

SAFETY DATA SHEET

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name: UltraCore® 70C

Product Size: 3/32" (2.4 mm)

Other means of identification

SDS number: 200000000054

Recommended use and restriction on use

Recommended use: FCAW-G (Gas Shielded Flux Cored Arc Welding)

Restrictions on use: Not known. Read this SDS before using this product.

Manufacturer/Importer/Supplier/Distributor Information

Company Name: The Lincoln Electric Company
Address: 22801 Saint Clair Avenue
Cleveland, Ohio 44117
USA
Telephone: +1 (216) 481-8100
Contact Person: Safety Data Sheet Questions: www.lincolnelectric.com/sds
Arc Welding Safety Information: www.lincolnelectric.com/safety

Company Name: The Lincoln Electric Company of Canada LP
Address: 179 Wicksteed Avenue
Toronto, Ontario M4G 2B9
Canada
Telephone: +1 (416) 421-2600
Contact Person: Safety Data Sheet Questions: www.lincolnelectric.com/sds
Arc Welding Safety Information: www.lincolnelectric.com/safety

Emergency telephone number:

USA/Canada/Mexico +1 (888) 609-1762
Americas/Europe +1 (216) 383-8962
Asia Pacific +1 (216) 383-8966
Middle East/Africa +1 (216) 383-8969

3E Company Access Code: 333988

2. HAZARDS IDENTIFICATION

Classified according to the criteria of the Globally Harmonized System of Classification and Labeling of Chemicals (GHS), The United States Occupational Safety and Health Administration's Hazard Communication Standard (29 CFR 1910.1200), Canada's Hazardous Product Regulations and Mexico's Harmonized System for the Identification and Communication of Hazards and Risks from Hazardous Chemicals in the Workplace.

Hazard Classification Not classified as hazardous according to applicable GHS hazard classification criteria.

Label Elements

Hazard Symbol: No symbol
Signal Word: No signal word.
Hazard Statement: Not applicable
Precautionary Not applicable

Statements:
Other hazards which do not result in GHS classification:

Electrical Shock can kill. If welding must be performed in damp locations or with wet clothing, on metal structures or when in cramped positions such as sitting, kneeling or lying, or if there is a high risk of unavoidable or accidental contact with work piece, use the following equipment: Semiautomatic DC Welder, DC Manual (Stick) Welder, or AC Welder with Reduced Voltage Control.

Arc rays can injure eyes and burn skin. Welding arc and sparks can ignite combustibles and flammable materials. Overexposure to welding fumes and gases can be hazardous. Read and understand the manufacturer's instructions, Safety Data Sheets and the precautionary labels before using this product. Refer to Section 8.

Substance(s) formed under the conditions of use:

The welding fume produced from this welding electrode may contain the following constituent(s) and/or their complex metallic oxides as well as solid particles or other constituents from the consumables, base metal, or base metal coating not listed below.

| Chemical Identity | CAS-No. |
|-------------------|------------|
| Carbon dioxide | 124-38-9 |
| Carbon monoxide | 630-08-0 |
| Nitrogen dioxide | 10102-44-0 |
| Ozone | 10028-15-6 |
| Manganese | 7439-96-5 |

3. COMPOSITION / INFORMATION ON INGREDIENTS
Reportable Hazardous Ingredients Mixtures

| Chemical Identity | CAS number | Content in percent (%)* |
|--|------------|-------------------------|
| Iron | 7439-89-6 | 50 - <100% |
| Titanium dioxide (naturally occurring) | 13463-67-7 | 1 - <5% |
| Manganese | 7439-96-5 | 1 - <5% |
| Zircon | 14940-68-2 | 0.1 - <1% |
| Titanium dioxide (synthetic) | 13463-67-7 | 0.1 - <1% |
| Quartz | 14808-60-7 | 0.1 - <1% |
| Silicon dioxide (amorphous) | 7631-86-9 | 0.1 - <1% |
| Silicon | 7440-21-3 | 0.1 - <1% |
| Magnesium oxide | 1309-48-4 | 0.1 - <1% |
| Aluminum oxide | 1344-28-1 | 0.1 - <1% |
| Titanium | 7440-32-6 | 0.1 - <1% |
| Iron oxide | 1309-37-1 | 0.1 - <1% |
| Magnesium | 7439-95-4 | 0.1 - <1% |
| Calcium fluoride | 7789-75-5 | 0.1 - <1% |
| Zirconium oxide | 1314-23-4 | 0.1 - <1% |
| Sodium oxide | 1313-59-3 | 0.1 - <1% |

* All concentrations are percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

Composition Comments: The term "Hazardous Ingredients" should be interpreted as a term defined in Hazard Communication standards and does not necessarily imply the existence of a welding or allied process hazard. The product may contain additional non-hazardous ingredients or may form additional compounds under the condition of use. Refer to Sections 2 and 8 for more information.

4. FIRST AID MEASURES

Ingestion: Avoid hand, clothing, food, and drink contact with fluxes, metal fume or powder which can cause ingestion of particulate during hand to mouth activities such as drinking, eating, smoking, etc. If ingested, do not induce vomiting. Contact a poison control center. Unless the poison control center advises otherwise, wash out mouth thoroughly with water. If symptoms develop, seek medical attention at once.

Inhalation: Move to fresh air if breathing is difficult. If breathing has stopped, perform artificial respiration and obtain medical assistance at once.

Skin Contact: Remove contaminated clothing and wash the skin thoroughly with soap and water. For reddened or blistered skin, or thermal burns, obtain medical assistance at once.

Eye contact: Dust or fume from this product should be flushed from the eyes with copious amounts of clean, tepid water until transported to an emergency medical facility. Do not allow victim to rub or keep eyes tightly closed. Obtain medical assistance at once.

Arc rays can injure eyes. If exposed to arc rays, move victim to dark room, remove contact lenses as necessary for treatment, cover eyes with a padded dressing and rest. Obtain medical assistance if symptoms persist.

Most important symptoms/effects, acute and delayed

Symptoms: Short-term (acute) overexposure to fumes and gases from welding and allied processes may result in discomfort such as metal fume fever, dizziness, nausea, or dryness or irritation of nose, throat, or eyes. May aggravate pre-existing respiratory problems (e.g. asthma, emphysema). Long-term (chronic) overexposure to fumes and gases from welding and allied processes can lead to siderosis (iron deposits in lung), central nervous system effects, bronchitis and other pulmonary effects. Refer to Section 11 for more information.

Hazards: The hazards associated with welding and its allied processes such as soldering and brazing are complex and may include physical and health hazards such as but not limited to electric shock, physical strains, radiation burns (eye flash), thermal burns due to hot metal or spatter and potential health effects of overexposure to fumes, gases or dusts potentially generated during the use of this product. Refer to Section 11 for more information.

Indication of immediate medical attention and special treatment needed

Treatment: Treat symptomatically.

5. FIRE-FIGHTING MEASURES

General Fire Hazards: As shipped, this product is nonflammable. However, welding arc and sparks as well as open flames and hot surfaces associated with brazing and soldering can ignite combustible and flammable materials. Read and

understand American National Standard Z49.1, "Safety in Welding, Cutting and Allied Processes" and National Fire Protection Association NFPA 51B, "Standard for Fire Prevention during Welding, Cutting and Other Hot Work" before using this product.

