory irritation. Eye contact with dusts from the alloys may cause mechanical irritation.

SENSITIZATION TO THE PRODUCT: Components of these products are known sensitizers, including Nickel, Beryllium, Cobalt. Although some persons can develop sensitivity to Nickel from prolonged contact with metals, exposure to dusts and fumes from the product is heated, cut or otherwise manipulated is more likely to produce sensitization and allergic skin and/or respiratory reaction. The Beryllium component is an occupational skin sensitizer and can cause skin ulceration and granulomas. Beryllium can also cause contact dermatitis. Inhalation of beryllium compounds can also result in allergic dermatitis. Cobalt-induced dermatitis has been well-documented and several human studies have shown that cobalt causes skin sensitization. Symptoms of skin sensitization can include redness, rash, itching and swelling. This reaction can increase in severity with each exposure and can spread from the hands or face to the rest of the body.

REPRODUCTIVE TOXICITY INFORMATION: Due to the solid form, this alloy is not expected to cause reproductive harm. Some components are reproductive toxins, including lead.

Mutagenicity: Inorganic lead compounds are considered mutagenic, based on positive results observed for lead acetate in both non-reproductive cells (somatic cells) and reproductive cells (germ cells) of animals exposed by relevant routes of exposure. Several studies have reported positive results (chromosomal aberrations, sister chromatid exchanges, DNA damage, micronuclei, DNA-protein crosslinks) in the white blood cells of workers with low to moderate exposure. The Cobalt compound is suspected of mutagenic effects.

Embryotoxicity/Teratogenicity: Inorganic lead compounds are considered to cause developmental toxicity based on human and animal information.

Reproductive Toxicity: Inorganic lead compounds are considered to cause reproductive toxicity based on human and animal information, including adverse effects on fertility in men.

12. ECOLOGICAL INFORMATION

ALL WORK PRACTICES MUST BE AIMED AT ELIMINATING ENVIRONMENTAL CONTAMINATION.

MOBILITY: These alloys have no hazard of mobility

PERSISTENCE AND BIODEGRADABILITY: As a formed metal product, the alloy will exist indefinitely in the environment as components do not decompose. Oxides can be formed.

BIO-ACCUMULATION POTENTIAL: No information available.

ECOTOXICITY: Although the alloy presents negligible adverse effects to the environment, some components are known to be toxic to marine organisms.

RESULTS OF PBT AND vPvB ASSESSMENT: No Data Available. PBT and vPvB assessments are part of the chemical safety report required for some substances in European Union Regulation (EC) 1907/2006, Article 14.

OTHER ADVERSE EFFECTS: The components of these products are not listed as having ozone depletion potential.

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. These products, if unaltered by use, may be recovered for recycling, 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 for solid alloy. Dusts may be subject to testing per the Toxicity Characteristic Leaching Procedure requirements of RCRA to determine if such wastes meet the following characteristics: D007 (Chromium), D008 (Lead) or D010 (Selenium).

EWC WASTE CODE: The provisions of Article 2 would not apply to pure metal alloys (not contaminated by dangerous substances) or unless this alloy is part of demolition waste. Other Waste Codes may be applicable to dusts or turnings, as follows: **12 01: wastes from shaping and physical and mechanical surface treatment of metals and plastics:** 12 01 01 ferrous metal filings and turnings; 12 01 02 ferrous metal dust and particles.

14. TRANSPORTATION INFORMATION

U.S. DEPARTMENT OF TRANSPORTATION: These products are NOT classified as dangerous goods, per U.S. DOT regulations, under 49 CFR 172.101.

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: These products do not meet the criteria of classification of Dangerous Goods, per regulations of Transport Canada.

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA): These products do not meet the criteria as Dangerous Goods, per rules of IATA.

INTERNATIONAL MARITIME ORGANIZATION (IMO) DESIGNATION: These products are NOT classified as Dangerous Goods by the International Maritime Organization.

EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR): These products do not meet the criteria as Dangerous Goods of the United Nations Economic Commission for Europe.

TRANSPORT IN BULK ACCORDING TO THE IBC CODE: Not applicable.

ENVIRONMENTAL HAZARDS: This alloy does not meet the criteria of environmentally hazardous according to the criteria of the UN Model Regulations (as reflected in the IMDG Code, ADR, RID, and ADN) and is not specifically listed in Annex III under MARPOL 73/78.

