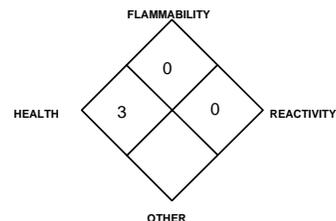


**NFPA RATING**

MATERIAL SAFETY DATA SHEET

Prepared to U.S. OSHA, CMA, ANSI and Canadian WHMIS Standards

PART I *What is the material and what do I need to know in an emergency?*

1. PRODUCT IDENTIFICATION

CHEMICAL NAME; CLASS: **SULFUR DIOXIDE - SO₂**
Document Number: P-0047

PRODUCT USE: For general analytical/synthetic chemical uses.

SUPPLIER/MANUFACTURER'S NAME: MESA Specialty Gases & Equipment
ADDRESS: 3619 Pendleton Avenue, Suite C
 Santa Ana, CA 92704

BUSINESS PHONE: 1-714-434-7102
EMERGENCY PHONE: INFOTRAC: 1-800-535-5053

DATE OF PREPARATION: May 20, 1996
SECOND REVISION: January 23, 1998

2. COMPOSITION and INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS #	mole %	EXPOSURE LIMITS IN AIR					
			ACGIH		OSHA		IDLH ppm	OTHER
			TLV ppm	STEL ppm	PEL ppm	STEL ppm		
Sulfur Dioxide	7446-09-5	> 99.98 %	2, A4 (Not Classifiable as Human Carcinogen)	5	5 2 (Vacated 1989 PEL)	5 (Vacated 1989 PEL)	100	NIOSH REL: 2 ppm TWA; 5 ppm STEL DFG-MAK: 2 ppm TWA
Maximum Impurities		< 0.02%	None of the trace impurities in this mixture contribute significantly to the hazards associated with the product. All hazard information pertinent to this product has been provided in this Material Safety Data Sheet, per the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200) and State equivalent standards.					

NE = Not Established

C = Ceiling Limit

See Section 16 for Definitions of Terms Used

NOTE: All WHMIS required information is included. It is located in appropriate sections based on the ANSI Z400.1-1993 format.

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: Sulfur Dioxide is a colorless, non-flammable, toxic gas with a distinct odor similar to burning sulfur. Sulfur Dioxide is shipped as a liquid which rapidly turns into a gas at standard atmospheric temperatures and pressures. Sulfur Dioxide is irritating to the respiratory system and to contaminated skin and eyes. Exposure to high concentrations of this gas may be fatal. Contact with rapidly expanding gases, or contact with the liquid, may cause frostbite. The gas reacts with water or moisture to generate sulfurous acid, which can also be corrosive to contaminated tissue.

SYMPTOMS OF OVEREXPOSURE BY ROUTE OF EXPOSURE: The most significant route of overexposure for Sulfur Dioxide is by inhalation. The following paragraphs describe symptoms of exposure by route of exposure.

INHALATION: Exposure to Sulfur Dioxide gas in low concentrations produces an irritating effect on the mucous membranes of the eyes, nose, throat, and lungs due to the formation of sulfurous acid when it comes into contact with moist tissues or moist air. Acute exposure through inhalation may result in dryness and irritation of the nose and throat, choking, coughing, and bronchospasm. Severe overexposure may cause death through systemic acidosis, pulmonary edema, or from respiratory arrest. High concentrations of Sulfur Dioxide gas may cause an oxygen deficient atmosphere. Exposure to high concentrations may cause unconsciousness, and under some circumstances, death.

Prolonged or repeated overexposures may cause impaired lung function, bronchitis, hacking cough, nasal irritation and discharge, increased fatigue, alteration in the senses of taste and smell. Repeated over exposures to Sulfur Dioxide can also result in dental erosion and gum disorders.

SKIN and EYE CONTACT: The gas may be irritating to the skin, especially in a moist environment. Symptoms of skin overexposure may include scratchiness, pain, and redness. If Sulfur Dioxide contaminates the eyes, damage to eye tissue will result in pain, inflammation, and potentially, blindness. Liquid Sulfur Dioxide will be very corrosive to contaminated skin and eye tissue, producing the same symptoms as described for the gas, but with the on-set of symptoms occurring more rapidly. Eye injury from contact with liquid Sulfur Dioxide may not be immediately noticed because of the damage which can occur to the optical nerves. Contact with liquid or rapidly expanding gases (which are released under high pressure) may cause frostbite. Symptoms of frostbite include change in skin color to white or grayish-yellow. The pain after such contact can quickly subside.

OTHER POTENTIAL HEALTH EFFECTS: While ingestion is highly unlikely, ingestion of Sulfur Dioxide can damage the tissues of the mouth, throat, esophagus, and other tissues of the digestive system. Ingestion of Sulfur Dioxide can be fatal. Additionally, aspiration by inhalation is possible, causing chemical pneumonia or death.