Suitable (and unsuitable) extinguishing media

Suitable extinguishing media: As shipped, the product will not burn. In case of fire in the surroundings: use appropriate extinguishing agent.

Unsuitable extinguishing media: Do not use water jet as an extinguisher, as this will spread the fire.

Specific hazards arising from the chemical: Welding arc and sparks can ignite combustibles and flammable products.

Special protective equipment and precautions for fire-fighters

Special fire-fighting procedures: Use standard firefighting procedures and consider the hazards of other involved materials.

Special protective equipment for fire-fighters: Selection of respiratory protection for fire fighting: follow the general fire precautions indicated in the workplace. Self-contained breathing apparatus and full protective clothing must be worn in case of fire.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures: If airborne dust and/or fume is present, use adequate engineering controls and, if needed, personal protection to prevent overexposure. Refer to recommendations in Section 8.

Methods and material for containment and cleaning up: Absorb with sand or other inert absorbent. Stop the flow of material, if this is without risk. Clean up spills immediately, observing precautions in the personal protective equipment in Section 8. Avoid generating dust. Prevent product from entering any drains, sewers or water sources. Refer to Section 13 for proper disposal.

Environmental Precautions: Avoid release to the environment. Prevent further leakage or spillage if safe to do so. Do not contaminate water sources or sewer. Environmental manager must be informed of all major spillages.

7. HANDLING AND STORAGE

Precautions for safe handling: Prevent formation of dust. Provide appropriate exhaust ventilation at places where dust is formed.

Read and understand the manufacturer's instruction and the precautionary label on the product. Refer to Lincoln Safety Publications at www.lincolnelectric.com/safety. See American National Standard Z49.1, "Safety In Welding, Cutting and Allied Processes" published by the American Welding Society, <http://pubs.aws.org> and OSHA Publication 2206 (29CFR1910), U.S. Government Printing Office, www.gpo.gov.

Conditions for safe storage, including any incompatibilities: Store in closed original container in a dry place. Store in accordance with local/regional/national regulations. Store away from incompatible materials.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION**Control Parameters**

Occupational Exposure Limits: US

| Chemical Identity | Type | Exposure Limit Values | Source |
|---|---------|--|---|
| Titanium dioxide (naturally occurring) | IDLH | 5,000 mg/m ³ | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| Titanium dioxide (naturally occurring) - Total dust. | PEL | 15 mg/m ³ | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| Titanium dioxide (naturally occurring) - Respirable fraction. | TWA | 5 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| Titanium dioxide (naturally occurring) - Total dust. | TWA | 50 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| Titanium dioxide (naturally occurring) - Respirable fraction. | TWA | 15 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| Titanium dioxide (naturally occurring) - Total dust. | TWA | 15 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| Titanium dioxide (naturally occurring) - Respirable finescale particles | TWA | 2.5 mg/m ³ | US. ACGIH Threshold Limit Values (01 2022) |
| Titanium dioxide (naturally occurring) - Respirable nanoscale particles | TWA | 0.2 mg/m ³ | US. ACGIH Threshold Limit Values (01 2022) |
| Manganese - Fume. - as Mn | Ceiling | 5 mg/m ³ | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| | REL | 1 mg/m ³ | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| | STEL | 3 mg/m ³ | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| Manganese - Inhalable fraction. - as Mn | TWA | 0.1 mg/m ³ | US. ACGIH Threshold Limit Values (03 2014) |
| Manganese - Respirable fraction. - as Mn | TWA | 0.02 mg/m ³ | US. ACGIH Threshold Limit Values (03 2014) |
| Manganese | IDLH | 500 mg/m ³ | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| Zircon - as Zr | STEL | 10 mg/m ³ | US. ACGIH Threshold Limit Values (12 2010) |
| | TWA | 5 mg/m ³ | US. ACGIH Threshold Limit Values (12 2010) |
| | PEL | 5 mg/m ³ | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| | REL | 5 mg/m ³ | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| | STEL | 10 mg/m ³ | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| Zircon | IDLH | 25 mg/m ³ | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| Titanium dioxide (synthetic) | IDLH | 5,000 mg/m ³ | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| Titanium dioxide (synthetic) - Total dust. | PEL | 15 mg/m ³ | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| Titanium dioxide (synthetic) - Respirable fraction. | TWA | 5 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| Titanium dioxide (synthetic) - Total dust. | TWA | 50 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| Titanium dioxide (synthetic) - Respirable fraction. | TWA | 15 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| Titanium dioxide (synthetic) - Total dust. | TWA | 15 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| Titanium dioxide (synthetic) - Respirable finescale particles | TWA | 2.5 mg/m ³ | US. ACGIH Threshold Limit Values (01 2022) |
| Titanium dioxide (synthetic) - | TWA | 0.2 mg/m ³ | US. ACGIH Threshold Limit Values (01 |

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|---|----------|---|--|
| Respirable nanoscale particles | | | 2022) |
| Quartz - Respirable. | TWA | 2.4 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (2000) |
| | TWA | 0.1 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (2000) |
| Quartz - Respirable dust. | REL | 0.05 mg/m ³ | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| Quartz - Respirable dust. | TWA | 0.05 mg/m ³ | US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050) (03 2016) |
| | OSHA_ACT | 0.025 mg/m ³ | US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050) (03 2016) |
| Quartz - Respirable dust. | PEL | 0.05 mg/m ³ | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (03 2016) |
| Quartz | IDLH | 50 mg/m ³ | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| Quartz - Respirable fraction. | TWA | 0.025 mg/m ³ | US. ACGIH Threshold Limit Values (02 2020) |
| Silicon dioxide (amorphous) | TWA | 20 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (2000) |
| | TWA | 0.8 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (2000) |
| | REL | 6 mg/m ³ | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| | IDLH | 3,000 mg/m ³ | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| Silicon dioxide (amorphous) - Inhalable particles. | TWA | 10 mg/m ³ | US. ACGIH Threshold Limit Values (01 2021) |
| Silicon dioxide (amorphous) - Respirable particles. | TWA | 3 mg/m ³ | US. ACGIH Threshold Limit Values (01 2021) |
| Silicon dioxide (amorphous) - Total dust. | TWA | 50 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (09 2016) |
| Silicon dioxide (amorphous) - Respirable fraction. | TWA | 15 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (09 2016) |
| | TWA | 5 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (09 2016) |
| Silicon dioxide (amorphous) - Total dust. | TWA | 15 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (09 2016) |
| Silicon dioxide (amorphous) | TWA | 0.8 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (09 2016) |
| | TWA | 20 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (09 2016) |
| Silicon - Total dust. | PEL | 15 mg/m ³ | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| Silicon - Respirable fraction. | PEL | 5 mg/m ³ | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| Silicon - Respirable. | REL | 5 mg/m ³ | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| Silicon - Total | REL | 10 mg/m ³ | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| Silicon - Respirable particles. | TWA | 3 mg/m ³ | US. ACGIH Threshold Limit Values (01 2021) |
| Silicon - Inhalable particles. | TWA | 10 mg/m ³ | US. ACGIH Threshold Limit Values (01 2021) |
| Silicon - Respirable fraction. | TWA | 5 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (09 2016) |
| Silicon - Total dust. | TWA | 50 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (09 2016) |
| | TWA | 15 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) |

