

Manganese, Metallurgical



Safety Data Sheet

Section 1: Identification

1.1 Product Identifier

Product Name: Manganese, Metallurgical
 Product Form: Solid
 Chemical Family: Metal Ore
 CAS Number: 7439-96-5 (for Manganese)
 Molecular Formula: See **Section 3.1**.
 Molecular Weight: Varies. See **Section 3.1**.

1.2 Other Means of Identification

Synonyms: DLA13623

1.3 Recommended Uses

Recommended Use: Alloy

1.4 Manufacturer, Importer, or Responsible Party

Responsible Party: Defense Logistics Agency Strategic Materials
 8725 John J. Kingman Road
 Fort Belvoir, Virginia 22060-6223
 (571) 767-5525

1.5 Emergency Phone Number

Emergency Phone Number: (800) 424-9300 (CHEMTREC)
 (703) 527-3887 (CHEMTREC INTERNATIONAL)

Section 2: Hazard(s) Identification

2.1 Classification of Chemical per OSHA CFR 1910.1200

Skin Irritation: Category 2
 Eye Irritation: Category 2B
 Respiratory Sensitization: Category 1A
 Carcinogenicity: Category 1A
 Reproductive Toxicity: Category 1A
 Target Organ- Prolonged: Category 1 (Nervous Systems)

2.2 Label Elements

Signal Word: DANGER



Symbol(s):

Hazard Statements:

Causes skin and eye irritation. May cause eye damage. May cause allergy or asthma symptoms, breathing difficulties, changes in body temperature, metal fume fever, nausea, vomiting, diarrhea or headache if inhaled. May cause cancer. May damage fertility or the unborn child. Causes damage to the nervous system through prolonged or repeated exposure.

Precautionary Statements:

Prevention: Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Wear protective gloves, protective clothing, eye protection, and face protection. Wash thoroughly after handling. Do not breathe dust, fume, vapors, and spray. In case of inadequate ventilation, wear respiratory protection. Do not eat, drink, or smoke when using this product.

Response: If on skin, wash with plenty of water. If skin irritation occurs, get medical advice and/or attention. Take off contaminated clothing and wash it before reuse. If in eyes, rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists, get medical advice and/or attention. If inhaled and breathing is difficult, remove person to fresh air and keep comfortable for breathing. If experiencing respiratory symptoms, call a doctor. If exposed or concerned, get medical advice and/or attention. Get medical advice and/or attention if you feel unwell. In case of fire: Use dolomite, dry powder for metal fires, dry sand, graphite, soda ash, sodium chloride to extinguish.

Storage: Store locked up. Store in a dry place. Store in a closed container.

Disposal: Dispose of contents in accordance with local, regional, national, and international regulations.

2.3 Other Hazards

Negligible fire and explosion hazard in bulk form. Dust/air mixtures may ignite or explode.

2.4 Unknown Acute Toxicity

Does not apply to this product.

Section 3: Composition / Information on Ingredients

3.1 Composition

Chemical Name: Manganese, Metallurgical-Grade Ore
Composition: 20.7% Mn (wtd. av.)

The health and physical hazards information provided in this SDS are for its major component. Manganese Metallurgical-Grade Ore contains other elements in addition to Mn. For concentrations of other components, see the Certificates of Analysis for each lot.

3.2 Common Names/Synonyms

Synonyms: See **Section 1.2** for common names and synonyms.

3.3 CAS Number/Unique Identifiers

CAS Number: 7439-96-5 (for Manganese)

3.4 Impurities/Stabilizing Additives

No data available.

Section 4: First-Aid Measures

4.1 Description of First-Aid Measures

Inhalation:	If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. Get immediate medical attention.
Skin Contact:	Wash skin with soap and water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention, if needed. Thoroughly clean and dry contaminated clothing and shoes before reuse.
Eye Contact:	Flush eyes with plenty of water for at least 15 minutes. Get immediate medical attention.
Ingestion:	If a large amount is swallowed, get medical attention.

4.2 Most Important Symptoms/Effects, Acute and Delayed

Inhalation (Acute):	Irritation, changes in body temperature, metal fume fever, nausea, vomiting, diarrhea, chest pain, difficulty breathing, headache
Inhalation (Chronic):	Irritation, cough, loss of appetite, weight loss, chest pain, difficulty breathing, disorientation, difficulty speaking, sleep disturbances, emotional disturbances, hallucinations, mood swings, tremors, muscle cramps, loss of coordination, hearing loss, visual disturbances, bluish skin color, lung congestion, lung damage, blood disorders, kidney damage, liver damage, nerve damage, and cancer.
Skin Contact (Acute):	Irritation.
Skin Contact (Chronic):	Irritation and skin disorders.
Eye Contact (Acute):	Irritation, eye damage.
Eye Contact (Chronic):	Irritation, eye damage.
Ingestion (Acute):	Gastrointestinal irritation, nausea, vomiting, and diarrhea.
Ingestion (Chronic):	Drowsiness.

4.3 Indication of Immediate Medical Attention/Special Treatment

Seek immediate medical attention if inhaled, exposed to eyes, and/or ingested.

Section 5: Fire Fighting Measures

5.1 Suitable Extinguishing Media

Dolomite, dry powder for metal fires, dry sand, graphite, soda ash, and sodium chloride.

5.2 Specific Hazards

Negligible fire and explosion hazard in bulk form. Dust/air mixtures may ignite or explode.

5.3 Special Protective Equipment and Precautions

Protect container from physical damage. Move container from fire area if it can be done without risk. Cool containers with water spray until well after the fire is out. Stay away from the ends of tanks. For fires in cargo or storage area: Cool containers with water from unmanned hose holder or monitor nozzles until well after fire is out. If this is impossible then take the following precautions: Keep unnecessary people away, isolate hazard area and deny entry. Let the fire burn. Use extinguishing agents appropriate for surrounding fire. Avoid inhalation of material or combustion by-products.