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in Lay Terms. Overexposure to Sulfur Dioxide may cause the following health effects:

ACUTE: This gas is toxic and damaging to the respiratory system as well as contaminated skin and eyes. Overexposures can result in severe irritation and burns of eyes, skin, mucous membranes, and any other exposed tissue. If inhaled, irritation of the respiratory system may occur, with coughing, and breathing difficulty. Overexposure to this gas may be fatal. Though unlikely to occur during occupational use, ingestion of large quantities may be fatal. Contact with liquid or rapidly expanding gases may cause frostbite.

CHRONIC: Prolonged or repeated overexposures may cause respiratory problems, bronchitis, hacking cough, nasal irritation and discharge, increased fatigue, alteration in the senses of taste and smell. Repeated over exposures to Sulfur Dioxide can also result in dental erosion and gum disorders.

TARGET ORGANS: Respiratory system, skin, eyes, central nervous system.

HAZARDOUS MATERIAL INFORMATION SYSTEM			
HEALTH		(BLUE)	3
FLAMMABILITY		(RED)	0
REACTIVITY		(YELLOW)	0
PROTECTIVE EQUIPMENT			H
EYES	RESPIRATORY	HANDS	BODY
	See Section 8		See Section 8
For routine industrial applications			

See Section 16 for Definition of Ratings

PART II *What should I do if a hazardous situation occurs?*

4. FIRST-AID MEASURES

RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO SULFUR DIOXIDE WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. At a minimum, Self-Contained Breathing Apparatus and Personal Protective Equipment should be worn

Remove victim(s) to fresh air, as quickly as possible. Trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation, if necessary. Only trained personnel should administer supplemental oxygen.

SKIN EXPOSURE: If Sulfur Dioxide contaminates the skin, immediately begin decontamination with running water. Minimum flushing is for 15 minutes. Remove exposed or contaminated clothing, taking care not to contaminate eyes. Victim must seek immediate medical attention.

Note: if frostbite has occurred after exposure to rapidly expanding gases, treatment for frostbite should be initiated after the contaminated areas has been flushed (per the instructions in the previous paragraph). In case of frostbite, place the frostbitten part in warm water. **DO NOT USE HOT WATER.** If warm water is not available, or is impractical to use, wrap the affected parts gently in blankets. Alternatively, if the fingers or hands are frostbitten, place the affected area in the armpit. Encourage victim to gently exercise the affected part while being warmed. Seek immediate medical attention.

EYE EXPOSURE: If liquid is splashed into eyes, or if irritation of the eye develops after exposure to liquid or gas, open victim's eyes while under gentle running water. Use sufficient force to open eyelids. Have victim "roll" eyes. Minimum flushing is for 15 minutes.

Victim(s) must be taken for medical attention. Rescuers should be taken for medical attention, if necessary. Take copy of label and MSDS to physician or other health professional with victim(s). Refer to "Recommendations to Physicians," Section 11 (Toxicological Information) for additional information on first-aid measures.

5. FIRE-FIGHTING MEASURES

FLASH POINT: Not applicable.

AUTOIGNITION TEMPERATURE: Not applicable.

FLAMMABLE LIMITS (in air by volume, %):

Lower (LEL): Not applicable.

Upper (UEL): Not applicable.

FIRE EXTINGUISHING MATERIALS: Use extinguishing media appropriate for the surrounding fire.

Water Spray: YES

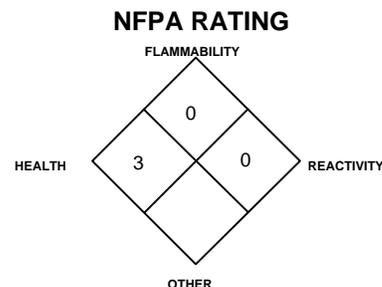
Carbon Dioxide: YES

Foam: YES

Dry Chemical: YES

Halon: YES

Other: Any "ABC" Class.



See Section 16 for Definition of Ratings

UNUSUAL FIRE AND EXPLOSION HAZARDS: Sulfur Dioxide is a toxic gas and presents a significant health hazard to firefighters. In the event of fire, cool containers of Sulfur Dioxide with water to prevent failure. Use a water spray or fog to reduce or direct vapors. Do not direct a water spray at the source of a release. Water spray should be used with care. Sulfur Dioxide can react with water to form a corrosive solution of sulfurous acid. Sulfurous acid can corrode metal.

Explosion Sensitivity to Mechanical Impact: Not sensitive.

Explosion Sensitivity to Static Discharge: Not sensitive.

SPECIAL FIRE-FIGHTING PROCEDURES: Incipient fire responders should wear eye protection. Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. Fight fires in a protected location. Approach fire from an upwind direction, to prevent overexposure to Sulfur Dioxide. If Sulfur Dioxide is involved in a fire, fire runoff water should be contained to prevent possible environmental damage. If unruptured cylinders are exposed to heat, the cylinder may rupture or burst and release the contents. It may be prudent to remove potentially heat-exposed cylinders from the area surrounding a fire, if it is safe for firefighters to do so.

6. ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK RESPONSE: Uncontrolled releases should be responded to by trained personnel using pre-planned procedures. Proper protective equipment should be used. In case of a release, clear the affected area, protect people, and respond with trained personnel. Adequate fire protection must be provided. Call CHEMTREC (1-800-424-9300) for emergency assistance.

Minimum Personal Protective Equipment should be **Level B: triple-gloves (rubber gloves and nitrile gloves, over latex gloves), chemically resistant suit and boots, hard-hat, and Self-Contained Breathing Apparatus.** A colorimetric tube is available for Sulfur Dioxide. If a colorimetric tube is used to indicate the concentration of Sulfur Dioxide, the reading obtained should be lower than the limits indicated in Section 2 (Composition and Information on Ingredients) before non-emergency personnel are permitted into area. Monitor the surrounding area for oxygen. The atmosphere must have at least 19.5 percent oxygen before personnel can be allowed in the area without Self-Contained Breathing Apparatus (SCBA).

Attempt to close the main source valve prior to entering the area. If this does not stop the release (or if it is not possible to reach the valve), allow the gas to release in-place or remove it to a safe area and allow the gas to be released there.

THIS IS A TOXIC GAS. Protection of all personnel and the area must be maintained.

PART III *How can I prevent hazardous situations from occurring?*

7. HANDLING and STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting Sulfur Dioxide ON YOU or IN YOU. Wash hands after handling chemicals. Do not eat or drink while handling chemicals. All work practices should minimize the release of Sulfur Dioxide. Be aware of any signs of exposure as indicated in Section 2 (Composition and Information on Ingredients); exposures to fatal concentrations of Sulfur Dioxide could occur rapidly.

STORAGE AND HANDLING PRACTICES: All employees who handle this material should be trained to handle it safely. Avoid breathing the gas or sprays or mists generated by Sulfur Dioxide. Store containers in a cool, dry location, away from direct sunlight, sources of intense heat, or where freezing is possible. Use only compatible materials for cylinders, process lines, and other Sulfur Dioxide-handling equipment. Anhydrous Sulfur Dioxide is not corrosive to steel and other common structural materials, except zinc. In the presence of moisture, however, corrosive conditions will develop. Lead, carbon, graphite, and stainless steel, type 316 are recommended for handling moist Sulfur Dioxide. Lines should be purged with dry nitrogen both before and after maintenance activity. Keep cylinder tightly closed when not in use. Keep cylinders away from incompatible material. Wash thoroughly after using this material. Workers must be thoroughly trained to handle Sulfur Dioxide without causing overexposure. Periodic inspections of process equipment by knowledgeable persons should be made to ensure that the equipment is used appropriately and the system is kept in suitable operating condition. Sulfur Dioxide emergency equipment should be available near the point of use.

- Workers who handle Sulfur Dioxide should wear protective clothing, as listed in Section 8 (Exposure Controls - Personal Protection).
- Instant-acting showers should be available in the event of an emergency.
- Special eye-wash fountains or similar equipment should be available for eye irrigation.
- Proper respiratory protection equipment must be provided and workers using such equipment must be carefully trained in its operation and limitations.
- Precautions must always be taken to prevent suck-back of foreign materials into the cylinder by using a check-valve, vacuum break, or trap, since suck-back may cause dangerous pressure changes within the cylinder.
- The cylinder valve should be closed after each use.

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS: Protect cylinders against physical damage. Store in cool, dry, well-ventilated area, away from sources of heat, ignition and direct sunlight. Do not allow area where cylinders are stored to exceed 52°C (125°F). Use a check valve or trap in the discharge line to prevent hazardous backflow. Post "No Smoking or Open Flame" signs in storage and use areas. Cylinders should be stored upright and be firmly secured to prevent falling or being knocked over. Cylinders can be stored in the open, but in such cases, should be protected against extremes of weather and from the dampness of the ground to prevent rusting. Never tamper with pressure relief devices. The rules following on the following page are applicable to situations in which cylinders are being used:

7. HANDLING and STORAGE (Continued)

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS (continued):

Before Use: Move cylinders with a suitable hand-truck. Do not drag, slide or roll cylinders. Do not drop cylinders or permit them to strike each other. Secure cylinders firmly. Leave the valve protection cap, if provided, in-place until cylinder is ready for use.

During Use: Use designated CGA fittings and other support equipment. Do not use adapters. Do not heat cylinder by any means to increase the discharge rate of the product from the cylinder. Use check valve or trap in discharge line to prevent hazardous backflow into the cylinder. Do not use oils or grease on gas-handling fittings or equipment.

After Use: Close main cylinder valve. Replace valve protection cap, if provided. Mark empty cylinders "EMPTY".