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| | | | (09 2016) |
| Silicon - Respirable fraction. | TWA | 15 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (09 2016) |
| Magnesium oxide - Inhalable fraction. | TWA | 10 mg/m ³ | US. ACGIH Threshold Limit Values (12 2010) |
| Magnesium oxide - Total particulate. | PEL | 15 mg/m ³ | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| Magnesium oxide | IDLH | 750 mg/m ³ | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| Aluminum oxide - Respirable fraction. | TWA | 1 mg/m ³ | US. ACGIH Threshold Limit Values (12 2010) |
| | PEL | 5 mg/m ³ | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| Aluminum oxide - Total dust. | PEL | 15 mg/m ³ | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| Aluminum oxide - Respirable fraction. | TWA | 15 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| | TWA | 5 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| Aluminum oxide - Total dust. | TWA | 15 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| | TWA | 50 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| Aluminum oxide - Inhalable particles. | TWA | 10 mg/m ³ | US. ACGIH Threshold Limit Values (01 2021) |
| Aluminum oxide - Respirable particles. | TWA | 3 mg/m ³ | US. ACGIH Threshold Limit Values (01 2021) |
| Iron oxide - Respirable fraction. | TWA | 5 mg/m ³ | US. ACGIH Threshold Limit Values (12 2010) |
| Iron oxide - Fume. | PEL | 10 mg/m ³ | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| Iron oxide - Dust and fume. - as Fe | REL | 5 mg/m ³ | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| Iron oxide | IDLH | 2,500 mg/m ³ | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| Calcium fluoride - as F | TWA | 2.5 mg/m ³ | US. ACGIH Threshold Limit Values (12 2010) |
| Calcium fluoride | IDLH | 250 mg/m ³ | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| | IDLH | 250 mg/m ³ | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| Calcium fluoride - as F | PEL | 2.5 mg/m ³ | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| Calcium fluoride - Dust. | TWA | 2.5 mg/m ³ | US. OSHA Table Z-2 (29 CFR 1910.1000) (02 2006) |
| Zirconium oxide - as Zr | STEL | 10 mg/m ³ | US. ACGIH Threshold Limit Values (12 2010) |
| | TWA | 5 mg/m ³ | US. ACGIH Threshold Limit Values (12 2010) |
| | REL | 5 mg/m ³ | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| | STEL | 10 mg/m ³ | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| | PEL | 5 mg/m ³ | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| Zirconium oxide | IDLH | 25 mg/m ³ | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| Zirconium oxide - Respirable particles. | TWA | 3 mg/m ³ | US. ACGIH Threshold Limit Values (01 2021) |
| Zirconium oxide - Inhalable particles. | TWA | 10 mg/m ³ | US. ACGIH Threshold Limit Values (01 2021) |

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| Zirconium oxide - Respirable fraction. | TWA | 5 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| | TWA | 15 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| Zirconium oxide - Total dust. | TWA | 15 mg/m ³ | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |
| | TWA | 50 millions of particles per cubic foot of air | US. OSHA Table Z-3 (29 CFR 1910.1000) (03 2016) |

Occupational Exposure Limits: Canada

| Chemical Identity | Type | Exposure Limit Values | Source |
|---|------------|------------------------|--|
| Titanium dioxide (naturally occurring) | TWA | 10 mg/m ³ | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |
| Titanium dioxide (naturally occurring) - Total dust. | TWA | 10 mg/m ³ | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| Titanium dioxide (naturally occurring) - Respirable fraction. | TWA | 3 mg/m ³ | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| Titanium dioxide (naturally occurring) | TWA | 10 mg/m ³ | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| | 8 HR ACL | 10 mg/m ³ | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 20 mg/m ³ | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| Titanium dioxide (naturally occurring) - Total dust. | TWA | 10 mg/m ³ | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| Titanium dioxide (naturally occurring) - Respirable finescale particles | TWA | 2.5 mg/m ³ | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (01 2022) |
| Titanium dioxide (naturally occurring) - Respirable nanoscale particles | TWA | 0.2 mg/m ³ | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (01 2022) |
| Manganese - as Mn | 8 HR ACL | 0.2 mg/m ³ | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 0.6 mg/m ³ | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| Manganese - Respirable fraction. - as Mn | TWA | 0.02 mg/m ³ | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2014) |
| Manganese - Inhalable fraction. - as Mn | TWA | 0.1 mg/m ³ | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2014) |
| Manganese - as Mn | TWA | 0.2 mg/m ³ | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (06 2015) |
| Manganese - Fume, total dust. - as Mn | TWA | 0.2 mg/m ³ | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| Manganese - as Mn | TWA | 0.2 mg/m ³ | Canada. Alberta OELs (Occupational |

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| | | | Health & Safety Code, Schedule 1, Table 2), as amended (08 2020) |
| Manganese - Respirable. - as Mn | TWA | 0.02 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2022) |
| Manganese - Total - as Mn | TWA | 0.2 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2022) |
| Zircon - as Zr | STEL | 10 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2011) |
| | TWA | 5 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2011) |
| | TWA | 5 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| | STEL | 10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| | 8 HR ACL | 5 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 10 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | TWA | 5 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| | STEL | 10 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| | TWA | 5 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (08 2020) |
| | STEL | 10 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (08 2020) |
| | TWA | 5 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2022) |
| | STEL | 10 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2022) |
| Titanium dioxide (synthetic) | TWA | 10 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |
| Titanium dioxide (synthetic) - Total dust. | TWA | 10 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| Titanium dioxide (synthetic) - Respirable fraction. | TWA | 3 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 |

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| | | | 2007) |
| Titanium dioxide (synthetic) | TWA | 10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| | 8 HR ACL | 10 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 20 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| Titanium dioxide (synthetic) - Total dust. | TWA | 10 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| Titanium dioxide (synthetic) - Respirable finescale particles | TWA | 2.5 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (01 2022) |
| Titanium dioxide (synthetic) - Respirable nanoscale particles | TWA | 0.2 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (01 2022) |
| Quartz - Respirable particles. | TWA | 0.025 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |
| Quartz - Respirable fraction. | 8 HR ACL | 0.05 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | TWA | 0.10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (06 2015) |
| Quartz - Respirable dust. | TWA | 0.1 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| Quartz - Respirable fraction. | TWA | 0.025 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2020) |
| | TWA | 0.025 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (01 2021) |
| Silicon dioxide (amorphous) | TWA | 10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (07 2010) |
| Silicon dioxide (amorphous) - Respirable particles. | TWA | 3 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (01 2019) |
| Silicon dioxide (amorphous) - Respirable fraction. | TWA | 3 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2020) |
| Silicon dioxide (amorphous) - Total dust. | TWA | 10 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2020) |
| Silicon dioxide (amorphous) - Respirable particles. | TWA | 3 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (01 2021) |
| Silicon dioxide (amorphous) - Inhalable particles. | TWA | 10 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (01 2021) |
| Silicon dioxide (amorphous) - Respirable fraction. | TWA | 3 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (01 2020) |
| Silicon dioxide (amorphous) - | TWA | 10 mg/m3 | Canada. Ontario OELs. (Control of |