Section 6: Accidental Release Measures

6.1 Personal Precautions, Protective Equipment, and Emergency Procedures

Subject to California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65). Notify Local Emergency Planning Committee and State Emergency Response Commission for release greater than or equal to RQ (U.S. SARA Section 304). If release occurs in the U.S. and is reportable under CERCLA Section 103, notify the National Response Center at (800) 424-8802 (USA) or (202) 426-2675 (USA). Keep out of water supplies and sewers. Keep all unauthorized people away, isolate hazard area, and deny entry. Personal protective equipment is discussed in **Section 8.3**.

6.2 Methods and Materials for Containment and Cleaning Up

Collect spilled material in appropriate container for disposal.

Section 7: Handling and Storage

7.1 Precautions for Safe Handling

Use methods to minimize dust. High standard of personal cleanliness and hygiene is essential. Adequate sanitary facilities, clothing, and time must be provided so that compulsory showering after work is completed. A change of clothes and ban on eating and smoking at work place can be effective. Personal protective equipment is discussed in **Section 8.3**.

7.2 Conditions for Safe Storage

Store in accordance with all current regulations and standards. See original container for storage recommendations. Keep separated from incompatible substances. Incompatible materials are identified in **Section 10.5**.

Section 8: Exposure Controls / Personal Protection

8.1 Exposure Limits

Exposure Limits: Manganese, Metallurgical

If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a time weighted average (TWA) for that day, shall be reduced according to the following formula: Maximum permissible limit (in ug/m³)=400 divided by hours worked in the day.

Manganese, Manganese and Compounds (as Mn)

OSHA PEL Ceiling:	5 mg/m ³ (metal) (fume) (compounds)
OSHA TWA (particulate)	(vacated by 58 FR 35338, June 30, 1993)
OSHA STEL (particulate)	(vacated by 58 FR 35338, June 30, 1993)
ACGIH TWA (2013):	0.02 mg/m ³ (metal and inorganic compounds) (respirable fraction)
ACGIH TWA:	0.1 mg/m ³ (metal and inorganic compounds) (inhalable fraction)
NIOSH REL TWA (10 hours):	1 mg/m ³ (metal) (fume) (compounds)
NIOSH REL STEL:	3 mg/m ³ (metal) (fume) (compounds)
DFG MAK:	0.5 mg/m ³ (inhalable fraction) (metal and inorganic compounds)
UK WEL TWA:	0.5 mg/m ³ (metal) (inorganic compounds)

ACGIH Excursion Limit Recommendation: Excursions in worker exposure levels may exceed 3 times the TLV-TWA for no more than a total of 30 minutes during a work day, and under no circumstances should they exceed 5 times the TLV-TWA, provided that the TLV-TWA is not exceeded.

Measurement method: NIOSH IV #7300, 7301, 7303, 9102; OSHA #ID121, ID135G

Iron Oxide Dust and Fume (as Fe):

OSHA TWA:	10 mg/m ³
ACGIH TWA:	5 mg(Fe ₂ O ₃)/m ³ (total particulate)
NIOSH TWA:	5 mg/m ³ 10 hour(s) (total particulate)
DFG MAK:	1.5 mg/m ³ (respirable fraction)
UK WEL TWA:	5 mg/m ³
UK WEL STEL:	10 mg/m ³

Measurement method: NIOSH IV# 7300, 7301, 7303, 9102; OSHA # ID121, ID125G

Aluminum Oxide (Alumina):

OSHA TWA:	5 mg/m ³ (respirable dust fraction)
OSHA TWA:	15 mg/m ³ (total dust)
OSHA TWA:	10 mg/m ³ (total particulate) (vacated by 58 FR 35338, June 30, 1993)
ACGIH TWA:	1 mg/m ³ (respirable fraction) (insoluble compounds)
DFG MAK:	1.5 mg/m ³ (respirable dust fraction)
DFG MAK:	4 mg (AL)/m ³ (inhalable dust fraction)
AGS TRK:	0.25 fibers/cc (fibrous forms) (effective 1 Jan 2005 no longer valid per

amendment)
 UK WEL TWA: 10 mg/m³ (total inhalable dust)
 UK WEL TWA: 4 mg/m³ (respirable dust)

Measurement Method: NIOSH IV #0500, 0600; OSHA ID109SG, ID198SG

Silicon Dioxide, Amorphous (Silica, Amorphous):

OSHA TWA: 20 mppcf (<1% crystalline silica)
 OSHA TWA: 80 mg/m³ divided by %SiO₂ (<1% crystalline silica)
 NIOSH recommended TWA: 6 mg/m³ recommended TWA 10 hr.(s)
 DFG MAK: 0.3 mg/m³ (respirable fraction)
 DFG MAK: 4 mg/m³ (inhalable fraction)
 UK WEL TWA: 6 mg/m³ (total inhalable dust)
 UK WEL TWA: 2.4 mg/m³ (respirable dust)

Measurement Method: NIOSH IV #7501

Lead, Inorganic Fumes and Dust (as Pb):

OSHA TWA (8 hours): 50 µg/m³
 OSHA Action Level: 30 µg/m³
 ACGIH TWA: 0.05 mg/m³ (metal and inorganic compounds)
 NIOSH TWA: 0.050 recommended TWA 10 hour(s) (metal and compounds)
 ED OEL TWA (BOELV): 0.15 mg/m³

Measurement Method: NIOSH IV # 7082, 7105, 7300, 7301, 7303, 7700, 7701, 7702, 9102, 9105; OSHA ID121, ID 125G, ID206 .

8.2 Appropriate Engineering Controls

Ventilation: Provide local exhaust ventilation system. Ensure compliance with applicable exposure limits.

8.3 Individual Protection Measures

Eye Protection: Wear splash resistant safety goggles. Provide an emergency eyewash fountain and quick drench shower in the immediate work area.

Clothing: Wear appropriate chemical resistant clothing.

Gloves: Wear appropriate chemical resistant gloves.

Respirator: Under conditions of frequent use or heavy exposure, respiratory protection may be needed. Respiratory protection is ranked in order from minimum to maximum. Consider warning properties before use.

high-

1. Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering face pieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100 or P100.
2. Any air powered, air-purifying respirator with high-efficiency particulate filter.
3. Any powered, air-purifying respirator with a tight-fitting face piece and a efficiency particulate filter.
4. Any powered air-purifying respirator with a full face piece that is operated in a pressure-demand or other positive pressure mode.

