

LUBEREF Liquid Sulphur Specifications

Type of test	Method	Unit	Min/Max	Liquid Sulphur
Color				Bright Yellow
Sulphur Purity		wt %	Min	99.8
Inorganic Ash		ppmw	Max	0.05
Carbon		ppmw	Max	0.05
H ₂ S		ppmw	Max	15
Arsenic		ppmw	Max	0.25
Selenium		ppmw	Max	1
Tellurium		ppmw	Max	1

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MATERIAL SAFETY DATA SHEET

LIQUID SULFUR

MSDS

EMERGENCY OVERVIEW

DANGER!

**FLAMMABLE SOLID - BURNING SULFUR EMITS TOXIC AND SUFFOCATING
SULFUR DIOXIDE - MOLTEN SULFUR MAY EVOLVE TOXIC AND
FLAMMABLE HYDROGEN SULFIDE GAS -**



MOLTEN SULFUR CAN CAUSE THERMAL BURNS NFPA 704 (Section 16)

Solid and molten sulfur can be ignited; burning sulfur produces sulfur dioxide, an irritating, toxic, and suffocating gas.

Dust particles may be irritating to the eyes, nose, throat, and skin. Molten sulfur can cause thermal burns.

Molten sulfur may evolve HYDROGEN SULFIDE (toxic gas) which may accumulate in storage container vapor space. High concentration may cause immediate unconsciousness - death may result unless victim is promptly and successfully resuscitated. Hydrogen sulfide causes eye irritation.

1. CHEMICAL PRODUCT AND COMPANY INFORMATION

Product name: Liquid Sulfur

Product Code:

Product Use: Sulfur

Company Identification

Saudi Aramco Base Oil Co. - LUBEREF

P.O. Box: 5188

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Transportation Emergency Response

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Health Emergency

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2. COMPOSITION and CHEMICAL INFORMATION ON INGREDIENTS

INGREDIENT NAME (CAS No.)	CONCENTRATION PERCENT BY WEIGHT
Sulfur (7704-34-9)	100
Hydrogen Sulfide (7783-06-4)	< trace - see below >

Hydrogen Sulfide (H₂S) may be present in trace quantities (by weight) in molten sulfur but may accumulate to toxic or flammable concentrations in enclosed spaces such as molten sulfur storage pits, tanks, or tanker/railcar headspaces. H₂S is not considered a hazard associated with solid sulfur.

3. HAZARDS IDENTIFICATION

EYES

Contact with molten sulfur may cause serious burns and blindness. Sulfur vapor may cause eye irritation. Dust contact with eyes may cause mechanical irritation (abrasion), characterized by a scratchy discomfort. This may progress to burning and tearing, with blurring of vision upon repeated or prolonged exposure. These symptoms are generally reversible once exposure is discontinued. Excessive exposure may cause more severe symptoms such as redness, pain, sensitivity to light, and conjunctivitis. Some severe exposure cases have resulted in permanent damage.

Exposure to approximately 8 ppm sulfur vapor has been shown to cause eye irritation.

SKIN

Prolonged contact with sulfur dust in a localized area may result in irritation, primarily from abrasive action. Molten sulfur may cause 1st, 2nd, or 3rd degree thermal burns.

INGESTION

Ingestion of small amounts of solid sulfur should not cause significant health effects. Large doses can produce mucous membrane irritation, difficult swallowing, redness of the throat and tongue, stomach, and urinary disturbances. Vomiting, abdominal pain and diarrhea may also occur. Long-term ingestion of small amounts may have a laxative effect. Ingestion of very large amounts may cause sore throat, nausea, headache, and possibly unconsciousness in severe cases. May be converted into hydrogen sulfide in the intestine.

INHALATION

Inhalation of low concentrations of dust should not cause significant health effects. Inhalation of large amounts of dust may cause inflammation of the nose and throat, resulting in secretions from the nose. Symptoms include sore throat, tightness of the chest, chest pain, lightheadedness, and persistent cough with sputum.

WARNING: Irritating and toxic hydrogen sulfide gas may be found in confined vapor spaces. Greater than 15 - 20 ppm continuous exposure can cause mucous membrane and respiratory tract irritation. 50 - 500 ppm can cause headache, nausea, and dizziness, loss of reasoning and balance, difficulty in breathing, fluid in the lungs, and possible loss of consciousness. Greater than 500 ppm can cause rapid or



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immediate unconsciousness due to respiratory paralysis and death by suffocation unless the victim is removed from exposure and successfully resuscitated.