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| Inhalable particles. | | | Exposure to Biological or Chemical Agents), as amended (01 2020) |
| Silicon dioxide (amorphous) - Inhalable fraction. | TWA | 10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (01 2020) |
| Silicon dioxide (amorphous) - Respirable particles. | TWA | 3 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (01 2020) |
| Silicon dioxide (amorphous) - Inhalable fraction. | 15 MIN ACL | 20 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (06 2016) |
| Silicon dioxide (amorphous) - Respirable fraction. | 15 MIN ACL | 6 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (06 2016) |
| | 8 HR ACL | 3 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (06 2016) |
| Silicon dioxide (amorphous) - Inhalable fraction. | 8 HR ACL | 10 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (06 2016) |
| Silicon dioxide (amorphous) - Total dust. | TWA | 10 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (03 2020) |
| Silicon dioxide (amorphous) - Total | TWA | 10 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (08 2020) |
| Silicon - Total dust. | TWA | 10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (07 2010) |
| Silicon | 8 HR ACL | 10 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 20 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| Silicon - Total dust. | TWA | 10 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| Silicon - Respirable particles. | TWA | 3 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (01 2019) |
| Silicon - Total dust. | TWA | 10 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2020) |
| Silicon - Respirable fraction. | TWA | 3 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2020) |
| Silicon - Inhalable particles. | TWA | 10 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (01 2021) |
| Silicon - Respirable particles. | TWA | 3 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (01 2021) |
| Silicon - Respirable fraction. | TWA | 3 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (01 2020) |
| Silicon - Inhalable fraction. | TWA | 10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (01 2020) |

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| Silicon - Inhalable particles. | TWA | 10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (01 2020) |
| Silicon - Respirable particles. | TWA | 3 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (01 2020) |
| Silicon - Total | TWA | 10 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (08 2020) |
| Magnesium oxide - Fume. | TWA | 10 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |
| Magnesium oxide - Respirable dust and/or fume. - as Mg | STEL | 10 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| Magnesium oxide - Inhalable fume. | TWA | 10 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| Magnesium oxide - Respirable dust and/or fume. - as Mg | TWA | 3 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| Magnesium oxide - Inhalable fraction. | TWA | 10 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2011) |
| | TWA | 10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| | 8 HR ACL | 10 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 20 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| Magnesium oxide - Inhalable dust. | TWA | 10 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (03 2020) |
| Aluminum oxide | TWA | 10 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |
| Aluminum oxide - Respirable fraction. | TWA | 1 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2011) |
| | TWA | 3 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (06 2015) |
| | TWA | 1 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| Aluminum oxide - Inhalable fraction. | TWA | 10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (06 2015) |
| Aluminum oxide | 8 HR ACL | 10 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 20 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| Aluminum oxide - Total dust. | TWA | 10 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for |

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| | | | Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2020) |
| Aluminum oxide - Respirable fraction. | TWA | 3 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2020) |
| Aluminum oxide - Inhalable particles. | TWA | 10 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (01 2021) |
| Aluminum oxide - Respirable particles. | TWA | 3 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (01 2021) |
| | TWA | 3 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (01 2020) |
| Aluminum oxide - Inhalable particles. | TWA | 10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (01 2020) |
| Aluminum oxide - Respirable. | TWA | 1.0 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2022) |
| Aluminum oxide - Total dust. | TWA | 10 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (04 2022) |
| Aluminum oxide - Respirable dust. | TWA | 5 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (04 2022) |
| Iron oxide - Dust. - as Fe | TWA | 5 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| Iron oxide - Fume. - as Fe | STEL | 10 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| | TWA | 5 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| Iron oxide - Respirable fraction. | TWA | 5 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2011) |
| | TWA | 5 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| Iron oxide | 8 HR ACL | 10 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 20 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| Iron oxide - Dust and fume. - as Fe | 15 MIN ACL | 10 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 8 HR ACL | 5 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety |

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| | | | Regulations, 1996, Table 21), as amended (05 2009) |
| | TWA | 5 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| Iron oxide - Respirable. | TWA | 5 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (08 2020) |
| Calcium fluoride - as F | TWA | 2.5 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |
| | TWA | 2.5 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |
| | TWA | 2.5 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2011) |
| | TWA | 2.5 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| | 8 HR ACL | 2.5 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 5 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | TWA | 2.5 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| | TWA | 2.5 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2022) |
| Zirconium oxide - as Zr | STEL | 10 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2011) |
| | TWA | 5 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2011) |
| | TWA | 5 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| | STEL | 10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| | 8 HR ACL | 5 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 10 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | TWA | 5 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| | STEL | 10 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| Zirconium oxide - Respirable particles. | TWA | 3 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (01 2019) |
| Zirconium oxide - Respirable fraction. | TWA | 3 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 |

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| Zirconium oxide - Total dust. | TWA | 10 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2020) |
| Zirconium oxide - Respirable particles. | TWA | 3 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (01 2021) |
| Zirconium oxide - Inhalable particles. | TWA | 10 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (01 2021) |
| Zirconium oxide - Respirable fraction. | TWA | 3 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (01 2020) |
| Zirconium oxide - Inhalable particles. | TWA | 10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (01 2020) |
| Zirconium oxide - Respirable particles. | TWA | 3 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (01 2020) |
| Zirconium oxide - Inhalable fraction. | TWA | 10 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (01 2020) |
| | 15 MIN ACL | 20 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (06 2016) |
| Zirconium oxide - Respirable fraction. | 8 HR ACL | 3 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (06 2016) |
| Zirconium oxide - Inhalable fraction. | 8 HR ACL | 10 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (06 2016) |
| Zirconium oxide - Respirable fraction. | 15 MIN ACL | 6 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (06 2016) |
| Zirconium oxide - Total dust. | TWA | 10 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (04 2019) |
| Zirconium oxide - Total | TWA | 10 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (08 2020) |
| Zirconium oxide - as Zr | TWA | 5 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (08 2020) |
| | STEL | 10 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (08 2020) |
| | TWA | 5 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2022) |
| | STEL | 10 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2022) |

Occupational Exposure Limits: Mexico

| Chemical Identity | Type | Exposure Limit Values | Source |
|-------------------|---------|-----------------------|----------------------------------|
| Iron - as Fe | VLE-PPT | 1 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 |

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| | | | Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Titanium dioxide (naturally occurring) | VLE-PPT | 10 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Manganese - as Mn | VLE-PPT | 0.2 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Zircon - as Zr | VLE-PPT | 5 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| | VLE-CT | 10 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Titanium dioxide (synthetic) | VLE-PPT | 10 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Quartz - Respirable fraction. | VLE-PPT | 0.025 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Silicon dioxide (amorphous) - Inhalable fraction. | VLE-PPT | 10 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Silicon dioxide (amorphous) - Respirable fraction. | VLE-PPT | 3 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Silicon - Inhalable fraction. | VLE-PPT | 10 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Silicon - Respirable fraction. | VLE-PPT | 3 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Magnesium oxide - Inhalable fraction. | VLE-PPT | 10 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Aluminum oxide | VLE-PPT | 10 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Iron oxide - Respirable fraction. | VLE-PPT | 5 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Calcium fluoride - as F | VLE-PPT | 2.5 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Zirconium oxide - as Zr | VLE-PPT | 5 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| | VLE-CT | 10 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Zirconium oxide - Respirable fraction. | VLE-PPT | 3 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Zirconium oxide - Inhalable | VLE-PPT | 10 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 |