Unknown Concentrations/IDLH:

1. Any self-contained breathing apparatus that has a full face piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode.
2. Any supplied-air respirator that has a full face piece and is operated in a pressure-demand or other positive-pressure mode.

Section 9: Physical and Chemical Properties

- 9.1 Appearance**
Physical State: Solid
Physical Description: Reddish-gray or silvery, brittle, metallic solid
- 9.2 Odor**
No data available.
- 9.3 Odor Threshold**
No data available.
- 9.4 pH**
Not applicable.
- 9.5 Melting/Freezing Points**
Melting Point: No data available.
Freezing Point: No data available.
- 9.6 Initial Boiling Point and Boiling Range**
Not applicable.
- 9.7 Flash Point**
No data available.
- 9.8 Evaporation Rate**
Not applicable.
- 9.9 Flammability**
No data available.
- 9.10 Upper/Lower Explosive Limits**
No data available.
- 9.11 Vapor Pressure**
Not applicable.
- 9.12 Vapor Density**
Not applicable.
- 9.13 Relative Density**
No data available.
- 9.14 Water Solubility(ies)**
Insoluble.
- 9.15 Partition Coefficient**
No data available.
- 9.16 Auto-Ignition Temperature**
No data available.
- 9.17 Decomposition Temperature**
No data available.
- 9.18 Viscosity**
No data available.
- 9.19 Solvent Solubility:**

Soluble: mineral acids

Section 10: Stability and Reactivity

10.1 Reactivity

Stable at normal temperatures and pressure.

10.2 Chemical Stability

Stable at normal temperatures and pressures.

10.3 Possibility of Hazardous Reactions

Manganese

Aluminum (Dust):	Forms explosive mixtures with air.
Ammonium Nitrate (Fused):	Violent or explosive reaction.
Bromine Pentafluoride:	Violent reaction and possible ignition.
Carbon Dioxide:	Ignites.
Chlorine:	Ignites.
Fluorine:	Incandescent reaction.
Hydrogen Peroxide:	Violent decomposition and/or ignition.
Nitric Acid:	Incandescent reaction and feeble explosion.
Nitrogen Dioxide:	Ignition.
Oxidizers (Strong):	Fire and explosion hazard.
Phosphorus:	Incandescent reaction when heated.
Sulfur Dioxide:	Burns brilliantly on warming.

Iron

Acetaldehyde:	Polymerizes readily
Ammonium Nitrate:	Violent or explosive reaction.
Ammonium Peroxodisulfate:	Violent reaction.
Bromine Pentafluoride:	Violent reaction and possible ignition.
Chloric Acid:	Forms explosive compound.
Chlorine (Gas):	Ignites.
Chlorine Trifluoride:	Violent reaction and possible ignition.
Chloroformamidinium Nitrate:	Explosive ignition.
Dinitrogen Tetraoxide:	Ignites.
Fluorine:	Ignites.
Hydrogen Peroxide:	Violent decomposition.
Mineral Acids:	Readily attacked.
Nitrogen Dioxide:	Incandescent reaction.
Nitryl Fluoride:	Incandesces when heated.
Organic Acids:	Attacked or dissolved.
Peroxyformic Acid:	Incompatible.
Phosphorus:	Incandesces when heated
Polystyrene Beads:	Possible static ignition.
Potassium Dichromate:	Ignites on contact.
Potassium Perchlorate + Manganese Dioxide:	Ignites.
Sodium Acetylde:	Possible violent reaction.
Sodium Peroxide:	Ignites under friction @ 240 C.
Sulfuric Acid:	Possible explosion hazard.
Aluminum Oxide (Alumina)	
Chlorinated Rubber (Hot):	Incompatible.
Chlorine Trifluoride:	Violent reaction and possible ignition.
Ethylene Oxide:	May initiate explosive polymerization.
Halocarbons:	Exothermic reaction above 200 C.
Halocarbons + Metals:	Exothermic reaction at ambient temperatures.
Oxygen Difluoride:	Exothermic reaction.

Sodium Nitrate:	May form explosive mixture.
Vinyl Acetate:	Possible vigorous reaction.
Silicon Dioxide	
Chlorine Trifluoride:	Fire hazard.
Fluorine:	Fire hazard.
Hydrochloric Acid + Water:	Explosion hazard with gel form.
Hydrofluoric Acid:	Dissolves, releasing silicon tetrafluoride.
Hydrogen Fluoride:	Incompatible.
Hydrogenated Vegetable Oils:	Incompatible.
Magnesium (Powdered):	Explosion hazard on heating in the presence of moisture.
Manganese Trifluoride:	May react violently on heating, releasing silicon tetrafluoride
Oxidizers (strong):	Fire and explosion hazard.
Oxygen Difluoride:	Explosion hazard under certain conditions and in the presence of moisture.
Ozone:	Potential explosion hazard at low temperatures if organic material is present.
Phosphoric Acid (concentrated):	Attacks on heating.
Sodium (burning):	Reacts with finely divided silica.
Vinyl Acetate (Vapor):	May react vigorously with gel form.
Xenon Hexafluoride:	May react explosively by forming xenon trioxide.

10.4 Conditions to Avoid

None reported.

10.5 Incompatible Materials

Metals, oxidizing materials, halogens, peroxides, combustible materials, acids, bases, halocarbons, metal salts.

Safe storage of the material is discussed in **Section 7.2**.

10.6 Hazardous Decomposition Products

Thermal Decomposition Products: Miscellaneous Decomposition Products

10.7 Polymerization

Will not polymerize.

Section 11: Toxicological Information

11.1 Likely Routes of Exposure

Routes of entry include inhalation, skin contact, eye contact, and ingestion.

11.2 Symptoms

See **Section 4.2** for symptoms related to the physical, chemical, and toxicological characteristics.