The "rotten egg" odor of hydrogen sulfide is not a reliable indicator for warning of exposure, since olfactory fatigue (loss of smell) readily occurs, especially at concentrations above 50 ppm. At high concentrations, the victim may not even recognize the odor before becoming unconscious.

CHRONIC

Long-term exposure to high concentrations can cause respiratory disease - see Section 11, Toxicological Information.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

Exposure may aggravate preexisting bronchitis, asthma, and open wounds, skin disorders, and dermatitis (rash).

4. FIRST AID MEASURES

EYES

In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

SKIN

Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or redness develops. Thermal burns require immediate medical attention depending on the severity and the area of the body burned.

INGESTION

DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Monitor for breathing difficulties. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

INHALATION

Remove person to fresh air. If person is not breathing provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

5. FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES:

FLASH POINT:	405 °F (207 °C)
AUTOIGNITION TEMPERATURE:	450 °F (232 °C)
LOWER EXPLOSIVE LIMIT (%):	35 gm/m ³ (dust); 4% for hydrogen sulfide
UPPER EXPLOSIVE LIMIT (%):	1,400 gm/m ³ (dust); 44% for hydrogen sulfide

FIRE AND EXPLOSION HAZARDS

Reference NFPA 655 "Prevention of Sulfur Fires and Explosions," 1993.

Flammable solid with a relatively low ignition temperature. Sulfur dust ignites easily in air. Grinding sulfur may produce an explosion hazard. Static discharge may ignite sulfur dust.



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Sulfur burns with a pale blue flame that may be difficult to see in daylight. Burning sulfur will flow and emits large quantities of sulfur dioxide (SO₂), a toxic, irritating, and suffocating gas that can cause severe lung damage and death.

Molten sulfur may evolve hydrogen sulfide (H₂S) - H₂S is a flammable gas and may present an explosion hazard in a confined space. Under certain conditions, H₂S can react to form pyrophoric iron compounds in enclosed spaces such as sulfur pits.

EXTINGUISHING MEDIA

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO₂, water spray, fire fighting foam, or Halon.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

FIRE FIGHTING INSTRUCTIONS

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment.

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing.

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

See Section 16 for the NFPA 704 Hazard Rating.

6. ACCIDENTAL RELEASE MEASURES

ACTIVATE FACILITY SPILL CONTINGENCY or EMERGENCY PLAN.

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Product may release substantial amounts of flammable vapors and gases (e.g., methane, ethane, and propane), at or below ambient temperature depending on source and process conditions and pressure.

Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection - do not discharge solid water stream patterns into the liquid resulting in splashing.

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal. Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

7. HANDLING and STORAGE

HANDLING and STORAGE PRECAUTIONS

Store solid sulfur in a well ventilated area away from incompatible materials. The hazards of hydrogen sulfide should be considered when storing or transporting molten sulfur. H₂S can accumulate in confined spaces such as sulfur pits and headspaces of truck trailers and railcars. Exposure to H₂S is possible during product transfer into/out of truck trailers and railcars.

Use appropriate engineering controls or respiratory protection. Sulfur pits should be vented away from possible worker exposure areas.



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Prohibit smoking in storage and work areas. Electrical installations and equipment in hazardous locations should be installed according to articles 501 and 502 of the National Electric Code. Reference also NFPA 655 Standard for the Prevention of Sulfur Fires and Explosions.

WORK/HYGIENIC PRACTICES

Protect against hot liquid. Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use gasoline or solvents (naphtha, kerosene, etc.) for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Consider the need to discard contaminated leather shoes and gloves.

8. EXPOSURE CONTROLS and PERSONAL PROTECTION

EXPOSURE LIMITS

Components (CAS No.)	Source	<u>Exposure Limits</u>		Note
		TWA/STEL		
Sulfur (17704-34-9)	OSHA ACGIH	PEL = None established TLV = None established		
Hydrogen Sulfide (H ₂ S) (7783-06-4)	OSHA ACGIH	PEL = 20ppm; STEL = 50 ppm TLV = 10 ppm; STEL = 15 ppm		2006 NOIC 1/5 ppm

ENGINEERING CONTROLS

Use adequate ventilation to keep vapor, hydrogen sulfide and dust concentrations of this product below occupational exposure limits and flammability limits, particularly in confined spaces. Use explosion-proof equipment and lighting in classified/controlled areas.

EYE/FACE PROTECTION

Safety goggles are recommended for excessive dust exposure. Use faceshield for protection against molten sulfur.

