Teck

SULFUR
MATERIAL SAFETY DATA SHEET

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product Identity: Molten Sulfur

Manufacturer:
Teck Metals Ltd.
Trail Operations
Trail, British Columbia
V1R 4L8
Emergency Telephone: 250-364-4214

Supplier:
Teck American Incorporated
Industrial Chemicals
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MSDS Preparer:
Teck Metals Ltd.
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Vancouver, British Columbia
V6C 0B3

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Product Use: Raw material used in the manufacture of sulfuric acid and sulfur dioxide.

Note: Although this MSDS was prepared to address the hazards of molten sulfur, Teck Metals Ltd. recognizes that the product transforms into a solid rapidly upon cooling. Sections 3, 4, 5, 6, 7, 8, 9, and 11 address the hazards of the dry, as well as the molten, state of sulfur.

SECTION 2. COMPOSITION / INFORMATION ON INGREDIENTS

Hazardous Ingredient	Approximate Percent by Weight	CAS Number	Occupational Exposure Limits (OELs)		LD_{50} / LC_{50} Species and Route	
Sulfur	99.5%	7704-34-9	OSHA PEL	None established*	LD_{50}, rat, oral	>8437 mg/kg
			ACGIH TLV	None established*	LC_{50}, mammal, inhal	1660 mg/m^3/?Hr
			NIOSH REL	None established*		

NOTE: OELs for individual jurisdictions may differ from OSHA PELs. Check with local authorities for the applicable OELs in your jurisdiction. OSHA - Occupational Safety and Health Administration; ACGIH - American Conference of Governmental Industrial Hygienists; NIOSH - National Institute for Occupational Safety and Health. OEL – Occupational Exposure Limit, PEL – Permissible Exposure Limit, TLV – Threshold Limit Value, REL – Recommended Exposure Limit.

* - NOTE: While there are no established OELs for elemental sulfur as such, there are OELs for the sulfur dioxide gas which will be formed during any combustion processes. The OSHA PEL for SO_2 is a time-weighted average concentration (TWA) of 5 ppm, the ACGIH TLV is a short term exposure limit (STEL) of 0.25 ppm and the NIOSH REL is a TWA of 2 ppm and a STEL of 5 ppm.

Trade Names and Synonyms: Sulphur, flowers of sulfur, brimstone.

SECTION 3. HAZARDS IDENTIFICATION

Emergency Overview: A bright yellow powder or an amber-to-yellow liquid. Sulfur is relatively non-toxic and poses little immediate health hazard to the environment or emergency response personnel unless it is involved in a fire. Both solid and liquid sulfur are combustible and generate large quantities of toxic and irritating sulfur dioxide gas on burning. Molten sulfur is hot enough to cause serious thermal burns to unprotected skin. Wear full protective clothing and positive pressure self-contained breathing apparatus in emergency situations involving burning sulfur.

Potential Health Effects: Sulfur is relatively non-toxic to humans, causing only mild local irritation to the eyes, nose, throat and upper airways. However, under certain circumstances it may release toxic hydrogen sulfide and/or sulfur dioxide gas. Sulfur is not listed as a carcinogen by OSHA, NTP, IARC or ACGIH. (See Toxicological Information, Section 11)

Potential Environmental Effects: This product has the potential to pose ecological risks to organisms in both aquatic and terrestrial environments. Discharge of the product to soil and water should be prevented. (See Ecological Information, Section 12)

SECTION 4. FIRST AID MEASURES

Eye Contact: Do not allow victim to rub eye(s). Let the eye(s) water naturally for a few minutes. If particle/dust does not dislodge, flush with lukewarm, gently flowing water for 5 minutes or until particle/dust is removed, while holding eyelid(s) open. If irritation persists, immediately obtain medical attention. DO NOT attempt to manually remove anything stuck to the eye.

Skin Contact: *Dry sulfur*: No health effects expected. If irritation does occur, flush with lukewarm, gently flowing water for 5 minutes. If irritation persists, obtain medical advice. *Molten sulfur:* Flush contact area to solidify and cool but do not attempt to remove encrusted material or clothing. Cover burns and seek medical attention immediately.

Inhalation: Remove source of contamination or move victim from exposure area to fresh air immediately. Obtain medical advice. If breathing has stopped, trained personnel should begin artificial respiration. If the heart has stopped, immediately start cardiopulmonary resuscitation (CPR), or automated external defibrillation (AED). If either of the above adverse circumstances occurs, quickly transport victim to an emergency care facility.