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| fraction. | | | Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
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Biological Limit Values: US

| Chemical Identity | Exposure Limit Values | Source |
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| Calcium fluoride (Fluoride: Sampling time: Prior to shift.) | 2 mg/l (Urine) | ACGIH BEI (03 2013) |
| Calcium fluoride (Fluoride: Sampling time: End of shift.) | 3 mg/l (Urine) | ACGIH BEI (03 2013) |

Biological Limit Values: Mexico

| Chemical Identity | Exposure Limit Values | Source |
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| Calcium fluoride (fluorides: Sampling time: End of shift.) | 10 mg/g (Creatinine in urine) | MX IBE (06 2012) |
| Calcium fluoride (fluorides: Sampling time: Prior to shift.) | 3 mg/g (Creatinine in urine) | MX IBE (06 2012) |

Additional exposure limits under the conditions of use: US

| Chemical Identity | Type | Exposure Limit Values | Source |
|-------------------|-----------|------------------------------|---|
| Carbon dioxide | TWA | 5,000 ppm | US. ACGIH Threshold Limit Values (12 2010) |
| | STEL | 30,000 ppm | US. ACGIH Threshold Limit Values (12 2010) |
| | PEL | 5,000 ppm 9,000 mg/m3 | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| | STEL | 30,000 ppm 54,000 mg/m3 | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| | REL | 5,000 ppm 9,000 mg/m3 | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| Carbon monoxide | IDLH | 40,000 ppm | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| | TWA | 25 ppm | US. ACGIH Threshold Limit Values (12 2010) |
| | PEL | 50 ppm 55 mg/m3 | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| | REL | 35 ppm 40 mg/m3 | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| | Ceil_Time | 200 ppm 229 mg/m3 | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| Nitrogen dioxide | IDLH | 1,200 ppm | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| | TWA | 0.2 ppm | US. ACGIH Threshold Limit Values (02 2012) |
| | Ceiling | 5 ppm 9 mg/m3 | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| | STEL | 1 ppm 1.8 mg/m3 | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| | IDLH | 20 ppm | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| Ozone | IDLH | 13 ppm | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| | PEL | 0.1 ppm 0.2 mg/m3 | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| | Ceil_Time | 0.1 ppm 0.2 mg/m3 | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| | TWA | 0.05 ppm | US. ACGIH Threshold Limit Values (03 2014) |
| | TWA | 0.10 ppm | US. ACGIH Threshold Limit Values (03 2014) |

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| | TWA | 0.08 ppm | US. ACGIH Threshold Limit Values (03 2014) |
| | IDLH | 5 ppm | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |
| | TWA | 0.20 ppm | US. ACGIH Threshold Limit Values (02 2020) |
| Manganese - Fume. - as Mn | Ceiling | 5 mg/m3 | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| | REL | 1 mg/m3 | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| | STEL | 3 mg/m3 | US. NIOSH: Pocket Guide to Chemical Hazards, as amended (2005) |
| Manganese - Inhalable fraction. - as Mn | TWA | 0.1 mg/m3 | US. ACGIH Threshold Limit Values (03 2014) |
| Manganese - Respirable fraction. - as Mn | TWA | 0.02 mg/m3 | US. ACGIH Threshold Limit Values (03 2014) |
| Manganese | IDLH | 500 mg/m3 | US. NIOSH. Immediately Dangerous to Life or Health (IDLH) Values (10 2017) |

Additional exposure limits under the conditions of use: Canada

| Chemical Identity | Type | Exposure Limit Values | Source |
|-------------------|------------|----------------------------|--|
| Carbon dioxide | STEL | 30,000 ppm 54,000 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |
| | TWA | 5,000 ppm 9,000 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |
| | TWA | 5,000 ppm | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| | STEL | 15,000 ppm | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| | TWA | 5,000 ppm | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2011) |
| | STEL | 30,000 ppm | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2011) |
| | STEL | 30,000 ppm | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| | TWA | 5,000 ppm | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| | 8 HR ACL | 5,000 ppm | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 30,000 ppm | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | TWA | 5,000 ppm 9,000 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| | STEL | 30,000 ppm 54,000 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| Carbon monoxide | TWA | 25 ppm 29 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |

| | | | | |
|------------------|------------|----------|-----------|--|
| | TWA | 25 ppm | | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| | STEL | 100 ppm | | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| | TWA | 25 ppm | | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2011) |
| | TWA | 25 ppm | | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (07 2010) |
| | 8 HR ACL | 25 ppm | | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 190 ppm | | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | TWA | 35 ppm | | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (04 2022) |
| | STEL | 175 ppm | | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (04 2022) |
| Nitrogen dioxide | STEL | 5 ppm | 9.4 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |
| | TWA | 3 ppm | 5.6 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |
| | CEILING | 1 ppm | | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| | TWA | 0.2 ppm | | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2012) |
| | STEL | 5 ppm | | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| | TWA | 3 ppm | | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (11 2010) |
| | 8 HR ACL | 3 ppm | | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 5 ppm | | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | TWA | 3 ppm | 5 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (04 2022) |
| Ozone | STEL | 0.3 ppm | 0.6 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |
| | TWA | 0.1 ppm | 0.2 mg/m3 | Canada. Alberta OELs (Occupational Health & Safety Code, Schedule 1, Table 2), as amended (07 2009) |
| | TWA | 0.05 ppm | | Canada. British Columbia OELs. (Occupational Exposure Limits for |

| | | | |
|--|---------------|------------------------|--|
| | | | Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| | TWA | 0.1 ppm | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| | TWA | 0.08 ppm | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| | TWA | 0.2 ppm | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (07 2007) |
| | TWA | 0.1 ppm 0.2 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (07 2010) |
| | STEL | 0.3 ppm 0.6 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (07 2010) |
| | 15 MIN ACL | 0.15 ppm | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 8 HR ACL | 0.05 ppm | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | CEILING | 0.1 ppm 0.2 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (12 2008) |
| | TWA | 0.05 ppm | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2014) |
| | TWA | 0.08 ppm | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2014) |
| | TWA | 0.10 ppm | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2014) |
| | TWA | 0.20 ppm | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (02 2020) |
| Manganese - as Mn | 8 HR ACL | 0.2 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| | 15 MIN ACL | 0.6 mg/m3 | Canada. Saskatchewan OELs (Occupational Health and Safety Regulations, 1996, Table 21), as amended (05 2009) |
| Manganese - Respirable fraction. - as Mn | TWA | 0.02 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2014) |
| Manganese - Inhalable fraction. - as Mn | TWA | 0.1 mg/m3 | Canada. Manitoba OELs (Reg. 217/2006, The Workplace Safety And Health Act), as amended (03 2014) |
| Manganese - as Mn | TWA | 0.2 mg/m3 | Canada. Ontario OELs. (Control of Exposure to Biological or Chemical Agents), as amended (06 2015) |
| Manganese - Fume, total dust. - as Mn | TWA | 0.2 mg/m3 | Canada. Quebec OELs. (Ministry of Labor - Regulation respecting occupational health and safety), as amended (09 2017) |
| Manganese - as Mn | TWA | 0.2 mg/m3 | Canada. Alberta OELs (Occupational |

| | | | |
|---------------------------------|-----|------------|--|
| | | | Health & Safety Code, Schedule 1, Table 2), as amended (08 2020) |
| Manganese - Respirable. - as Mn | TWA | 0.02 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2022) |
| Manganese - Total - as Mn | TWA | 0.2 mg/m3 | Canada. British Columbia OELs. (Occupational Exposure Limits for Chemical Biological Substances, Occupational Health and Safety Regulation 296/97, as amended) (06 2022) |