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SKIN PROTECTION

Avoid repeated or prolonged skin contact. For protection from molten sulfur, gloves and skin protection constructed of leather or heat resistant materials are recommended.

RESPIRATORY PROTECTION

If a hydrogen sulfide hazard is present (that is, exposure potential above H₂S permissible exposure limit), use a positive-pressure SCBA or Type C supplied air respirator with escape bottle.

Dust protection: where it has been determined that there is no hydrogen sulfide exposure hazard (that is, exposure potential below H₂S permissible exposure limit), a NIOSH/ MSHA-approved air-purifying respirator with dust cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, ANSI Z88.21992, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

9. PHYSICAL and CHEMICAL PROPERTIES

APPEARANCE

Yellow solid in block or pellet form; easily crushed into yellow dust. Hot, yellow liquid

ODOR

Pure sulfur is odorless and tasteless. However, trace hydrocarbon impurities may give it a faint oily and/or rotten egg odor.

Hydrogen sulfide (H₂S) has a rotten egg “sulfurous” odor. This odor should not be used as a warning property of toxic levels because H₂S can overwhelm and deaden the sense of smell. Also, the odor of H₂S in heavy oils can easily be masked by the petroleum-like odor of the oil. Therefore, the smell of H₂S should not be used as an indicator of a hazardous condition - a H₂S meter or colorimetric indicating tubes are typically used to determine the concentration of H₂S.

BASIC PHYSICAL PROPERTIES

BOILING POINT:	832 °F (445 °C)
MELTING POINT:	235 to 248 °F (113 to 120 °C)
VAPOR PRESSURE:	4x10 ⁻⁶ mm Hg @ 86 °F (30 °C)
SPECIFIC GRAVITY (H ₂ O = 1):	AP 1.96 (varies)
PERCENT VOLATILES:	Negligible
SOLUBILITY:	Insoluble in water

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10. STABILITY and REACTIVITY

STABILITY: Stable. Hazardous polymerization will not occur.

CONDITIONS TO AVOID and INCOMPATIBLE MATERIALS

Avoid high temperatures, open flames, welding, smoking and ignitions sources. Under certain conditions, H₂S can react to form pyrophoric iron compounds in enclosed spaces such as sulfur pits. Exposure of pyrophoric compounds to air or moisture can cause excessive heat generation, smoke and toxic gases, and fire.

INCOMPATIBLE MATERIALS

Sulfur is incompatible with a number of chemical materials including, but not limited to, chlorates, nitrates, other oxidizers, carbides, halogens, phosphorus, and heavy metals. This incompatibility may result in fire, excessive heat generation, uncontrolled reaction, release of toxic products and/or explosion. A comprehensive list of incompatible materials may be found in the latest edition of Sax's "Dangerous Properties of Industrial Materials" and the NFPA "Hazardous Materials Guide".

HAZARDOUS DECOMPOSITION PRODUCTS:

Sulfur burns to sulfur dioxide. Sulfur reactions with hydrocarbons and other organic materials may produce hydrogen sulfide and carbon disulfide. Other possibly toxic reaction or decomposition products are highly dependent on the incompatible material.

11. TOXICOLOGICAL PROPERTIES

ACUTE TOXICITY

Large doses (15 grams) by mouth may lead to hydrogen sulfide production in the body, chiefly due to bacterial action within the colon.

Rat-oral LD50 = 175 mg/kg

CHRONIC EFFECTS AND CARCINOGENICITY

Carcinogenicity: **OSHA:** NO **IARC:** NO **NTP:** NO **ACGIH:** NO

Prolonged inhalation of dust over several years (as demonstrated in miners) may cause respiratory disease, complicated by emphysema and bronchiectasis. Asthma and inflammation of the frontal and maxillary sinuses are frequent complications. Pulmonary function may be reduced showing increased oxygen consumption, reduced respiratory volume, and impaired carbon dioxide diffusion capacity. Radiological examinations have revealed irregular opacities in the lungs and nodulation.

12. ECOLOGICAL INFORMATION

Keep out of sewers, drainage areas, and waterways. Report spills and releases, as applicable, under Federal and State regulations.