NOTE: Use only DOT or ASME code containers. Close valve after each use and when empty. Cylinders must not be recharged except by or with the consent of owner. For additional information refer to the Compressed Gas Association Pamphlet P-1, *Safe Handling of Compressed Gases in Containers*. Additionally, refer to CGA Bulletin SB-2 "Oxygen Deficient Atmospheres" and CGA Pamphlet G-3, "Sulfur Dioxide".

TANK CAR SHIPMENTS: Tank cars carrying Sulfur Dioxide should be loaded and unloaded in strict accordance with tank-car manufacturer's recommendations and all established on-site safety procedures. Appropriate personal protective equipment must be used during tank car operations (see Section 8, Exposure Controls - Personal Protection). All loading and unloading equipment must be inspected, prior to each use. Loading and unloading operations must be attended, at all times. Tank cars must be level and wheels must be locked or blocked prior to loading or unloading. Tank car (for loading) or storage tank (for unloading) must be verified to be correct for receiving Sulfur Dioxide and be properly prepared, prior to starting the transfer operations. Hoses must be verified to be clean and free of incompatible chemicals, prior to connection to the tank car or vessel. Valves and hoses must be verified to be in the correct positions, before starting transfer operations. A sample (if required) must be taken and verified (if required) prior to starting transfer operations. All lines must be blown-down and purged before disconnecting them from the tank car or vessel.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Make certain application equipment is locked and tagged-out safely. Purge gas handling equipment with inert gas (e.g., nitrogen) before attempting repairs.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation. Local exhaust ventilation is preferred, because it prevents Sulfur Dioxide dispersion into the work place by eliminating it at its source. If appropriate, install automatic monitoring equipment to detect the level of Sulfur Dioxide and oxygen. Eye wash stations/safety showers should be near areas where Sulfur Dioxide is used or stored.

RESPIRATORY PROTECTION: Maintain Sulfur Dioxide below the exposure limits provided in Section 2 (Composition and Information on Ingredients) and oxygen levels above 19.5% in the workplace. Use supplied air respiratory protection during emergency response to a release of Sulfur Dioxide or if oxygen levels are below 19.5%. If respiratory protection is required, follow the requirements of the Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), or equivalent State standards. The following NIOSH recommendations for Sulfur Dioxide concentrations in air are in place.

CONCENTRATION

Up to 20 ppm:

Up to 50 ppm:

Up to 100 ppm:

RESPIRATORY EQUIPMENT

Chemical cartridge respirator with cartridge(s); or Supplied Air Respirator (SAR).

Powered air-purifying respirator with cartridge(s); or SAR operated in continuous-flow mode.

Full-Facepiece chemical cartridge respirator with cartridge(s); or gas mask with canister; or powered air-purifying respirator with a tight-fitting facepiece and cartridge(s); or full-facepiece Self-Contained Breathing Apparatus (SCBA); or full-facepiece SAR; or SAR with a tight-fitting facepiece operated in a continuous-flow mode.

Emergency or Planned Entry into Unknown Concentration or IDLH Conditions: Positive pressure, full-facepiece SCBA; or positive pressure, full-facepiece SAR with an auxiliary positive pressure SCBA.

The IDLH concentration for Sulfur Dioxide is 100 ppm.

EYE PROTECTION: Splash goggles or safety glasses, for protection from rapidly expanding gases and splashes of Liquid Sulfur Dioxide. Additionally, face-shields should be worn if there is a potential for contact with liquid Sulfur Dioxide.

HAND PROTECTION: Wear mechanically-resistant gloves when handling cylinders of Sulfur Dioxide. Wear chemically-resistant gloves when using this gas. Butyl rubber, chlorinated polyethylene, neoprene are recommended.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION (Continued)

BODY PROTECTION: Use body protection appropriate for task. Coveralls may be appropriate if splashes from the liquefied gas are anticipated. Transfer of large quantities under pressure may require protective equipment appropriate to protect employees from splashes of liquefied product.

9. PHYSICAL and CHEMICAL PROPERTIES

VAPOR DENSITY: 2.668 kg/m³ (0.1665 lb/ft³)

SPECIFIC GRAVITY (air = 1): 2.263

SOLUBILITY IN WATER: Converts to soluble sulfurous acid.

VAPOR PRESSURE (psia): 49.1

ODOR THRESHOLD: 3-5 ppm.

pH: Not applicable. (1% solution in water will have a pH < 3).

COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.

EVAPORATION RATE (nBuAc = 1): Not applicable.

FREEZING POINT: -75.5°C (-103.9°F)

BOILING POINT @ 1 atm: -10°C (14.0°F)

EXPANSION RATIO: Not available.

SPECIFIC VOLUME (ft³/lb): 5.9

APPEARANCE AND COLOR: Colorless gas. The liquid is also colorless. The odor for both the liquid and gas is similar to that of burning sulfur.