11.3 Short and Long Term Effects

Inhalation (Aluminum Oxide,
Alumina):

Inhalation of high concentrations may cause coughing, shortness of breath, respiratory tract irritation due to mechanical action, unpleasant deposits in the nasal passages, and exacerbation of symptoms in persons with impaired pulmonary function. Humans exposed chronically to aluminum oxide, particle size approximately 1.2 microns, did not experience either systemic or respiratory adverse effects. Hydrated aluminum oxide, injected intratracheally, produced dense and numerous nodules of advanced fibrosis in rates, a reticulin network with occasional collagen fibers in mice and Guinea pigs, and only a slight reticulin network in rabbits. A production process in which aluminum oxide (bauxite), iron, coke, and silica are fused at 2000 C poses a threat of Shaver's disease, a rapidly progressive and often fatal interstitial fibrosis of the lungs. See information on metal fume fever.

Acute Exposure (Manganese):

Dust or fumes may be irritating to the mucous membranes. Occupational

exposure to dust or fumes has been reported to cause upper respiratory tract problems, black mucous membrane discharge from the nose, and neurological damage. Metal fume fever, an influenza-like illness, may occur due to the inhalation of freshly formed metal oxide particles sized below 1.5 microns and usually between 0.02-0.05 microns. Symptoms may be delayed 4-12 hours and begin with a sudden onset of thirst, and a sweet, metallic or foul taste in the mouth. Other symptoms may include upper respiratory tract irritation accompanied by coughing and a dryness of the mucous membranes, lassitude and a generalized feeling of malaise. Fever, chills, muscular pain, mild to severe headache, nausea, occasional vomiting, exaggerated mental activity, profuse sweating, excessive urination, diarrhea and prostration may also occur. Tolerance to fumes develops rapidly, but is quickly lost. All symptoms usually subside within 24-36 hours.

Acute Exposure (Iron):

Dust may cause mucous membrane and respiratory irritation due to mechanical action. Metal fume fever, an influenza-like illness, may occur due to the inhalation of freshly formed iron oxide particles sized below 1.5 microns and usually between 0.02 and 0.05 microns. Symptoms may be delayed 4-12 hours and begin with a sudden onset of thirst, and a sweet, metallic or foul taste in the mouth. Other symptoms may include upper respiratory tract irritation accompanied by coughing and a dryness of the mucous membranes. Lassitude and a generalized feeling of malaise. Fever, chills, muscular pain, mild to severe headache, nausea, occasional vomiting, exaggerated mental activity, profuse sweating, excessive urination, diarrhea, and prostration may also occur. Tolerance to fumes develops rapidly, but is quickly lost. All symptoms usually subside within 24-36 hours.

Acute Exposure (Metal Fume Fever):

Metal fume fever, an influenza-like illness, may occur due to the inhalation of freshly formed metal oxide particles sized below 1.5 microns and usually between 0.02-0.05 microns. Symptoms may be delayed 4-12 hours and begin with a sudden onset of thirst, and a sweet, metallic or foul taste in the mouth. Other symptoms may include upper respiratory tract irritation accompanied by coughing and a dryness of the mucous membranes. Lassitude and a generalized feeling of malaise. Fever, chills, muscular pain, mild to severe headache, nausea, occasional vomiting, exaggerated mental activity, profuse sweating, excessive urination, diarrhea, and prostration may also occur. Tolerance to fumes develops rapidly, but is quickly lost. All symptoms usually subside within 24-36 hours.

Acute Exposure (Silicon Dioxide):

Dusts may cause irritation of the respiratory tract and coughing.

Acute Exposure (Quartz):

Exposure to high concentrations may cause physical discomfort of the upper respiratory tract.

Chronic Exposure (Manganese):

If sufficient quantities of manganese dust or fumes are inhaled and absorbed, systemic poisoning known as "manganism", a Parkinsonian-like syndrome may occur. It is characterized initially by anorexia, asthenia, headache, insomnia or somnolence, irritability, restlessness, and spasm or pain in the muscles. Manganese psychosis may follow with uncontrollable behavior, unaccountable laughing or crying, visual hallucinations, confusion and euphoria. Sexual excitement followed by impotence may occur. These symptoms may disappear with the onset of true neurological manifestations of slow, slurred and irregular speech, monotonous tone, double vision, impaired hearing, and difficulty with fine motor movements, and disturbances in gait and balance with frequent propulsion or retropulsion. Mask-like face, decreased movement of the eyelids and eyes and tremors of the upper extremities and head may also occur. Other signs and symptoms may include urinary bladder disturbances, excessive salivation and sweating, hematological changes, vasomotor disorders, decreased pulmonary function, kidney and possibly liver damage. Removal from exposure shortly after onset of symptoms usually results in improvement, although there may be residual disturbances in gait and speech. Once manganism is well established it becomes irreversible and progressive, but not fatal. An increased incidence of bronchitis and pneumonitis has been reported in studies of workers exposed to manganese dust and fume, and although these effects have been confirmed by animal