15. REGULATORY INFORMATION

U.S. REGULATIONS:

U.S. SARA Reporting Requirements: Not applicable as an article. The components of these products may have requirements as pure compounds; if dusts from the product are produced, SARA requirements may be applicable.

U.S. SARA Threshold Planning Quantity (TPQ): Not applicable as an article. The components of these products may have requirements as pure compounds; if dusts from the product are produced, SARA requirements may be applicable.

U.S. CERCLA Reportable Quantity (RQ): Not applicable as an article.

U.S. TSCA Inventory Status: This is an article and is not subject to the requirements of TSCA.

Other U.S. Federal Regulations: These products meet the definition of an “Article” under the U.S. Federal OSHA Hazard Communication Standard (29 CFR 1910.1200). For further information, the definition of “Article” is provided below.

Article means a manufactured item other than a fluid or particle: (i) which is formed to a specific shape or design during manufacture; (ii) which has end use function(s) dependent in whole or in part upon its shape or design during end use; and (iii) which under normal conditions of use does not release more than very small quantities, *e.g.,* minute or trace amounts of a hazardous chemical, and does not pose a physical hazard or health risk to employees.

California Safe Drinking Water And Toxic Enforcement Act (Proposition 65): Components of these products are on the California Proposition 65 lists, including Nickel, Lead, and Cobalt (powder); however, Proposition 65 warnings are not applicable for articles.

CANADIAN REGULATIONS:

Canadian DSL/NDSL Inventory Status: Components of the product are on the DSL Inventory.

Other Canadian Regulations: Not applicable.

Canadian Environmental Protection Act (CEPA) Priorities Substances Lists: As an article, not applicable.

Canadian WHMIS HPR 2015 Classification and Symbols: See information in Section 16 under the Global Harmonization Standard classification.

EUROPEAN UNION REGULATIONS:

Chemical Safety Assessment: No Data Available. The chemical safety assessment is required for some substances according to European Union Regulation (EC) 1907/2006, Article 14.

Substances of Very High Concern (SVHC) Status: None.

AUSTRALIAN REGULATIONS:

Australian Inventory Of Chemical Substances (AICS) Status: The components of these products are listed on the AICS.

Hazardous Substances Information System (HSIS): As an article, not applicable.

JAPANESE REGULATIONS:

Japanese ENCS: The components of these products are on the ENCS Inventory.

Japanese Ministry Of Economy, Trade, and Industry (MITI) Status: Not applicable.

Poisonous and Deleterious Substances Control Law: As an article, not applicable.

KOREAN REGULATIONS:

Korean Existing Chemicals List (ECL) Status: The components are on the Korean ECL Inventory.

SINGAPORE REGULATIONS:

Code Of Practice On Pollution Control Requirements: As an article, not applicable.

16. OTHER INFORMATION

GLOBAL HARMONIZATION AND EU CLP REGULATION (EC) 1272/2008 LABELING AND CLASSIFICATION: Per 1.3.4.1 of Annex I to CLP, 'Metals in massive form', alloys do not require a label according to this Annex, if they do not present a hazard to human health by inhalation, ingestion or contact with skin or to the aquatic environment in the form in which they are placed on the market, although classified as hazardous in accordance with the criteria of this Annex'. These products are a metal alloy consisting of two or more elements so combined that they cannot be readily separated by mechanical means. In solid form, these products have no applicable classification under CLP. Per 1.3.4.2. Instead, the supplier shall provide the information to downstream users or distributors by means of the SDS.

GLOBAL HARMONIZATION LABELING AND CLASSIFICATION: These products are articles and are not required to be classified under all jurisdictions.

CLASSIFICATION FOR COMPONENTS:

Full Text Global Harmonization:

Aluminum (Stabilized):
Classification: Water Reactive Category 2, Flammable Solid Category 1
Hazard Statement Codes: H261: In contact with water releases flammable gases. H228: Flammable solid.