Ingestion: If swallowed, no specific intervention is indicated as this material is not likely to be hazardous by ingestion. However, if irritation or discomfort occurs, obtain medical advice.

SECTION 5. FIRE FIGHTING MEASURES

Fire and Explosion Hazards: Both molten and solid forms are combustible and will ignite at high temperatures (>200°C), burning with a pale blue flame that may be difficult to see in daylight. Sulfur dust suspended in air ignites easily and can cause explosions in confined spaces. Sulfur dust clouds can be ignited by friction, static electricity, heat, sparks or flames. Traces of hydrogen sulfide and sulfur vapor may present an explosion hazard if evolved into a confined space or enclosed space, particularly from molten sulfur. The LEL of hydrogen sulfide (4.3% by volume in air) may be exceeded in enclosed spaces above molten sulfur.

Extinguishing Media: Use water spray, fog or foam. Do not use direct water streams. Sand, dry chemical or fine earth/finely crushed stone may be used for small fires. Steam or inert gases are excellent extinguishers for use in containers that can be tightly closed.

Fire Fighting: Toxic fumes of sulfur dioxide will result from combustion. Fire fighters must be fully-trained and wear full protective clothing including an approved, self-contained breathing apparatus which supplies a positive air pressure within a full face-piece mask. Do not spray water directly into containers of molten sulfur due to the danger of boil over. Also avoid spraying direct streams of water that may scatter burning sulfur and spread the fire or create sulfur dust clouds and cause an explosion. Evacuate non-essential personnel from the fire area immediately. For large fires, consider evacuation of an area downwind of fire if necessary. Fire will rekindle until mass has been cooled to below approximately 150°C. Cool surrounding area and containers until well after the fire is out to prevent re-ignition.

Flashpoint and Method: 207°C.

Upper and Lower Flammable Limit: Dust in air 1400 g/m^3 and 35 g/m^3.

Autoignition Temperature: 232°C.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Procedures for Cleanup: Control source of spillage if possible to do so safely. Contain spill, isolate area, and deny entry to unauthorized personnel. Remove all potential ignition sources. Ventilate area. Prevent spread of liquid by diking or ditching and allowing material to cool and solidify. Clean up spilled material immediately, observing precautions in Section 8, Personal Protection and using methods which will minimize dust generation (e.g., dampen material and shovel or wet sweep using natural fiber brooms and aluminum shovels to prevent sparks). Return uncontaminated spilled material to the process if possible. Place contaminated material in suitable labeled containers for later recovery or disposal. Treat or dispose of waste material in accordance with all local, regional, and national requirements. If molten sulfur is accidentally released into a confined or enclosed space, monitor for hydrogen sulfide and sulfur dioxide build-up in the vapor space above the spill.

Personal Precautions: Protective clothing, gloves, and an acid gas/particulate respirator are recommended for persons responding to an accidental release. Close-fitting safety goggles may also be necessary in some circumstances to prevent eye contact with sulfur dust.

Environmental Precautions: This product has the potential to pose ecological risks to organisms in both aquatic and terrestrial environments. Discharge of the product to soil and water should be prevented. Prevent spillage from entering sewers or natural watercourses.

SECTION 7. HANDLING AND STORAGE

Keep container closed and store in a dry, cool, covered, and well-ventilated area, away from flammable materials, sources of ignition and oxidizing agents. Hydrogen sulfide gas may accumulate in storage tanks and bulk transport compartments containing this material, particularly when molten, so always exercise caution when working around or opening bulk containers. Closed tanks or pits should be vented to the atmosphere using steam jacketed vent lines. Head space above molten sulfur may contain high concentrations of hydrogen sulfide or sulfur dioxide in the toxic and explosive range. Ventilate thoroughly before permitting entry. Avoid generating dust and the release of dust into the workplace as this creates a potential explosion hazard. Since dry sulfur may accumulate static charge build-up, which could become an ignition source, transfer using proper grounding procedures. See the latest edition of NFPA Standard 655 – Prevention of Sulfur Fires and Explosions for specific guidance on dust explosion prevention.

Precautions should be taken to minimize skin and eye contact with material. Refrain from eating, drinking, or smoking in work areas. Thoroughly wash hands before eating, drinking, or smoking in appropriate designated areas.

SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Protective Clothing: Gloves and coveralls, shop coat or other work clothing with long sleeves are recommended to prevent direct skin contact, particularly when handling molten sulfur. Eye protection should be worn where fume or dust is generated. Chemical splash goggles and full face shield should be worn where any possibility exists that eye contact with liquid sulfur may occur. Respiratory protection may be required where fume or dust is generated. Workers should wear insulated gloves and heat- and chemical-resistant clothing when handling molten sulfur. Safety type boots are recommended.

Ventilation: Use adequate local or general ventilation to maintain the concentration of sulfur dioxide and hydrogen sulfide in the working environment well below recommended occupational exposure limits. Use a non-sparking, grounded ventilation system separate from other exhaust ventilation systems. Locate dust collectors outdoors if possible and provide dust collectors with explosion vents. Supply sufficient replacement air to make up for air removed by the exhaust system. Ventilation systems may need to be designed using steam tracing or other means to prevent plugging with sublimed sulfur.

Respiratory Protection: Where dust or sulfur dioxide are generated and cannot be controlled to within acceptable levels, use appropriate NIOSH-approved respiratory protection equipment (a combination of a 42CFR84 Class N, R or P-95 or 100 particulate filter and an acid gas cartridge). Where hydrogen sulfide is present or possibly present in confined spaces at hazardous levels a NIOSH-approved supplied air respirator or self-contained breathing apparatus (SCBA) is necessary.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Amber to Yellow Liquid/Solid	**Odor:** Odorless or faint rotten egg odor	**Physical State:** Liquid or Solid	**pH:** Not Applicable
Vapor Pressure: <0.001 mm Hg @ 20°C 0.11 mm Hg @140°C	**Vapor Density:** Not Applicable	**Boiling Point/Range:** 444.6°C	**Melting Point/Range:** 112-120°C
Specific Gravity: 1.92 - 2.07 Solid Sulfur 1.811 Molten Sulfur	**Evaporation Rate:** Not Available	**Coefficient of Water/Oil Distribution:** Not Available	**Odor Threshold:** H2S – <0.01 ppm
Solubility in Water: Insoluble	**Other:** Bulk Density -Liquid 1.811 kg/L (113 lb/ft^3) -Lumps 1201-1842 kg/m^3 (75 – 115 lb/ft^3) -Powder 528-1281 kg/m^3 (33 – 80 lb/ft^3)		

SECTION 10. STABILITY AND REACTIVITY

Stability and Reactivity: Sulfur is stable and not considered reactive under normal temperatures and pressures. Hazardous polymerization or runaway reactions will not occur.

Incompatibilities: Oxidizing agents, alkali metals, hydrogen, chlorine, fluorine. Sulfur may form explosive mixtures with powerful oxidizing agents such as chlorates, perchlorates and/or nitrates. Damp sulfur is corrosive to steel, particularly in the presence of chlorides.

Hazardous Decomposition Products: Burning sulfur liberates large volumes of sulfur dioxide which will be extremely irritating to eyes and breathing passages. Hydrogen sulfide gas may be released from molten sulfur under certain storage conditions and can accumulate to toxic and potentially explosive concentrations in the vapor space of molten sulfur storage or transportation systems.

SECTION 11. TOXICOLOGICAL INFORMATION

General: Sulfur itself is essentially non-toxic. Molten sulfur is a hazardous material because of its high temperature (>122°C). Under certain conditions both heated and dry sulfur may evolve toxic hydrogen sulfide and sulfur dioxide gases. At increasing concentration levels, these gases can cause eye and respiratory irritation. Breathing failure, unconsciousness and death may result from exposure to high concentrations of hydrogen sulfide, without any warning odor being sensed.

Acute:
Skin/Eye: *Molten:* Skin contact with molten material will cause thermal burns. Molten sulfur in the eye will cause burns and permanent damage. Exposure to sulfur vapors may be irritating to the eyes. *Dry:* Eye contact with dusts may be irritating.

Inhalation: Dusts may be irritating to the throat and lungs. Inhalation of low levels of vapors containing hydrogen sulfide or sulfur dioxide can produce respiratory tract irritation characterized by sneezing, coughing, sore throat and chest pain. At increasing concentrations exposure to hydrogen sulfide and sulfur dioxide can result in pulmonary edema, dizziness, nausea, respiratory paralysis, unconsciousness and death. Asthmatics may be more susceptible to sulfur dioxide exposures.

Ingestion: Ingestion of dry sulfur may cause irritation of the mouth and sore throat.