Additional exposure limits under the conditions of use: Mexico

| Chemical Identity | Type | Exposure Limit Values | Source |
|-------------------|---------|-----------------------|--|
| Carbon dioxide | VLE-CT | 30,000 ppm | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| | VLE-PPT | 5,000 ppm | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Carbon monoxide | VLE-PPT | 25 ppm | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Nitrogen dioxide | VLE-PPT | 0.2 ppm | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Ozone | VLE-P | 0.1 ppm | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |
| Manganese - as Mn | VLE-PPT | 0.2 mg/m3 | Mexico. OELs. (NOM-010-STPS-2014 Chemical Pollutants at the Workplace; Assessment and Control), as amended (04 2014) |

Appropriate Engineering Controls

Ventilation: Use enough ventilation and local exhaust at the arc, flame or heat source to keep the fumes and gases from the worker's breathing zone and the general area. Train the operator to keep their head out of the fumes. **Keep exposure as low as possible.**

Individual protection measures, such as personal protective equipment

General information:

Exposure Guidelines: To reduce the potential for overexposure, use controls such as adequate ventilation and personal protective equipment (PPE). Overexposure refers to exceeding applicable local limits, the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) or the Occupational Safety and Health Administration's (OSHA) Permissible Exposure Limits (PELs). Workplace exposure levels should be established by competent industrial hygiene assessments. Unless exposure levels are confirmed to be below the applicable local limit, TLV or PEL, whichever is lower, respirator use is required. Absent these controls, overexposure to one or more compound constituents, including those in the fume or airborne particles, may occur resulting in potential health hazards. According to the ACGIH, TLVs and Biological Exposure Indices (BEIs) "represent conditions under which ACGIH believes that nearly all workers may be repeatedly exposed without adverse health effects." The ACGIH further states that the TLV-TWA should be used as a guide in the control of health hazards and should not be used to indicate a fine line between safe and dangerous exposures. See Section

10 for information on constituents which have some potential to present health hazards. Welding consumables and materials being joined may contain chromium as an unintended trace element. Materials that contain chromium may produce some amount of hexavalent chromium (CrVI) and other chromium compounds as a byproduct in the fume. In 2018, the American Conference of Governmental Industrial Hygienists (ACGIH) lowered the Threshold Limit Value (TLV) for hexavalent chromium from 50 micrograms per cubic meter of air (50 µg/m³) to 0.2 µg/m³. At these new limits, CrVI exposures at or above the TLV may be possible in cases where adequate ventilation is not provided. CrVI compounds are on the IARC and NTP lists as posing a lung cancer and sinus cancer risk. Workplace conditions are unique and welding fume exposures levels vary. Workplace exposure assessments must be conducted by a qualified professional, such as an industrial hygienist, to determine if exposures are below applicable limits and to make recommendations when necessary for preventing overexposures.

Eye/face protection:

Wear helmet or use face shield with filter lens shade number 12 or darker for open arc processes – or follow the recommendations as specified in ANSI Z49.1, Section 4, based on your process and settings. No specific lens shade recommendation for submerged arc or electroslag processes. Shield others by providing appropriate screens and flash goggles.

Skin Protection**Hand Protection:**

Wear protective gloves. Suitable gloves can be recommended by the glove supplier.

Other:

Protective Clothing: Wear hand, head, and body protection which help to prevent injury from radiation, open flames, hot surfaces, sparks and electrical shock. See Z49.1. At a minimum, this includes welder's gloves and a protective face shield when welding, and may include arm protectors, aprons, hats, shoulder protection, as well as dark substantial clothing when welding, brazing and soldering. Wear dry gloves free of holes or split seams. Train the operator not to permit electrically live parts or electrodes from contacting the skin . . . or clothing or gloves if they are wet. Insulate yourself from the work piece and ground using dry plywood, rubber mats or other dry insulation.

Respiratory Protection:

Keep your head out of fumes. Use enough ventilation and local exhaust to keep fumes and gases from your breathing zone and the general area. An approved respirator should be used unless exposure assessments are below applicable exposure limits.

Hygiene measures:

Do not eat, drink or smoke when using the product. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Determine the composition and quantity of fumes and gases to which workers are exposed by taking an air sample from inside the welder's helmet if worn or in the worker's breathing zone. Improve ventilation if exposures are not below limits. See ANSI/AWS F1.1, F1.2, F1.3 and F1.5, available from the American Welding Society, www.aws.org.

9. PHYSICAL AND CHEMICAL PROPERTIES

| | |
|------------------------|---------------------|
| Appearance: | Cored welding wire. |
| Physical state: | Solid |
| Form: | Solid |

| | |
|--|--------------------|
| Color: | No data available. |
| Odor: | No data available. |
| Odor threshold: | No data available. |
| pH: | No data available. |
| Melting point/freezing point: | No data available. |
| Initial boiling point and boiling range: | No data available. |
| Flash Point: | No data available. |
| Evaporation rate: | No data available. |
| Flammability (solid, gas): | No data available. |
| Upper/lower limit on flammability or explosive limits | |
| Flammability limit - upper (%): | No data available. |
| Flammability limit - lower (%): | No data available. |
| Explosive limit - upper: | No data available. |
| Explosive limit - lower: | No data available. |
| Vapor pressure: | No data available. |
| Vapor density: | No data available. |
| Density: | No data available. |
| Relative density: | No data available. |
| Solubility(ies) | |
| Solubility in water: | No data available. |
| Solubility (other): | No data available. |
| Partition coefficient (n-octanol/water): | No data available. |
| Auto-ignition temperature: | No data available. |
| Decomposition temperature: | No data available. |
| Viscosity: | No data available. |

10. STABILITY AND REACTIVITY

| | |
|--|--|
| Reactivity: | The product is non-reactive under normal conditions of use, storage and transport. |
| Chemical Stability: | Material is stable under normal conditions. |
| Possibility of hazardous reactions: | None under normal conditions. |
| Conditions to avoid: | Avoid heat or contamination. |
| Incompatible Materials: | Strong acids. Strong oxidizing substances. Strong bases. |
| Hazardous Decomposition Products: | Fumes and gases from welding and its allied processes such as brazing and soldering cannot be classified simply. The composition and quantity of both are dependent upon the metal to which the joining or hot work is applied, the process, procedure - and where applicable - the electrode or consumable used. Other conditions which also influence the composition and quantity of the fumes and gases to which workers may be exposed include: coatings on the metal being welded or worked (such as paint, plating, or galvanizing), the number of operators and the volume of the work area, the quality and amount of ventilation, the position of the operator's head with respect to the fume plume, as well as the presence of |

contaminants in the atmosphere (such as chlorinated hydrocarbon vapors from cleaning and degreasing activities.)