HOW TO DETECT THIS SUBSTANCE (warning properties): Though the odor is extremely disagreeable, it does not serve as a reliable warning property for Sulfur Dioxide. The Odor Threshold is the same order of magnitude as the concentration of exposure associated with adverse health effects. In terms of leak detection, fittings and joints can be painted with a soap solution to detect leaks, which will be indicated by a bubble formation. Wet lead acetate paper can be used for leak detection. Additionally, leaks of Sulfur Dioxide in lines or equipment may be located by passing a squeeze bottle of aqueous ammonia over sites of suspected leaks; dense, white fumes will be formed near the leaks.

10. STABILITY and REACTIVITY

STABILITY: Stable.

DECOMPOSITION PRODUCTS: Will react with water or, moist air to form sulfurous acid.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Sulfur Dioxide is not compatible with the following materials: strong bases, strong oxidizers, powdered metals, metal oxides, sodium hydride, silver azide, cesium azide, zinc, zinc compounds, metal acetylides.

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Contact with moisture and incompatible materials. Cylinders exposed to high temperatures or direct flame can rupture or burst.

PART IV *Is there any other useful information about this material?*

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: The following information is for Sulfur Dioxide.

Eye, rabbit = 6 ppm/4 hours/32 days; mild effects

Mutation in Microorganisms System Test = 10 mmol/L

DNA damage System Test (human, lymphocyte) = 5700 ppb

TCLo (inhalation, mouse) = 32 ppm/ 24 hours (female 7-28 day post); reproductive effects.

TCLo (inhalation, mouse) = 25 ppm/7 hours (female 6-15 days post); teratogenic effects

TCLo (inhalation, mouse) = 500 ppm/5 minutes/30 weeks; equivocal tumorigenic data

LCLo (inhalation, human) = 1000 ppm/10 minutes; pulmonary effects

TCLo (inhalation, human) = 3 ppm/5 days; pulmonary effected

TCLo (inhalation, human) = 12 ppm/1 hour; pulmonary effects

LCLo (inhalation, human) = 3000 ppm/5 minutes

LC₅₀ (inhalation, rat) = 2520 ppm/1 hour

LC₅₀ (inhalation, mouse) = 3000 ppm/30 minutes

LCLo (inhalation, guinea pig) = 1039 ppm/24 hours

LCLo (inhalation, frog) = 1 pph/ 15 minutes

LCLo (inhalation, mammal) = 3,000 ppm/5 minutes

TCLo (inhalation, rat) = 4,910 mg/m³/6 hours/17 weeks–intermittent

TCLo (inhalation, rat) = 500 mg/m³/96 days– intermittent

TCLo (inhalation, dog) = 1 ppm/90 minutes/1 year– intermittent

TCLo (inhalation, dog) = 500 ppm/2 hours/21 weeks– intermittent

TCLo (inhalation, rabbit) = 200 mg/m³/3 hours/13 weeks– intermittent

EYE IRRITATION: Temporary clouding of eyes was seen in rabbits, guinea pigs, and mice exposed to 400 ppm for 4 hours. Very severe eye injury in rabbits was produced by a 5-second exposure to a stream of pure sulfur dioxide.

11. TOXICOLOGICAL INFORMATION (Continued)

TOXICITY DATA (continued):

SHORT-TERM INHALATION STUDIES: Most studies indicate that high concentrations of Sulfur Dioxide effect the mechanics of respiration. A dose-related narrowing of the bronchiole tubes leading to bronchio-constriction was seen in guinea pigs exposed to concentrations of 0.2-100 ppm for 1 hour. Exposure of male mice for up to 72 hours to concentrations around 10 ppm produced nasal cavity injury (runny nose, ciliary loss, fluid accumulation, and tissue death). The effects became more severe as exposure time increased. Less severe effects were seen in the trachea and lungs. Other studies have not been reported any effects after 1-2 hour exposures to less than 1 ppm.

LONG-TERM INHALATION STUDIES: Exposure to 5 ppm for 225 days produced pulmonary function changes in dogs. Increased swelling, secretions, and reddening of the trachea, as well as decreased mucosal flow was seen in dogs intermittently exposed to 1 ppm for 12 months. There was no apparent effect on pulmonary function. No adverse effects were seen in guinea pigs exposed for 22 hours day, 7 days a week, for 52 weeks to concentrations of 0.13-5.72 ppm. No adverse effects were seen in monkeys exposed for 78 weeks to 0.14 - 1.28 ppm.

SUSPECTED CANCER AGENT: Sulfur Dioxide is not found on the following lists: FEDERAL OSHA Z LIST, NTP, IARC, CAL/OSHA; therefore it is not considered to be, nor suspected to be a cancer-causing agent by these agencies.

IRRITANCY OF PRODUCT: Sulfur Dioxide is severely irritating to the eyes and may be irritating to the skin.

SENSITIZATION TO THE PRODUCT: Sulfur Dioxide is not known to cause sensitization in humans. One study involving guinea pigs exposed to 4.3 ppm Sulfur Dioxide, 8 hours/day for 5 days enhanced an allergic reaction to ovalbumin (a known allergen).

REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the effects of Sulfur Dioxide on the human reproductive system.

Mutagenicity: In terms of clinical studies in animals, the following information was obtained: Sulfur Dioxide and its aqueous forms gave both positive and negative results in bacterial test. Sulfur Dioxide did not induce sister chromatid exchange, chromosomal aberrations, or micronucleus formation in the bone marrow of mice or Chinese Hamsters in in-vivo test. However, it induced morphological transformation of Syrian hamster embryo cells. Other mutagenic data are available as follows:

oms-esc = 2 mmol/L
mmo-omi = 10 mmol/L (S9)
sln-dmg-oral = 200 mmol/L
mmo-smc = 5 mmol/L (S9)
dnd- human: lymphocytes = 5,700 ppb

dni- human: lymphocytes = 5,700 ppb
oms-human: lymphocytes = 5,700 ppb
oms-ctl: other = 2,500 mmol/L
cytogenic-dom: other = 5 mmol/L
cytogenic-ctl: other = 2,500 mmol/L

Embryotoxicity: Sulfur Dioxide is not reported to cause embryotoxic effects in humans. Refer to the following paragraph for additional information.

Teratogenicity: No teratogenicity effects on humans have been described for Sulfur Dioxide. In terms of clinical studies in animals, the following information was obtained: Slight signs of fetotoxicity were seen in mice exposed to 32, 65, 125, or 250 ppm. Slight embryotoxicity was also seen when pregnant rabbits were exposed to 70 ppm during 6-15 days of pregnancy. Slight maternal toxicity was observed in both mice and rabbits. Additional teratogenic data are available as follows:

TCLo (inhalation, rat) = 4 mg/m³/24 hours (72-days preg)
TCLo (inhalation, rat) = 4 mg/m³/24 hours (72-days preg)
TCLo (inhalation, rat) = 4,970 mg/m³/12 hours (12-weeks preg)
TCLo (inhalation, rat) = 30 ppm/6 hours (21-weeks male)

TCLo (inhalation, mouse) = 25 ppm/7 hours (6-15-days preg)
TCLo (inhalation, mouse) = 25 ppm/7 hours (6-15-days preg)
TCLo (inhalation, mouse) = 32 ppm/24 hours (7-18-days preg)
TCLo (inhalation, rabbit) = 70 ppm/7 hours (6-18-days preg)

Reproductive Toxicity: No reproductive toxicity effects on humans have been described for Sulfur Dioxide.

*A **mutagen** is a chemical which causes permanent changes to genetic material (DNA) such that the changes will propagate through generation lines. An **embryotoxin** is a chemical which causes damage to a developing embryo (i.e. within the first eight weeks of pregnancy in humans), but the damage does not propagate across generational lines. A **teratogen** is a chemical which causes damage to a developing fetus, but the damage does not propagate across generational lines. A **reproductive toxin** is any substance which interferes in any way with the reproductive process.*

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Conditions relating to the target organs may be aggravated by overexposures to Sulfur Dioxide. See Section 3 (Hazard Identification) for information on these conditions.

RECOMMENDATIONS TO PHYSICIANS: Administer oxygen, treat symptoms, and reduce overexposure. Oxygen administration is most effective if expiration is made against a positive pressure of 4 cm. In cases of severe overexposure, the victim should breath 100% oxygen under positive pressure exhalation pressure for 1.2 hour every hour for 3 hours. Be observant for the initial stages of pulmonary edema or pneumonitis. In some cases, respiratory and circulatory stimulants (coramine, metrazol, and caffeine-sodium benzoate) may be of value.

BIOLOGICAL EXPOSURE INDICES (BEIs): Currently, Biological Exposure Indices (BEIs) are not applicable for Sulfur Dioxide.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: This gas will be dissipated rapidly in well-ventilated areas. Sulfur Dioxide is extremely stable to heat [up to 200°C (392°F)]. Complex reactions of Sulfur Dioxide occur in the atmosphere, producing sulfates and other sulfur compounds which contribute to air pollution.

EFFECT OF MATERIAL ON PLANTS or ANIMALS: Any adverse effect on animals would be related to oxygen-deficient environments, respiratory system damage, and damage to the skin and eyes. Because Sulfur Dioxide produces corrosive sulfurous acid upon contact with moisture, plants may be damaged or destroyed. Frost may also be produced, in the presence of rapidly-expanding gases.

EFFECT OF CHEMICAL ON AQUATIC LIFE: Sulfur Dioxide hydrolyzes to sulfurous acid solution when in contact with water. Sulfurous acid is very soluble in water, and even low concentrations of Sulfur Dioxide or sulfurous acid in water is detrimental to aquatic life. If a release of Sulfur Dioxide occurs near a river or other body of water, the release has the potential to kill fish and other aquatic life. Additional aquatic toxicity data are available for Sulfur Dioxide, as follows:

Concentration (ppm)	Exposure (hours)	Species	Effect	Test Environment
16		sunfish	lethal	
16-19	1	sunfish	lethal	
10	0.17	trout	toxic	tap water
5		trout	lethal	
0.5	1	fish	toxic	as HSO ₃
1	2	tench	lethal	as HSO ₃

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations. Return cylinders with any residual product to MESA Specialty Gases & Equipment. Do not dispose of locally.