13. DISPOSAL CONSIDERATIONS

Consult federal, state and local waste regulations to determine appropriate disposal options

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14. TRANSPORTATION INFORMATION	<u>DOMESTIC SHIPMENT</u>	<u>INTERNATIONAL SHIPMENT</u>
PROPER SHIPPING NAME:	SULFUR	SULFUR
HAZARD CLASS, PACKING GROUP:	9, PG III	4.1, PG III
DOT IDENTIFICATION NUMBER:	NA 1350	UN 1350
DOT SHIPPING LABEL:	CLASS 9	FLAMMABLE SOLID
	SULFUR, MOLTEN	SULFUR, MOLTEN
PROPER SHIPPING NAME:		
HAZARD CLASS, PACKING GROUP:	9, PG III	4.1, PG III
DOT IDENTIFICATION NUMBER:	NA 2448	UN 2448
DOT SHIPPING LABEL:	CLASS 9	FLAMMABLE SULFUR

15. REGULATORY INFORMATION

U.S. FEDERAL, STATE, and LOCAL REGULATORY INFORMATION

Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other regulations at the state and/or local level. Consult those regulations applicable to your facility/operation.

CLEAN WATER ACT (OIL SPILLS)

Any spill or release of this product to "navigable waters" (essentially any surface water, including certain wetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of a sludge or emulsion must be reported immediately to the National Response Center (1-800-424-8802) as required by U.S. Federal Law. Also contact appropriate state and local regulatory agencies as required.

CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIRONMENT)

The CERCLA definition of hazardous substances contains a "petroleum exclusion" clause which exempts crude oil, refined, and unrefined petroleum products and any indigenous components of such. However, other federal reporting requirements (e.g., SARA Section 304) may still apply.

SARA SECTION 311/312 - HAZARD CLASSES

<u>ACUTE HEALTH REACTIVE</u>	<u>CHRONIC HEALTH</u>	<u>FIRE</u>	<u>SUDDEN RELEASE OF PRESSURE</u>	
X	X	X	--	--

SARA SECTION 313 - SUPPLIER NOTIFICATION

This product does not contain any chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372.

CALIFORNIA PROPOSITION 65 LIST OF CHEMICALS

This product does not contain chemicals that are included on the Proposition 65 "List of Chemicals" required by the California Safe Drinking Water and Toxic Enforcement Act of 1986.

CANADIAN REGULATORY INFORMATION (WHMIS)

Class B, Division 4 (Flammable Solid) and Class D, Div 1A (Very Toxic material - hydrogen sulfide)

NFPA® HAZARD RATING HEALTH: 1
 FIRE: 1
 REACTIVITY: 0

Refer to NJPA 704 "Identification of the Fire Hazards of Materials" for further information



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HMIS® HAZARD RATING	HEALTH:	1 *	Slight
	FIRE:	1	Moderate
	Physical:	0	Negligible
			* Chronic

SPECIAL HAZARDS: Toxic and flammable hydrogen sulfide (poison gas) may accumulate in the vapor space of molten sulfur storage container

SUPERSEDES MSDS DATED: 03/22/2000

ABBREVIATIONS:

AP = Approximately < = Less than > = Greater than
N/A = Not Applicable N/D = Not Determined ppm = parts per million

ACRONYMS:

ACGIH American Conference of Governmental Industrial Hygienists
AIHA American Industrial Hygiene Association ANSI American National Standards Institute (212) 642-4900
API American Petroleum Institute (202) 682-8000
CERCLA Comprehensive Emergency Response, Compensation, and Liability Act
DOT U.S. Department of Transportation [General info: (800) 467-4922]
EPA U.S. Environmental Protection Agency
HMIS Hazardous Materials Information System
IARC International Agency For Research On Cancer
MSHA Mine Safety and Health Administration NFPA National Fire Protection Association (617)770-3000
NIOSH National Institute of Occupational Safety and Health
NOIC Notice of Intended Change (proposed change to ACGIH TLV)

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DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES

NTP	National Toxicology Program
OPA	Oil Pollution Act of 1990
OSHA	U.S. Occupational Safety & Health Administration
PEL	Permissible Exposure Limit (OSHA)
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limit (NIOSH)
SARA	Superfund Amendments and Reauthorization Act of 1986 Title III
SCBA	Self-Contained Breathing Apparatus
SPCC	Spill Prevention, Control, and Countermeasures
STEL	Short-Term Exposure Limit (generally 15 minutes)
TLV	Threshold Limit Value (ACGIH)
TSCA	Toxic Substances Control Act
TWA	Time Weighted Average (8 hr.)
WEEL	Workplace Environmental Exposure Level (AIHA)
WHMIS	Canadian Workplace Hazardous

Materials Information System

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written

contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.