Chronic: Repeated or prolonged contact with dry sulfur powder may be irritating to the eyes and skin in some individuals, leading to dermatitis, eczema, skin ulcers, and allergic reactions. Repeated inhalation exposure to dust may cause bronchitis and irritation to mucous membranes and the respiratory tract. Prolonged exposure to low levels of sulfur dioxide has produced respiratory problems in animals. Sulfur is not considered a human carcinogen by the Occupational Safety and Health Administration (OSHA), the National Toxicology Program (NTP), the American Conference of Governmental Industrial Hygienists (ACGIH) or the International Agency for Research on Cancer (IARC).

SECTION 12. ECOLOGICAL INFORMATION

There is minimal immediate ecological risk from spills of this product. However, over long-term exposure under aerobic conditions, sulfur can oxidize, yielding acidic runoff (water) or acidic conditions in soils; the oxidized form, due to its acid nature, has the potential to adversely affect aquatic and terrestrial organisms. In addition, under anaerobic conditions, elemental sulfur can be biochemically reduced to forms such as sulfide ion or hydrogen sulfide, which also have the potential to pose ecological risks.

SECTION 13. DISPOSAL CONSIDERATIONS

If material cannot be returned to process or salvage, dispose of in accordance with applicable regulations.

SECTION 14. TRANSPORT INFORMATION*

Proper Shipping Name U.S. DOT and Transport Canada..... Sulfur, molten
Transport Canada and U.S. DOT Hazard Classification ..... Class 4.1, Packing Group III
Transport Canada and U.S. DOT Product Identification Number..... UN2448
Marine Pollutant..... No
IMO Classification..... Class 4.1

**Product is transported in a molten state.*

SECTION 15. REGULATORY INFORMATION

U.S.
Ingredient Listed on TSCA Inventory..... Yes

Hazardous Under Hazard Communication Standard ..... Yes

CERCLA Section 103 Hazardous Substances..... No

EPCRA Section 302 Extremely Hazardous Substance..... No

EPCRA Section 311/312 Hazard Categories ..... Physical Hazard - Flammable Solid

EPCRA Section 313 Toxic Release Inventory:..... This product does not contain toxic chemicals subject to Toxic Release Inventory reporting requirements.

CANADIAN:
Listed on Domestic Substances List:..... Yes
WHMIS Classification: ..... Controlled Product, Classification B4 (Flammable Solid)

SECTION 16. OTHER INFORMATION

The information in this Material Safety Data Sheet is based on the following references:

- American Conference of Governmental Industrial Hygienists, 2004, Documentation of the Threshold Limit Values and Biological Exposure Indices, 7th Edition plus updates.
- American Conference of Governmental Industrial Hygienists, 2012, Guide to Occupational Exposure Values.
- American Conference of Governmental Industrial Hygienists, 2012, Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.
- Bretherick's Handbook of Reactive Chemical Hazards, 20th Anniversary Edition. (P. G. Urben, Ed), 1995.
- Commission de la santé et la sécurité du travail, Service du répertoire toxicologique, Soufre, 2008-03.
- Extoxnet Pesticide Information Profile – Sulfur (Revised 9/95), National Pesticide Information Centre, Oregon State University.
- Industry Canada, Controlled Products Regulations SOR/88-66, as amended.
- International Labour Office (WHO/ILO) Encyclopedia of Occupational Health & Safety 4th Ed. CD-ROM Version (1998).
- International Uniform Chemical Information Database (IUCLID), European Chemicals Bureau, SULFUR, 19-Feb-2000.
- Merck & Co., Inc., 2001, The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals, Thirteenth Edition.
- National Library of Medicine, National Toxicology Information Program, Hazardous Substance Data Bank. (on-line version accessed 3-Nov-09).
- New Zealand Department of Labour, Approved Code of Practice for the Prevention of Sulphur Fires and Explosions, Sept 1993.
- Patty's Toxicology, Fifth Edition, 2001: E. Bingham, B. Cohrssen & C.H. Powell, Ed.
- U.S. Dept. of Health and Human Services, National Institute for Occupational Safety and Health. NIOSH Pocket Guide to Chemical Hazards. CD-ROM Edition DHHS (NIOSH) September 2005.
- U.S. Dept. of Health and Human Services, National Institute for Occupational Safety and Health, Registry of Toxic Effects of Chemical Substances (RTECS) CCOHS Web Access subscription *(last accessed 29-Sept-12)*.
- U.S. Occupational Safety and Health Administration, 1989, Code of Federal Regulations, Title 29, Part 1910.

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