Beryllium: This is a published classification.
Classification: Carcinogenicity (Inhalation) Category 1B, Acute Inhalation Toxicity Category 2, Acute Oral Toxicity Category 3, Skin Irritation Category 2, Eye Irritation Category 2A, Specific Target Organ Toxicity (Inhalation-Respiratory Irritation) Single Exposure Category 3, Skin Sensitization Cat. 1, Specific Target Organ Toxicity (Inhalation) Repeated Exposure Category 1
Hazard Statement Codes: H350i: May cause cancer by inhalation. H330: Fatal if inhaled. H301: Toxic if swallowed. H315: Causes skin irritation. H319: Causes serious eye irritation. H335: May cause respiratory irritation. H317: May cause an allergic skin reaction. H372: Causes damages to organs through prolonged or repeated exposure.

Boron:
Classification: Acute Oral Toxicity Category 4
Hazard Statement Codes: H302: Harmful if swallowed.

Chromium metal:
Classification: Acute Oral Toxicity Category 4
Hazard Statement Codes: H303: May be harmful if swallowed.

Columbium:
Classification: Flammable Solid Category 1
Hazard Statement Codes: H228: Flammable solid.

Cobalt:
Classification: Carcinogenicity (Inhalation) Category 1B, Reproductive Toxicity Category 2, Acute Inhalation Toxicity Category 2, Acute Oral Toxicity Category 4, Eye Irritation Category 2A, Respiratory Sensitizer Category 1, Skin Sensitizer Category 1, Specific Target Organ Toxicity (Inhalation-Lung) Repeated Exposure Category 2, Aquatic Acute Toxicity Category 1, Aquatic Chronic Toxicity Category 1
Hazard Statement Codes: H350i: May cause cancer by inhalation. H361fd: Suspected of damaging fertility. Suspected of damaging the unborn child. H302: Harmful if swallowed. H319: Causes serious eye irritation. H317: May cause an allergic skin reaction. H334: May cause allergy or asthma symptoms or breathing difficulties if inhaled. H373: May cause damage to the lungs through prolonged or repeated exposure by inhalation. H410: Very toxic to aquatic life with long-lasting effects.

Copper:
Classification: Acute Oral Toxicity Category 4, Eye Irritation Cat. 2A, Aquatic Acute Toxicity Category 4
Hazard Statement Codes: H302: Harmful if swallowed. H319: Causes serious eye irritation. H319: Causes serious eye irritation. H413: May cause long-lasting harmful effects to aquatic life.

Iron (dusts):
Classification: Flammable Solid Category 1, Self-Heating Solid Category 1
Hazard Statement Codes: H228: Flammable solid. H251: Self-heating: may catch fire.

Lead (For Powder ≥ 1 mm Particle Size):
Classification: Reproductive Toxicity Category 1A, Lactation Hazard Category 1, Acute Oral Toxicity Category 4, Acute Inhalation Toxicity Category 4, Specific Target Organ Toxicity (Inhalation/Ingestion-Neurological System) Repeated Exposure Category 2, Aquatic Acute Toxicity Category 1, Aquatic Chronic Toxicity Category 1
Hazard Statement Codes: H361Df: May damage the unborn child. Suspected of damaging fertility. H362: May cause harm to breast-fed children. H302 + H332: Harmful if swallowed or inhaled. H372: Causes damage to central and neurological systems through prolonged or repeated exposure by inhalation. H410: Very toxic to aquatic life with long-lasting effects.

Manganese:
Classification: Water Reactive Category 2
Hazard Statement Codes: H261: In contact with water releases flammable gases.

Nickel:
Classification: Carcinogenicity (Inhalation) Category 2, Specific Target Organ Toxicity Repeated Exposure Category 1, Skin Sensitizer Category 1A, Respiratory Sensitization Category 1B, Aquatic Chronic Toxicity Category 3
Hazard Statement Codes: H350i: May cause cancer by inhalation. H372: Causes damages to organs through prolonged or repeated exposure. H317: May cause an allergic skin reaction. H334: May cause allergy or asthma symptoms or breathing difficulties if inhaled. H412: Harmful to aquatic life with long-lasting effects.

Phosphorous, White:
Classification: Pyrophoric Solid Category 1, Acute Oral Toxicity Category 2, Acute Inhalation Toxicity Category 2, Skin Corrosion Category 1B, Aquatic Chronic Toxicity Category 3
Hazard Statement Codes: H250: Catches fire spontaneously if exposed to air. H310 + H330: Fatal in contact with skin or if inhaled. H314: Causes severe skin burns and eye damage. H412: Harmful to aquatic life with long-lasting effects.