In cases where an electrode or other applied material is consumed, the fume and gas decomposition products generated are different in percent and form from the ingredients listed in Section 3. Decomposition products of normal operation include those originating from the volatilization, reaction, or oxidation of the materials shown in Section 3, plus those from the base metal and coating, etc., as noted above. Reasonably expected fume constituents produced during arc welding and brazing include the oxides of iron, manganese and other metals present in the welding consumable or base metal. Hexavalent chromium compounds may be in the welding or brazing fume of consumables or base metals which contain chromium. Gaseous and particulate fluoride may be in the fume of consumables or flux materials which contain fluoride. Gaseous reaction products may include carbon monoxide and carbon dioxide. Ozone and nitrogen oxides may be formed by the radiation from the arc associated with welding.

11. TOXICOLOGICAL INFORMATION

General information: The International Agency for Research on Cancer (IARC) has determined welding fumes and ultraviolet radiation from welding are carcinogenic to humans (Group 1). According to IARC, welding fumes cause cancer of the lung and positive associations have been observed with cancer of the kidney. Also according to IARC, ultraviolet radiation from welding causes ocular melanoma. IARC identifies gouging, brazing, carbon arc or plasma arc cutting, and soldering as processes closely related to welding. Read and understand the manufacturer's instructions, Safety Data Sheets and the precautionary labels before using this product.

Information on likely routes of exposure

- Inhalation:** Potential chronic health hazards related to the use of welding consumables are most applicable to the inhalation route of exposure. Refer to Inhalation statements in Section 11.
- Skin Contact:** Arc rays can burn skin. Skin cancer has been reported.
- Eye contact:** Arc rays can injure eyes.
- Ingestion:** Health injuries from ingestion are not known or expected under normal use.

Symptoms related to the physical, chemical and toxicological characteristics

Inhalation: Respiratory exposure to the crystalline silica present in this welding electrode is not anticipated during normal use. Respiratory overexposure to airborne crystalline silica is known to cause silicosis, a form of disabling pulmonary fibrosis which can be progressive and may lead to death. Crystalline silica is on the IARC (International Agency for Research on Cancer) and NTP (National Toxicology Program) lists as posing a cancer risk to humans. Note: All regional authorities do not use the same criteria for assigning carcinogenic classifications to chemicals. For example, the European Union (EU) CLP does not require classifying crystalline silica as a carcinogenic compound. Short-term (acute) overexposure to fumes and gases from welding and allied processes may result in discomfort such as metal fume fever, dizziness, nausea, or dryness or irritation of nose, throat, or eyes. May aggravate pre-existing respiratory problems (e.g. asthma, emphysema). Long-term (chronic) overexposure to fumes and gases from welding and allied processes can lead to siderosis (iron deposits in lung), central nervous system effects, bronchitis and other pulmonary effects.

Information on toxicological effects**Acute toxicity (list all possible routes of exposure)****Oral**

| | |
|--------------------------------|--------------------------|
| Product: | Not classified |
| Specified substance(s): | |
| Iron | LD 50 (Rat): 98.6 g/kg |
| Zircon | LD 50 (Rat): 3,200 mg/kg |
| Calcium fluoride | LD 50 (Rat): 4,250 mg/kg |

Dermal

Product: Not classified

Inhalation

Product: Not classified

Repeated dose toxicity

Product: Not classified

Skin Corrosion/Irritation

Product: Not classified

Serious Eye Damage/Eye Irritation

Product: Not classified

Respiratory or Skin Sensitization

Product: Not classified

Carcinogenicity

Product: Arc rays: Skin cancer has been reported.

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans:

| | |
|--|--|
| Titanium dioxide (naturally occurring) | Overall evaluation: 2B. Possibly carcinogenic to humans. |
| Titanium dioxide (synthetic) | Overall evaluation: 2B. Possibly carcinogenic to humans. |
| Quartz | Overall evaluation: 1. Carcinogenic to humans. |

US. National Toxicology Program (NTP) Report on Carcinogens:

Quartz Known To Be Human Carcinogen.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050), as amended:

Quartz Cancer

Germ Cell Mutagenicity

In vitro

Product: Not classified

In vivo

Product: Not classified

Reproductive toxicity

Product: Not classified

Specific Target Organ Toxicity - Single Exposure

Product: Not classified

Specific Target Organ Toxicity - Repeated Exposure

Product: Not classified

Aspiration Hazard

Product: Not classified

Other effects: Organic polymers may be used in the manufacture of various welding consumables. Overexposure to their decomposition byproducts may result in a condition known as polymer fume fever. Polymer fume fever usually occurs within 4 to 8 hours of exposure with the presentation of flu like symptoms, including mild pulmonary irritation with or without an increase in body temperature. Signs of exposure can include an increase in white blood cell count. Resolution of symptoms typically occurs quickly, usually not lasting longer than 48 hours.

Symptoms related to the physical, chemical and toxicological characteristics under the condition of use

Inhalation:

Specified substance(s):

Manganese Overexposure to manganese fumes may affect the brain and central nervous system, resulting in poor coordination, difficulty speaking, and arm or leg tremor. This condition can be irreversible.

Additional toxicological Information under the conditions of use:

Acute toxicity

Inhalation

Specified substance(s):

| | |
|------------------|---------------------------------|
| Carbon dioxide | LC Lo (Human, 5 min): 90000 ppm |
| Carbon monoxide | LC 50 (Rat, 4 h): 1300 ppm |
| Nitrogen dioxide | LC 50 (Rat, 4 h): 88 ppm |
| Ozone | LC Lo (Human, 30 min): 50 ppm |

Other effects:

Specified substance(s):

| | |
|------------------|------------------------------------|
| Carbon dioxide | Asphyxia |
| Carbon monoxide | Carboxyhemoglobinemia |
| Nitrogen dioxide | Lower respiratory tract irritation |

12. ECOLOGICAL INFORMATION

Ecotoxicity**Acute hazards to the aquatic environment:****Fish**

| | |
|--------------------------------|------------------------|
| Product: | Not classified. |
| Specified substance(s): | |
| Calcium fluoride | LC 50 (96 h): 340 mg/l |

Aquatic Invertebrates

| | |
|--------------------------------|--|
| Product: | Not classified. |
| Specified substance(s): | |
| Manganese | EC 50 (Water flea (Daphnia magna), 48 h): 40 mg/l |
| Calcium fluoride | EC 50 (Daphnia magna; Daphnia sp., 48 h): 270 mg/l |

Chronic hazards to the aquatic environment:**Fish**

| | |
|-----------------|-----------------|
| Product: | Not classified. |
|-----------------|-----------------|

Aquatic Invertebrates

| | |
|-----------------|-----------------|
| Product: | Not classified. |
|-----------------|-----------------|

Toxicity to Aquatic Plants

| | |
|-----------------|-----------------|
| Product: | Not classified. |
|-----------------|-----------------|

Persistence and Degradability**Biodegradation**

| | |
|-----------------|--------------------|
| Product: | No data available. |
|-----------------|--------------------|

Bioaccumulative potential**Bioconcentration Factor (BCF)**

| | |
|-----------------|--------------------|
| Product: | No data available. |
|-----------------|--------------------|

Mobility in soil:

No data available.