Chronic Exposure (Iron):	experiments, they may represent an aggravation of a pre-existing condition. Allergic diseases of the respiratory tract have also been reported in one study. Prolonged or repeated exposure may cause a mottling of the lungs, a condition called siderosis which is considered to be a benign pneumoconiosis that does not cause significant physiologic impairment. Symptoms may include chronic bronchitis, emphysema, and dyspnea on exertion.
Chronic Exposure (Metal Fume Fever):	There is no form of chronic metal fume fever, however, repeated bouts with symptoms as described above are quite common. Resistance to the condition develops after a few days of exposure, but is quickly lost in 1 or 2 days.
Chronic Exposure (Silicon Dioxide):	Exposure to dusts of crystalline or amorphous silica for 6 months to 30 years may result in silicosis with symptoms of cough, chest pain, dyspnea, tachypnea, marked weakness and weight loss. The pulmonary insufficiency may be characterized by diffuse nodular fibrosis, distortion of bronchi, diminished chest expansion, decreased vital capacity and compensatory and bullous emphysema. Although pulmonary fibrosis has been reported from workers exposed to amorphous silica, the crystalline form is the established cause of fibrotic response in the lung. However, the amorphous form has been reported fibrogenic to a lesser extent. As the disease progresses, cor pulmonale, cardiorespiratory failure, and death may occur. Various forms and preparations of crystalline silica produced adenocarcinomas and squamous cell carcinomas of the lungs in rats.
Chronic Exposure (Quartz):	Inhalation of very high concentrations of finely divided crystalline silica dust, exposure ranging from a few weeks to 4-5 years, may cause a rapidly developing silicosis, characterized by pulmonary insufficiency with severe dyspnea, violent coughing, tachypnea, weight loss, and cyanosis leading to the development of cor pulmonale and death within a relatively short period of time. A slowly developing silicosis may result from exposure for 6 months-30 years relatively low levels of the dust. The first symptom is usually a slowly increasing, non-disabling, exertional dyspnea due to pulmonary fibrosis and the emphysema associated with it. Continued exposures may increase the rate of progression of the disease. Also, the fibrogenic action may continue when exposure ceases. As the fibrosis advances, other symptoms may include shortness of breath, productive cough, wheezing, chest tightness or pain, marked weakness, decreased capacity for work, and repeated non-specific chest illnesses. Cyanosis, clubbing of digits, orthopnea, or serious weight loss are not usually evident until the disease is advanced. Pulmonary infections, which may be indicated by hemoptysis, and cardiac decompensation may exacerbate the symptoms. Three major complications, which are the most frequent causes of death, are pulmonary tuberculosis, respiratory insufficiency which is due to the massive emphysematous and fibrotic changes and is sometimes accompanied by chronic cor pulmonale, and acute bronchopulmonary risk for dying from lung cancer. This increase has been seen among miners, quarry workers, foundry workers, ceramic workers, granite workers, and stonecutters. In some of these studies, the risk of lung cancer increased with the duration of employment. Various forms and preparations of crystalline silica produced adenocarcinomas and squamous cell carcinomas of the lungs in rats.
Skin Contact	
Acute Exposure (Manganese):	500 mg applied to the skin of rabbits caused mild irritation.
Acute Exposure (Iron):	Dust may cause irritation. Penetration of iron particles in the skin may cause an exogenous siderosis which may be characterized by a red-brown pigmentation of the affected area.
Acute Exposure (Aluminum Oxide, Alumina):	Contact may cause an irritant dermatitis accompanied by pruritus.
Acute Exposure (Silicon Dioxide):	Prolonged skin contact with dry particulate may cause drying of the skin.
Acute Exposure (Quartz):	May cause irritation of intact skin due to mechanical abrasion. If the skin is abraded, a heavy growth of scar tissue may be induced.

Chronic Exposure (Manganese):	Sensitization has been reported in guinea pigs.
Chronic Exposure (Iron):	May cause same effects as reported in acute exposure.
Chronic Exposure (Aluminum Oxide, Alumina):	No data available.
Chronic Exposure (Silicon Dioxide):	No data available.
Chronic Exposure (Quartz):	No data available.
Eye Contact	
Acute Exposure (Manganese):	Dust or fumes may be irritating to the eyes. 500 mg applied to the eyes of rabbits caused mild irritation.
Acute Exposure (Iron):	May cause irritation due to mechanical action. Iron particles imbedded in the eye may cause ocular siderosis. Effect may include discoloration of the cornea and iris, and pupillary effects including poor reaction to light and accommodation. If particle enters the lens there may be cataract formation. Glaucoma occurs rarely in some cases of ocular siderosis.
Acute Exposure (Aluminum Oxide, Alumina):	Dust may cause mechanical irritation with redness and possibly swelling of the conjunctiva.
Acute Exposure (Silicon Dioxide):	Dusts may cause irritation with redness and pain.
Acute Exposure (Quartz):	May cause irritation due to mechanical action. Particles of silica in the range of 2-3 micrometers introduced into the corneal stroma of rabbit eyes caused very little reaction. These same particles introduced into the anterior chamber resulted in an inflammatory reaction in 3-5 weeks with the formation of fibrotic nodules in the iridocorneal angle. Finely divided silica injected into the vitreous of rabbit eyes has caused necrosis of the retina and atrophy of the choroid.
Chronic Exposure (Manganese):	Fumes may cause conjunctivitis.
Chronic Exposure (Iron):	Repeated or prolonged contact may cause conjunctivitis and other effects reported in acute exposure.
Chronic Exposure (Aluminum Oxide, Alumina):	No data available.
Chronic Exposure (Silicon Dioxide):	No data available.
Chronic Exposure (Quartz):	An abnormally high silicon content in the cornea, and a gradual decrease in visual acuity due to corneal opacities in the pupillary area, have been reported in a group of foundry workers.
Ingestion	
Acute Exposure (Manganese):	Extremely large doses may cause gastrointestinal irritation and possibly systemic toxicity.
Acute Exposure (Iron):	There are no reports available on poisoning from metallic iron, which is poorly absorbed. The principal manifestations of poisoning with iron compounds are vomiting, diarrhea, and circulatory collapse.
Acute Exposure (Aluminum Oxide, Alumina):	Not data available.
Acute Exposure (Silicon Dioxide):	The effects of ingestion are purely mechanical as the substance is inert chemically and biologically.
Acute Exposure (Quartz):	Effects of ingestion are due to mechanical action as crystalline silicas are biologically inert.
Chronic Exposure (Manganese):	Manganese poisoning has been reported in persons drinking manganese-contaminated well water. Prolonged ingestion of manganese in water has produced lethargy, edema, and decreased movement of the eyes and eyelids.
Chronic Exposure (Iron):	Repeated or prolonged exposure may cause hemosiderosis or hemochromatosis.
Chronic Exposure (Aluminum Oxide, Alumina):	Some aluminum compounds cause constipation.
Chronic Exposure (Silicon Dioxide):	No data available.
Chronic Exposure (Quartz):	No data available.