Selenium: This is a published classification.
Classification: Carcinogenicity Category 1B, Reproductive Toxicity Category 1A, Lactation Hazard Category 1, Acute Oral Toxicity Category 3, Inhalation Toxicity Category 3, Skin Sensitization Category 1B, Specific Target Organ Toxicity (Inhalation) Repeated Exposure Category 2, Aquatic Chronic Toxicity Category 3
Hazard Statement Codes: H351: Suspected of causing cancer. H360FD: May damage fertility. May damage the unborn child. H362: May cause harm to breast-fed children. H301 + H331: Toxic if swallowed or if inhaled. H373: May cause damage to organs through prolonged or repeated exposure. H317: May cause an allergic skin reaction. H412: Harmful to aquatic life with long-lasting effects.

Silicon: This is a self-classification.
Classification: Flammable Solid Category 1, Acute Oral Toxicity Category 5
Hazard Statement Codes: H228: Flammable solid. H303: May be harmful if swallowed.

Sulfur: This is a published classification.
Classification: Skin Irritation Category 2
Hazard Statement Codes: H315: Causes skin irritation.

Tantalum:
Classification: Flammable Solid Category 1, Acute Oral Toxicity Category 4
Hazard Statement Codes: H228: Flammable solid. H302: Harmful if swallowed.

Tungsten:
Classification: Flammable Solid Category 1
Hazard Statement Codes: H228: Flammable solid.

Vanadium:
Classification: Acute Oral Toxicity Category 5
Hazard Statement Codes: H303: May be harmful if swallowed.

White Phosphorous: This is a self-classification.
Classification: Flammable Solid Category 1, Acute Oral Toxicity Category 2, Aquatic Chronic Toxicity Category 3
Hazard Statement Codes: H228: Flammable solid. H300: Fatal if swallowed. H412: Harmful to aquatic life with long-lasting effects.

Yttrium: This is a self-classification.
Classification: Flammable Solid Category 1, Pyrophoric Solid Category 1, Acute Oral Toxicity Category 4, Acute Dermal Toxicity Category 4, Acute Inhalation Toxicity Category 4
Hazard Statement Codes: H228: Flammable solid. H250: Catches fire spontaneously if exposed to air. H302 + H312 + H332: Harmful if swallowed, in contact with skin, or if inhaled.

16. OTHER INFORMATION (Continued)

CLASSIFICATION FOR COMPONENTS (continued):

Full Text Global Harmonization (continued):

Zinc (dust, stabilized): This is a published classification.
Classification: Aquatic Acute Toxicity Category 1, Aquatic Chronic Toxicity Category 1
Hazard Statement Codes: H410: Very toxic to aquatic life with long-lasting effects.
Zirconium (powder, non-pyrophoric): This is a published classification.
Classification: Self-Heating Substance Category 1, Water Reactive Category 1
Hazard Statement Codes: H251: Self-heating: may catch fire. H260: In contact with water releases flammable gases which may ignite spontaneously.
All Other Components: No classification has been published or is applicable.

REVISION DETAILS: March 2018: Up-date of entire SDS to current format for GHS under U.S., Canada, the EU, Australia, Korea, Japan, China, Mexico and Australian country requirements.

REFERENCES AND DATA SOURCES: Contact Supplier as indicated in Section 1 of this SDS.

METHODS OF EVALUATING INFORMATION FOR THE PURPOSE OF CLASSIFICATION: Bridging principles were used to prepare this SDS.

PREPARED BY: CHEMICAL SAFETY ASSOCIATES, Inc. • PO Box 1961, Hilo, HI 96721 • 800/441-3365 • 808/969-4846

DATE OF PRINTING: March 26, 2018

DEFINITIONS OF TERMS

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

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

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

LOQ: Limit of Quantitation.

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

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

NIC: Notice of Intended Change.

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

NIOSH RELs: NIOSH's Recommended Exposure Limits.