13. Disposal considerations**General information:**

The generation of waste should be avoided or minimized whenever possible. When practical, recycle in an environmentally acceptable, regulatory compliant manner. Dispose of non-recyclable products in accordance with all applicable Federal, State, Provincial, and Local requirements.

Disposal instructions:

Disposal of this product may be regulated as a Hazardous Waste. The welding consumable and/or by-product from the welding process (including, but not limited to slag, dust, etc.) may contain levels of leachable heavy metals such as Barium or Chromium. Prior to disposal, a representative sample must be analyzed in accordance with US EPA's Toxicity Characteristic Leaching Procedure (TCLP) to determine if any constituents exist above regulated threshold levels. Discard any product, residue, disposable container, or liner in an environmentally acceptable manner according to Federal, State and Local Regulations.

Contaminated Packaging:

Dispose of contents/container to an appropriate treatment and disposal facility in accordance with applicable laws and regulations, and product characteristics at time of disposal.

14. TRANSPORT INFORMATION

DOT

UN number or ID number:
UN Proper Shipping Name: NOT DG REGULATED
Transport Hazard Class(es)
Class: NR
Label(s): –
Packing Group: –
Marine Pollutant: No

IMDG

UN number or ID number:
UN Proper Shipping Name: NOT DG REGULATED
Transport Hazard Class(es)
Class: NR
Label(s): –
EmS No.: –
Packing Group: –
Marine Pollutant: No

IATA

UN number or ID number:
Proper Shipping Name: NOT DG REGULATED
Transport Hazard Class(es):
Class: NR
Label(s): –
Packing Group: –
Marine Pollutant: No
Cargo aircraft only: Allowed.

TDG

UN number or ID number:
UN Proper Shipping Name: NOT DG REGULATED
Transport Hazard Class(es)
Class: NR
Label(s): –
Packing Group: –
Marine Pollutant: No

15. REGULATORY INFORMATION**US Federal Regulations****TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)**

None present or none present in regulated quantities.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050), as amended**Chemical Identity**

Quartz

OSHA hazard(s)

kidney effects
lung effects
immune system effects
Cancer

CERCLA Hazardous Substance List (40 CFR 302.4):**Chemical Identity**

Manganese

Reportable quantity

Included in the regulation but with no data values. See regulation for further details.

Superfund Amendments and Reauthorization Act of 1986 (SARA)**Hazard categories**

Not classified
Not classified

SARA 302 Extremely Hazardous Substance

None present or none present in regulated quantities.

SARA 304 Emergency Release Notification

None present or none present in regulated quantities.

SARA 311/312 Hazardous Chemical**Chemical Identity****Threshold Planning Quantity****SARA 313 (TRI Reporting)****Chemical Identity**

Manganese

**Reporting threshold
for other users**

10000 lbs

**Reporting threshold for
manufacturing and processing**

25000 lbs.

Clean Water Act Section 311 Hazardous Substances (40 CFR 117.3)

None present or none present in regulated quantities.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130):

None present or none present in regulated quantities.

US State Regulations**US. California Proposition 65**

WARNING: This product can expose you to chemicals including, Titanium dioxide (naturally occurring), Titanium dioxide (synthetic), Quartz, Nickel, which is [are] known to the State of California to cause cancer.

For more information go to www.P65Warnings.ca.gov.

WARNING: This product contains or produces a chemical known to the State of California to cause cancer and birth defects (or other reproductive harm). (California Health & Safety Code Section 25249.5 et seq.)

WARNING: Cancer and Reproductive Harm – www.P65Warnings.ca.gov

US. New Jersey Worker and Community Right-to-Know Act**Chemical Identity****US. Massachusetts RTK - Substance List****Chemical Identity**

Quartz

Chromium and chromium alloys or compounds (as Cr)

Nickel

US. Pennsylvania RTK - Hazardous Substances**Chemical Identity**

Titanium dioxide (naturally occurring)

Manganese

US. Rhode Island RTK

No ingredient regulated by RI Right-to-Know Law present.

Canada Federal Regulations**List of Toxic Substances (CEPA, Schedule 1)**

Not Regulated

Export Control List (CEPA 1999, Schedule 3)

Not Regulated

National Pollutant Release Inventory (NPRI)**Canada. National Pollutant Release Inventory (NPRI) Substances, Part 5, VOCs with Additional Reporting Requirements**

NPRI PT5 Not Regulated

Canada. National Pollutant Release Inventory (NPRI) (Schedule 1, Parts 1-4)

NPRI Not Regulated

Greenhouse Gases

Not Regulated

Controlled Drugs and Substances Act

CA CDSI Not Regulated

CA CDSII Not Regulated

CA CDSIII Not Regulated

CA CDSIV Not Regulated

CA CDSV Not Regulated

CA CDSVII Not Regulated

CA CDSVIII Not Regulated

Precursor Control Regulations

Not Regulated

Mexico. Substances subject to reporting for the pollutant release and transfer registry (PRTR): Not applicable

Inventory Status:

| | |
|--|---|
| Canada DSL Inventory List: | On or in compliance with the inventory |
| EINECS, ELINCS or NLP: | On or in compliance with the inventory |
| Japan (ENCS) List: | One or more components are not listed or are exempt from listing. |
| China Inv. Existing Chemical Substances: | On or in compliance with the inventory |
| Korea Existing Chemicals Inv. (KECI): | On or in compliance with the inventory |
| Canada NDSL Inventory: | One or more components are not listed or are exempt from listing. |
| Philippines PICCS: | On or in compliance with the inventory |
| US TSCA Inventory: | On or in compliance with the inventory |
| New Zealand Inventory of Chemicals: | On or in compliance with the inventory |
| Japan ISHL Listing: | One or more components are not listed or are exempt from listing. |
| Japan Pharmacopoeia Listing: | One or more components are not listed or are exempt from listing. |
| Mexico INSQ: | On or in compliance with the inventory |
| Ontario Inventory: | On or in compliance with the inventory |
| Taiwan Chemical Substance Inventory: | On or in compliance with the inventory |
| Australia Industrial Chem. Act (AIIIC): | On or in compliance with the inventory |
| Switzerland New Subs Notified/Registered: | One or more components are not listed or are exempt from listing. |
| Thailand Existing Chemical Inv. List: | One or more components are not listed or are exempt from listing. |
| Vietnam National Chemical Inventory: | One or more components are not listed or are exempt from listing. |

16. OTHER INFORMATION**Definitions:**

Revision Date: 09/26/2023

Further Information: Additional information is available by request.

Disclaimer: The Lincoln Electric Company urges each end user and recipient of this SDS to study it carefully. See also www.lincolnelectric.com/safety. If necessary, consult an industrial hygienist or other expert to understand this information and safeguard the environment and protect workers from potential hazards associated with the handling or use of this product. This information is believed to be accurate as of the revision date shown above. However, no warranty, expressed or implied, is given. Because the conditions or methods of use are beyond Lincoln Electric's control, we assume no liability resulting from the use of this product. Regulatory requirements are subject to change and may differ between various locations. Compliance with all applicable Federal, State, Provincial, and local laws and regulations remain the responsibility of the user.

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