11.4 Numerical Measures of Toxicity

Manganese

Format: GHS

Language: English (US)

Revised: April 24, 2015

Version 2

Irritation Data:	500 mg/24 hour(s) skin-rabbit mild 500 mg/24 hour(s) eyes-rabbit mild
Toxicity Data:	2,300 µg/m ³ inhalation-man TCL ₀ ; 9 gm/kg oral-rat LD ₅₀ ; 3,709 mg/m ³ /6 hour(s)-13 week(s) intermittent inhalation-rat TCL ₀ ; 180 mg/kg/30 day(s) intermittent intraperitoneal-rat TDL ₀ ; 210 µg/m ³ /5 year(s) intermittent inhalation-man TCL ₀ ; 0.3 mg/m ³ /5 hour(s)-26 week(s) intermittent inhalation-rat TCL ₀ ; 0.3 mg/m ³ /5 hour(s)-26 week(s) intermittent inhalation-monkey TCL ₀ ; 0.7 mg/m ³ /24 hour(s)-22 week(s) continuous inhalation-rat TCL ₀ ; 0.7 mg/m ³ /24 hour(s)-22 week(s) continuous inhalation-mouse TCL ₀ ; 250 mg/m ³ /1 year(s) intermittent inhalation-human TCL ₀ ; 0.5 mg/m ³ /39 week(s) intermittent inhalation-human TCL ₀ ; 200 mg/kg/20 day(s) intermittent oral-rat TDL ₀ ; 216 mg/kg/15 week(s) intermittent intraperitoneal-rat TDL ₀ ; 144 mg/kg/5 week(s) intermittent intraperitoneal-rat TDL ₀ ; 24 mg/kg/5 week(s) intermittent unreported-rat TDL ₀ ; 72 mg/kg/5 week(s) intermittent unreported-rat TDL ₀ ; 57.6 mg/kg/4 week(s) intermittent intraperitoneal-rat TDL ₀ ; 0.71 mg/m ³ /2 hour(s)-10 day(s) intermittent inhalation-rat; 5.25 mg/kg/21 day(s) intermittent oral-rat; 185 mg/kg/37 day(s) continuous oral-rat TDL ₀
Acute Toxicity Level:	Slightly Toxic (ingestion)
Target Organs:	Nervous System
Conditions Aggravated By Exposure:	History of alcoholism, blood system disorders, liver disorders, nervous system disorders, and respiratory disorders.
Tumorigenic Data:	400 mg/kg intramuscular-rat TDL ₀ /1 year(s) intermittent
Mutagenic Data:	Dominant lethal test - rat intraperitoneal 25 mg/kg
Reproductive Effects Data:	50 mg/kg oral-rat TDL ₀ 20 day(s) post pregnancy continuous; 322.5 mg/kg oral-mouse TDL ₀ 43 day(s) male; 1,290 mg/kg oral-mouse TDL ₀ 43 day(s) male; 0.71 mg/m ³ inhalation-rat TCL ₀ 15-16 day(s) pregnant female continuous; 0.71 mg/m ³ inhalation-rat TCL ₀ multigenerations; 90 mg/kg oral-rat TDL ₀ 18 day(s) post pregnancy continuous
Additional Data:	Symptoms may depend on a combination of contributing factors including genetic predisposition, age, nutrition, anemia or alcohol.
Iron	
Toxicity Data:	77 mg/kg oral-child TCL ₀ ; 30 gm/kg oral-rat LD ₅₀ ; 20 mg/kg intraperitoneal-rabbit LD ₅₀ ; 20 gm/kg oral-guinea pig LD ₅₀ ; 200 mg/kg oral-human LD ₅₀ ; 63 gm/kg/6 week(s) continuous oral-rat TCL ₀ ; 250 mg/m ³ /6 hour(s)-4 week(s) intermittent inhalation-rat TCL ₀ ; 150 mg/m ³ /4 hour(s)-78 week(s) intermittent inhalation-rat TCL ₀ ; 105 mg/kg/5 week(s) continuous oral-rat TCL ₀ ; 16800 mg/kg/4 week(s) continuous oral-rat TDL ₀ ; 41.4 mg/kg/2 week(s) intermittent subcutaneous-mouse TDL ₀ ; 219.6 gm/kg/183 day(s) continuous oral-rat TDL ₀
Carcinogen Status:	Iron itself has not been evaluated by IARC. However iron and steel founding has been evaluated as IARC Group 1 (Human Sufficient Evidence). Studies have shown that certain exposures in iron and steel founding can cause lung cancer in humans. Excesses of leukemia and urogenital and digestive system cancers have also been reported.
Acute Toxicity Level:	Relatively Non-Toxic (ingestion)
Tumorigenic Data:	450 mg/kg intratracheal-rat TDL ₀ /15 weeks intermittent
Aluminum Oxide	
Toxicity Data:	>3600 mg/kg intraperitoneal-mouse LD ₅₀ ; 200 mg/m ³ /5 hour(s)-28 week(s) intermittent inhalation-rat TCL ₀ ; 200 mg/m ³ /5 hour(s)-28 weeks intermittent inhalation-rabbit
Carcinogen Status:	ACGIH; A4-Not Classifiable as a Human Carcinogen (Aluminum insoluble compounds)
Medical Conditions Aggravated by Exposure:	Respiratory disorders
Tumorigenic Data:	90 mg/kg intrapleural-rat TDL ₀ ; 200 mg/kg implant-rat TDL ₀ ; 200 mg/kg implant-rat TD

Silicon Dioxide**Toxicity Data:**

>200 gm/m³/1 hour(s) inhalation-rat LC; 1 mg/kg intratracheal-rat TDLo; 224 mg/kg/4 week(s) continuous oral-dog TDLo

Carcinogen Status:

Human Inadequate Evidence, Animal Inadequate Evidence, Group 3 (Amorphous silica)

Medical Conditions Aggravated by Exposure:

Respiratory disorders

Quartz**Toxicity Data:**

16 mppcf/8 hour(s)-17.9 year(s) intermittent inhalation-human TCLo; 300 ug/m³/10 year(s) intermittent inhalation-human LCLo; 90 mg/kg intravenous-rat LDLo; 200 mg/kg intratracheal-rat LDLo; 40 mg/kg intravenous mouse LDLo; >20 mg/kg intratracheal-mouse LD; 20 mg/kg/ intravenous-dog LDLo; 200 mg/kg inhalation-rat TCLo; 250 mg/kg intratracheal-rat LDLo; 240 mg/kg/1 hour(s) intratracheal-rat TDLo; 1.5 mg/kg intratracheal-rat TDLo; 120 gm/kg oral-rat TDLo; 15.69 mg/kg intratracheal-rat TDLo; 16.7 mg/kg intratracheal-mouse TDLo; 40 mg/kg inhalation-mouse TDLo; 25 mg/kg intratracheal-rat TDLo; 20 mg/kg implant-rabbit TDLo; 80 mg/kg intratracheal-mouse TDLo; 150 mg/kg intratracheal-rat TDLo; 100 mg/kg intratracheal-rat TDLo; 100 mg/kg intratracheal-mouse TDLo; 1 mg/kg inhalation-rat TDLo; 10 mg/kg intratracheal-rat TDLo; 1250 ug/kg intratracheal-rat TDLo; 100 mg/kg intratracheal-rat TDLo; 30 mg/kg intratracheal rat TDLo; 50 mg/kg intratracheal-rat TDLo; 5 mg/kg intratracheal-rat TDLo; 1 mg/kg intratracheal-rat TDLo; 80 mg/ m³/26 weeks intermittent inhalation-rat TCLo; 108 mg/m³/6 hour(s)-3 day(s) intermittent inhalation-rat TCLo ; 58 mg/m³/13 week(s) intermittent inhalation-rat TCLo; 1475 ug/m³/8 hour(s)-21 week(s) intermittent inhalation-mouse TCLo; 4932 ug/m³/24 hour(s)- 39 week(s) continuous inhalation-mouse TCLo; 28 mg/m³/3 week(s) intermittent inhalation-guinea pig TCLo; 3 mg/m³/6 hour(s)-78 week(s) intermittent inhalation-hamster TCLo; 1000 gm/m³/10 day(s) intermittent inhalation-domestic animal TCLo; 2.88 mg/kg/12 week(s) intermittent intratracheal-rat TCLo; 11.52 mg/kg/12 week(s) intermittent intratracheal-rat TCLo; 15 mg/m³/26 week(s) intermittent inhalation-rat TCLo; 0.74 mg/m³/2 year(s) intermittent inhalation-rat TCLo; 10 mg/m³/75 day(s) intermittent inhalation-rat TCLo; 10 mg/m³/818 day(s) intermittent inhalation-monkey TCLo; 240 ug/m³/12 week(s) intermittent intratracheal-rat TCLo; 960 ug/kg/12 week(s) intermittent intratracheal rat TCLo; 160 mg/kg/2 week(s) intermittent inhalation-mouse TCLo; 6.2 mg/ m³/6 hour(s)-6 week(s) intermittent inhalation-rat TCLo; 15 mg/m³/79 day(s) intermittent inhalation-rat TCLo; 300 ug/kg/12 week(s) intermittent intratracheal rat TCLo; 25 mg/ m³/5 day(s) intermittent inhalation-rat TCLo

Carcinogen Status:

NTP: Known Human Carcinogen; IARC: Human Sufficient Evidence, Animal Sufficient Evidence, Group 1; ACGIH: A2- Suspected Human Carcinogen; EC: Category 2 Adenocarcinomas and squamous-cell carcinomas of the lung in rats were produced after inhalation or repeated intratracheal instillation of various forms of crystalline silica. Malignant lymphomas developed in rats after intrapleural and intraperitoneal injections of quartz suspensions and intrapleural injection of cristobalite and tridymite. Epidemiologic studies indicate lung cancer occurs more frequently among silicotics than in the general population.

Medical Conditions Aggravated By Exposure:

respiratory disorders

Tumorigenic Data:

50 mg/kg inhalation-rat TCLo/6 hour(s)-71 week(s) intermittent; 45 mg/kg intraperitoneal-rat TCLo; 90 mg/kg intravenous-rat TDLo; 90 mg/kg intrapleural-rat TDLo; 111 mg/kg intratracheal-rat TDLo; 100 mg/kg intratracheal-rat TDLo/19 weeks intermittent; 900 mg/kg implant-rat TDLo; 4000 mg/kg implant-mouse TDLo; 84 mg/kg intrapleural-hamster TDLo; 90 mg/kg intraperitoneal-rat TD/4 week(s) intermittent; 450 mg/kg intrapleural-rat TD; 100 mg/kg intrapleural-rat TD

Mutagenic Data:

Micronucleus test-human lung 40 ug/cm²; micronucleus test-hamster lung 160

Format: GHS

Revised: April 24, 2015

Language: English (US)