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

SKIN: Used when a 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_{50} Rat*: < 5000 mg/kg. *Dermal Toxicity LD_{50}Rat or Rabbit*: < 2000 mg/kg. *Inhalation Toxicity 4-hrs LC_{50} 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_{50} Rat*: > 500-5000 mg/kg. *Dermal Toxicity LD_{50}Rat or Rabbit*: > 1000-2000 mg/kg. *Inhalation Toxicity LC_{50}* 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_{50} Rat*: > 50-500 mg/kg. *Dermal Toxicity LD_{50}Rat or Rabbit*: > 200-1000 mg/kg. *Inhalation Toxicity LC_{50} 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*:

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS (continued):

HEALTH HAZARD (continued): 3 (continued): 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_{50} Rat*: > 1-50 mg/kg. *Dermal Toxicity LD_{50}Rat or Rabbit*: > 20-200 mg/kg. *Inhalation Toxicity LC_{50} 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_{50} Rat*: ≤ 1 mg/kg. *Dermal Toxicity LD_{50}Rat or Rabbit*: ≤ 20 mg/kg. *Inhalation Toxicity LC_{50} 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]); **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.

DEFINITIONS OF TERMS (Continued)

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM HAZARD RATINGS (continued):

PHYSICAL HAZARD (continued): 3 (continued): *Compressed Gases*: Pressure ≥ 514.7 psi absolute at 21.1°C (70°F) [500 psig]. *Pyrophorics*: No Rating. *Oxidizers*: Packing Group I Solids: any material that, in either concentration tested, exhibits a mean burning time less than the mean burning time of a 3.:2 potassium bromate/cellulose mixture. Liquids: Any material that spontaneously ignites when mixed with cellulose in a 1:1 ratio, or which exhibits a mean pressure rise time less than the pressure rise time of a 1:1 perchloric acid (50%)/cellulose mixture. *Unstable Reactives*: Substances that may polymerize, decompose, condense or self-react at ambient temperature and/or pressure and have a moderate potential to cause significant heat generation or explosion.); **4** (*Water Reactivity*: Materials that react explosively with water without requiring heat or confinement. *Organic Peroxides*: Materials that are readily capable of detonation or explosive decomposition at normal temperature and pressures. *Explosives*: Division 1.1 & 1.2-explosive substances that have a mass explosion hazard or have a projection hazard. A mass explosion is one that affects almost the entire load instantaneously. *Compressed Gases*: No Rating. *Pyrophorics*: Add to the definition of Flammability "4". *Oxidizers*: No "4" rating. *Unstable Reactives*: Substances that may polymerize, decompose, condense or self-react at ambient temperature and/or pressure and have a high potential to cause significant heat generation or explosion.).

NATIONAL FIRE PROTECTION ASSOCIATION HAZARD RATINGS:

HEALTH HAZARD: **0** (materials that, under emergency conditions, would offer no hazard beyond that of ordinary combustible materials): Gases and vapors whose LC_{50} for acute inhalation toxicity is greater than 10,000 ppm. Dusts and mists whose LC_{50} for acute inhalation toxicity is greater than 200 mg/L. Materials whose LD_{50} for acute dermal toxicity is greater than 2000 mg/kg. Materials whose LD_{50} 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_{50} for acute inhalation toxicity is greater than 5,000 ppm but less than or equal to 10,000 ppm. Dusts and mists whose LC_{50} for acute inhalation toxicity is greater than 10 mg/L but less than or equal to 200 mg/L. Materials whose LD_{50} for acute dermal toxicity is greater than 1000 mg/kg but less than or equal to 2000 mg/kg. Materials whose LD_{50} for acute oral toxicity is greater than 500 mg/kg but less than or equal to 2000 mg/kg. Materials that cause slight to moderate irritation to the respiratory tract, eyes and skin. **2** (materials that, under emergency conditions, can cause temporary incapacitation or residual injury): Gases and vapors whose LC_{50} for acute inhalation toxicity is greater than 3,000 ppm but less than or equal to 5,000 ppm. Dusts and mists whose LC_{50} for acute inhalation toxicity is greater than 2 mg/L but less than or equal to 10 mg/L. Materials whose LD_{50} for acute dermal toxicity is greater than 200 mg/kg but less than or equal to 1000 mg/kg. Materials whose LD_{50} 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_{50} for acute inhalation toxicity, if its LC_{50} 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_{50} for acute inhalation toxicity is greater than 1,000 ppm but less than or equal to 3,000 ppm. Dusts and mists whose LC_{50} for acute inhalation toxicity is greater than 0.5 mg/L but less than or equal to 2 mg/L. Materials whose LD_{50} for acute dermal toxicity is greater than 40 mg/kg but less than or equal to 200 mg/kg. Materials whose LD_{50} 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_{50} for acute inhalation toxicity, if its LC_{50} 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_{50} for acute inhalation toxicity less than or equal to 1,000 ppm. Dusts and mists whose LC_{50} for acute inhalation toxicity is less than or equal to 0.5 mg/L. Materials whose LD_{50} for acute dermal toxicity is less than or equal to 40 mg/kg. Materials whose LD_{50} 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_{50} for acute inhalation toxicity, if its LC_{50} 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 according with Annex D. **1** Materials that must be preheated before ignition can occur. Materials in this degree require considerable preheating, under all ambient temperature conditions, before ignition and combustion can occur: Materials that will burn in air when exposed to a temperature of 816°C (1500°F) for a period of 5 minutes in accordance with Annex D. Liquids, solids and semisolids having a flash point at or above 93.4°C (200°F) (i.e. Class IIIB liquids). Liquids with a flash point greater than 35°C (95°F) that do not sustain combustion when tested using the Method of Testing for Sustained Combustibility, per 49 CFR 173, Appendix H or the UN Recommendation on the Transport of Dangerous Goods, Model Regulations (current edition) and the related Manual of Tests and Criteria (current edition). Liquids with a flash point greater than 35°C (95°F) in a water-miscible solution or dispersion with a water non-combustible liquid/solid content of more than 85 percent by weight. Liquids that have no fire point when tested by ASTM D 92 Standard Test Method for Flash and Fire Points by Cleveland Open Cup, up to a boiling point of the liquid or up to a temperature at which the sample being tested shows an obvious physical change. Combustible pellets with a representative diameter of greater than 2 mm (10 mesh). Solids containing greater than 0.5 percent by weight of a flammable or combustible solvent are rated by the closed up flash point of the solvent. Most ordinary combustible materials. **2** Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating could release vapor in sufficient quantities to produce hazardous atmospheres with air: Liquids having a flash point at or above 37.8°C (100°F) and below 93.4°C (200°F) (i.e. Class II and Class IIIA liquids.) Solid materials in the form of powders or coarse dusts of representative diameter between 420 microns (40 mesh) and 2 mm (10 mesh) that burn rapidly but that generally do not form explosive mixtures in air. Solid materials in fibrous or shredded form that burn rapidly and create flash fire hazards, such as cotton, sisal and hemp. Solids and semisolids that readily give off flammable vapors. Solids containing greater than 0.5 percent by weight of a flammable or combustible solvent are rated by the closed cup flash point of the solvent.**3** Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials in this degree produce hazardous atmospheres with air under almost all ambient temperatures or, though unaffected by ambient temperatures, are readily ignited under almost all conditions: Liquids having a flash point below 22.8°C (73°F) and having a boiling point at or above 37.8°C (100°F) and those liquids having a flash point at or above 22.8°C (73°F) and below 37.8°C (73°F) and below 37.8°C (100°F) (i.e. Class IB and IC liquids).

NATIONAL FIRE PROTECTION ASSOCIATION HAZARD RATINGS (continued):

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

FLAMMABILITY LIMITS IN AIR:

Much of the information related to fire and explosion is derived from the **N**ational **F**ire **P**rotection **A**ssociation (**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.

ECOLOGICAL INFORMATION:

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

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_{50}** - Lethal Dose (solids & liquids) which kills 50% of the exposed animals; **LC_{50}** - 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^3** 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.

REPRODUCTIVE TOXICITY INFORMATION:

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.

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. **O**ccupational **S**afety and **H**ealth **A**dministration (**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.

AUSTRALIA:

AICS: Australian Inventory of Chemical Substances. NOHSC: National Occupational Health & Safety Code.

EUROPE:

EU: European Union (formerly known as the EEC, European Economic Community). EINECS: European Inventory of Now-Existing Chemical Substances. ARD: European Agreement Concerning the International Carriage of Dangerous Goods by Road. RID: International Regulations Concerning the Carriage of Dangerous Goods by Rail.

JAPAN:

METI: Ministry of Economy, Trade and Industry.