14. TRANSPORTATION INFORMATION

THIS MATERIAL IS HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.

PROPER SHIPPING NAME: Sulfur dioxide, liquefied
HAZARD CLASS NUMBER and DESCRIPTION: 2.3 (Poison Gas)
UN IDENTIFICATION NUMBER: UN 1079
PACKING GROUP: Not Applicable
DOT LABEL(S) REQUIRED: Poison Gas

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (1996): 125

SPECIAL PROVISION: Sulfur Dioxide is poisonous by inhalation. Shipments must be properly described as inhalation hazards. ZONE C.

MARINE POLLUTANT: Sulfur Dioxide is not classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B).

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: THIS MATERIAL IS CONSIDERED AS DANGEROUS GOODS. Use the above information for the preparation of Canadian Shipments.

SPECIAL PROVISION for CANADA: 102 (Poison-Inhalation Hazard). Emergency Response Assistance Planning requirements must be met for shipments in excess of 3,000 kg or liters.

15. REGULATORY INFORMATION

U.S. SARA REPORTING REQUIREMENTS: Sulfur Dioxide is subject to the reporting requirements of Sections 302, 304, and 313 of Title III of the Superfund Amendments and Reauthorization Act, as follows:

CHEMICAL NAME	SARA 302 (40 CFR 355, Appendix A)	SARA 304 (40 CFR Table 302.4)	SARA 313 (40 CFR 372.65)
Sulfur Dioxide	YES	YES	NO

15. REGULATORY INFORMATION (Continued)

U.S. SARA THRESHOLD PLANNING QUANTITY: Sulfur Dioxide = 500 lb.

U.S. CERCLA REPORTABLE QUANTITY (RQ): Sulfur Dioxide is listed as an EHS (Extremely Hazardous Substance); RQ = 1 lb.

CANADIAN DSL/NDSL INVENTORY STATUS: Sulfur Dioxide is on the DSL Inventory.

U.S. TSCA INVENTORY STATUS: Sulfur Dioxide is listed on the TSCA Inventory.

OTHER U.S. FEDERAL REGULATIONS: Sulfur Dioxide (anhydrous) is subject to the reporting requirements of Section 112(r) of the Clean Air Act. The Threshold Quantity for this gas is 5,000 pounds. Compliance with the OSHA Process Safety Standard (29 CFR 1910.119) may be applicable to operations involving the use of Sulfur Dioxide. Under this regulation Sulfur Dioxide (liquid) is listed in Appendix A of this Standard and the threshold quantity for Sulfur Dioxide is 1000 pounds.

U.S. STATE REGULATORY INFORMATION: Sulfur Dioxide is covered under specific State regulations, as denoted below:

Alaska - Designated Toxic and Hazardous Substances: Sulfur Dioxide.

California - Permissible Exposure Limits for Chemical Contaminants: Sulfur Dioxide.

Florida - Substance List: Sulfur Dioxide.

Illinois - Toxic Substance List: Sulfur Dioxide.

Kansas - Section 302/313 List: Sulfur Dioxide.

Massachusetts - Substance List: Sulfur Dioxide.

Michigan - Critical Materials Register: No.
Minnesota - List of Hazardous Substances: Sulfur Dioxide.

Missouri - Employer Information/Toxic Substance List: Sulfur Dioxide.

New Jersey - Right to Know Hazardous Substance List: Sulfur Dioxide.

North Dakota - List of Hazardous Chemicals, Reportable Quantities: No.

Pennsylvania - Hazardous Substance List: Sulfur Dioxide.

Rhode Island - Hazardous Substance List: Sulfur Dioxide.

Texas - Hazardous Substance List: Sulfur Dioxide.

West Virginia - Hazardous Substance List: Sulfur Dioxide.

Wisconsin - Toxic and Hazardous Substances: Sulfur Dioxide.

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): Sulfur Dioxide is not on the California Proposition 65 lists.

LABELING:

DANGER:

**CORROSIVE LIQUID AND GAS UNDER PRESSURE.
CAN CAUSE EYE, SKIN, AND RESPIRATORY TRACT BURNS.**

Avoid breathing gas.

Store and use with adequate ventilation.

Do not get in eyes, on skin or clothing.

Use only with equipment of compatible material and construction.

Cylinder temperature should not exceed 52°C (125°F).

Close valve after each use and when empty.

Use in accordance with the Material Safety Data Sheet.

NOTE:

Suck-back into cylinder may cause rupture.

Always use a back flow preventative device in piping.