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Additional Data:	ug/cm ² ; DNA damage-rat intratracheal 3 mg/kg Smoking may enhance the toxic effects.
Lead Toxicity Data:	450 mg/kg/6 year(s) oral-woman TDLo; 10 ug/m ³ inhalation-human TCLo; 1 gm/kg intraperitoneal – rat LDLo; 160 mg/kg oral-pigeon LDLo; 271 mg/m ³ inhalation-human LCLo; 155 mg/kg oral-rat TDLo; 50 mg/kg intraperitoneal-rabbit TDLo; 88 mg/kg parenteral-chicken TDLo; 0.2 mg/kg oral-rat TDLo; 1050 ug/kg/30 week(s) intermittent oral-rat TDLo; 6879 mg/kg/5 week(s) continuous oral-mouse TDLo; 20 mg/m ³ /6 hour(s)-30 day(s) intermittent inhalation-guinea pig TCLo; 200 ug/m ³ /6 hour(s)-26 week(s) intermittent inhalation-guinea pig TCLo; 582 mg/kg/30 day(s) continuous oral-non-mammalian species TDLo; 4099.2 mg/kg/8 week(s) intermittent oral-mouse TDLo; 10248 mg/kg 20 week(s) intermittent oral-mouse TDLo; 9.9 mg/m ³ /122 day(s) intermittent inhalation-human TCLo; 0.011 mg/m ³ /26 week(s) intermittent inhalation-human TCLo; 0.012 mg/kg/10 day(s) intermittent unreported-rat TDLo; 120 mg/kg/60 day(s) intermittent unreported-horse, donkey TDLo; 93.6 mg/kg/30 day(s) continuous oral-rat TDLo; 0.03 mg/m ³ /1 year(s) intermittent inhalation-man TCLo; 0.03 mg/m ³ /5 year(s) intermittent inhalation-man TCLo; 0.109 mg/m ³ /5 year(s) intermittent inhalation-man TCLo; 43.75 mg/kg/1 week(s) continuous oral-rat TDLo;
Carcinogen Status:	IARC: Human Limited Evidence, Animal Inadequate Evidence, Group 2A (Inorganic lead compounds); ACGIH: A3-Confirmed Animal Carcinogen Renal tumors were produced in animals by lead acetate, lead subacetate, and lead phosphate given orally, subcutaneously, or intraperitoneally. Two studies in rats exposed to lead powder orally or by intramuscular injection and one study on intrarenal injection did not produce tumors.
Target Organs: Medical Conditions Aggravated By Exposure:	nervous system, kidneys, teratogen blood system disorders, gastrointestinal disorders, nervous system disorders, respiratory disorders
Mutagenic Data:	cytogenetic analysis- human unreported 50 ug/m ³ ; cytogenetic analysis – rat inhalation 23 ug/m ³ 16 week(s); cytogenetic analysis – monkey oral 42 mg/kg 30 week(s); DNA damage- human inhalation 4.2 ng/L 6 year(s) – intermittent
Reproductive Effects Data:	790 mg/kg oral-rat TCLo multigenerations; 1140 mg/kg oral-rat TCLo 14 day(s) pre pregnancy/21 day(s) post pregnancy continuous; 520 mg/kg oral-rat TCLo 7-22 day(s) pregnant female/10 day(s) post pregnancy continuous; 1100 mg/kg oral-rat TCLo 1-22 day(s) pregnant female continuous; 10 mg/m ³ inhalation-rat TCLo/24 hour(s) 1-21 day(s) pregnant female continuous; 3 mg/m ³ inhalation-rat TCLo/24 hour(s) 1-21 day(s) pregnant female continuous; 1120 mg/kg oral-mouse TCLo multigenerations; 6300 mg/kg oral-mouse TCLo 1-21 day(s) pregnant female continuous; 300 mg/kg oral-mouse TCLo 1-2 day(s) pregnant female continuous; 4800 mg/kg oral-mouse TCLo 1-16 day(s) pregnant female continuous; 662 mg/kg oral-domestic animal TCLo 1-21 week(s) pregnant female continuous; 814 mg/kg oral-domestic animal TCLo 15 day(s) post pregnancy continuous; 4099.2 mg/kg oral-mouse TCLo 56 day(s) male; 24 ug/kg oral-mouse TCLo multigenerations; 1545 gm/kg oral-rat TCLo 8 week(s) pre pregnancy/21 day(s) post pregnancy continuous.
Additional Data:	May cross the placenta. Smoking may result in higher blood lead levels. May be excreted in breast milk.

Section 12: Ecological Information

12.1 Ecotoxicity

No data available.

12.2 Persistence and Degradability

No data available.

12.3 Bioaccumulative Potential

No data available.

12.4 Mobility in Soil

No data available.

12.5 Other Adverse Effects

No data available.

Section 13: Disposal Considerations

Dispose in accordance with all applicable regulations. Hazardous Waste Number(s): D008. Dispose of in accordance with U.S. EPA 40 CFR 262 for concentrations at or above the regulatory level. Regulatory level-5.0 mg/L.

Section 14: Transport Information

14.1 UN Number

UN Number: Not applicable.

14.2 UN Proper Shipping Name

UN Proper Shipping Name: Not applicable.

14.3 Transport Hazard Class(es)

U.S. Department of Transportation:	No classification assigned.
CA Transportation/Dangerous Goods:	No classification assigned.
Land Transport ADR:	No classification assigned.
Land Transport RID:	No classification assigned.
Air Transport IATA:	No classification assigned.
Air Transport ICAO:	No classification assigned.
Maritime Transport IMDG:	No classification assigned.

14.4 Packing Group

No classification assigned.

14.5 Environmental Hazards

No data available.

14.6 Transport in Bulk

No data available.

14.7 Special Precautions

No data available.

Section 15: Regulatory Information

US Regulations

CERCLA 102A/103 (40 CFR 302.4): Lead: 10 lbs. RQ (solid metal particles < 100 micrometer diameter (0.004 inches))

SARA Title III	
Section 302 (40 CFR 355.30):	Not regulated.
Section 304 (40 CFR 355.40):	Not regulated.
Sections 311/312 (40 CFR 370.21):	Yes (Acute, Chronic)
Section 313 (40 CFR 372.65):	Yes (Aluminum Oxide (Alumina) (fibrous forms), Manganese and Compounds {as Mn}, lead)
OSHA Process Safety:	Not regulated.
State Regulations	
California Proposition 65:	Lead: Cancer (Oct 01, 1992); Developmental toxicity (Feb 27, 1987); Male reproductive toxicity (Feb 27, 1987); Female reproductive toxicity (Feb 27, 1987)
Canadian Regulations:	WHMIS Classification: Not determined.
European Regulations:	EC Classification (calculated): Not determined.
National Inventory Status	
U.S. Inventory (TSCA):	Listed on inventory.
TSCA 12(b) Export Notification:	Not listed.

Section 16: Other Information

The information in this Safety Data Sheet meets the requirements of the United States Department of Labor OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION and regulations promulgated thereunder (29 CFR 1910.1200 et. seq.). This document is intended only as a guide to the appropriate precautionary material handling by a person trained in, or supervised by a person trained in, chemical handling. Exposure to this chemical may have serious adverse health effects. This chemical may interact with other substances. Since the potential uses are so varied, all of the potential hazards of use or interaction with other chemicals or materials cannot be identified on this Safety Data Sheet. The user should recognize that this chemical can cause injury, especially if improperly handled, precautionary measures are not followed, and personal protective equipment not worn. Read and understand all precautionary information prior to use. The Defense Logistics Agency (DLA) shall not be held liable for any damage resulting from handling or from contact with the above chemical.

References:

ChemAdvisor, Inc. *Material Safety Data Sheet: Ferromanganese, High Carbon*. Revision Date: January 27, 2009.

American Conference of Governmental Industrial Hygienists. *2013 TLVs® and BEIs®*, ACGIH® Publication #0113. 2013.

US Department of Transportation. *Emergency Response Guidebook*. 2012

Centers for Disease Control and Prevention. *NIOSH Pocket Guide to Chemical Hazards*, <http://www.cdc.gov/niosh/npg/>.

National Institute of Health, Toxicology Data Network. <http://toxnet.nlm.nih.gov/>

NOTE: No data available: no data for this topic found using references listed.

Date of Preparation of Updated SDS: February 8, 2017