FIRST-AID:

IF INHALED, remove to fresh air. If not breathing, give artificial respiration. (Rescuer may receive chemical burns as a result of giving mouth to mouth). If breathing is difficult, give oxygen. Call a physician. Keep under medical observation.

IN CASE OF CONTACT, immediately flush eyes or skin with water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash clothing before reuse. (Discard contaminated shoes).

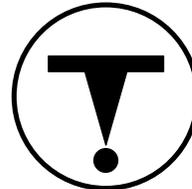
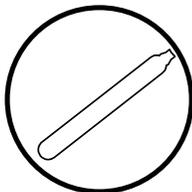
DO NOT REMOVE THIS PRODUCT LABEL.

CANADIAN WHMIS SYMBOLS:

Class A: Compressed Gas

Class D1A: Toxic Material/Immediate and Serious Effects

Class D2A: Other Toxic Effects/Very Toxic



16. OTHER INFORMATION

The information contained herein is based on data considered accurate. However, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. MESA SPECIALTY GASES & EQUIPMENT assumes no responsibility for injury to the vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, MESA SPECIALTY GASES & EQUIPMENT 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 his use of the material.

DEFINITIONS OF TERMS

A large number of abbreviations and acronyms appear on a MSDS. Some of these which are commonly used include the following:

CAS #: This is the Chemical Abstract Service Number which uniquely identifies each constituent. It is used for computer-related searching.

EXPOSURE LIMITS IN AIR:

ACGIH - American Conference of Governmental Industrial Hygienists, a professional association which establishes exposure limits. **TLV** - Threshold Limit Value - an airborne concentration of a substance which represents conditions under which it is generally believed that nearly all workers may be repeatedly exposed without adverse effect. The duration must be considered, including the 8-hour Time Weighted Average (**TWA**), the 15-minute Short Term Exposure Limit, and the instantaneous Ceiling Level (**C**). Skin absorption effects must also be considered.

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

IDLH - Immediately Dangerous to Life and Health - This level represents a concentration from which one can escape within 30-minutes without suffering escape-preventing or permanent injury. **The DFG - MAK** is the Republic of Germany's Maximum Exposure Level, similar to the U.S. PEL. **NIOSH** is the National Institute of Occupational Safety and Health, which is the research arm of the U.S. Occupational Safety and Health Administration (**OSHA**). NIOSH issues exposure guidelines called **Recommended Exposure Levels (RELs)**. When no exposure guidelines are established, an entry of **NE** is made for reference.

HAZARD RATINGS:

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM: Health Hazard: **0** (minimal acute or chronic exposure hazard); **1** (slight acute or chronic exposure hazard); **2** (moderate acute or significant chronic exposure hazard); **3** (severe acute exposure hazard; onetime overexposure can result in permanent injury and may be fatal); **4** (extreme acute exposure hazard; onetime overexposure can be fatal). Flammability Hazard: **0** (minimal hazard); **1** (materials that require substantial pre-heating before burning); **2** (combustible liquid or solids; liquids with a flash point of 38-93°C [100-200°F]); **3** (Class IB and IC flammable liquids with flash points below 38°C [100°F]); **4** (Class IA flammable liquids with flash points below 23°C [73°F] and boiling points below 38°C [100°F]. Reactivity Hazard: **0** (normally stable); **1** (material that can become unstable at elevated temperatures or which can react slightly with water); **2** (materials that are unstable but do not detonate or which can react violently with water); **3** (materials that can detonate when initiated or which can react explosively with water); **4** (materials that can detonate at normal temperatures or pressures).

NATIONAL FIRE PROTECTION ASSOCIATION: Health Hazard: **0** (material that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials); **1** (materials that on exposure under fire conditions could cause irritation or minor residual injury); **2** (materials that on intense or continued exposure under fire conditions could cause temporary incapacitation or possible residual injury); **3** (materials that can on short exposure could cause serious temporary or residual injury); **4** (materials that under very short exposure causes death or major residual injury).

NATIONAL FIRE PROTECTION ASSOCIATION (Continued): Flammability Hazard and Reactivity Hazard: Refer to definitions for "Hazardous Materials Identification System".

FLAMMABILITY LIMITS IN AIR:

Much of the information related to fire and explosion is derived from the National Fire Protection Association (**NFPA**). Flash Point - Minimum temperature at which a liquid gives off sufficient vapors to form an ignitable mixture with air. Autoignition Temperature: The minimum temperature required to initiate combustion in air with no other source of ignition. LEL - the lowest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source. UEL - the highest percent of vapor in air, by volume, that will explode or ignite in the presence of an ignition source.

TOXICOLOGICAL INFORMATION:

Possible health hazards as derived from human data, animal studies, or from the results of studies with similar compounds are presented. Definitions of some terms used in this section are: **LD₅₀** - Lethal Dose (solids & liquids) which kills 50% of the exposed animals; **LC₅₀** - Lethal Concentration (gases) which kills 50% of the exposed animals; **ppm** concentration expressed in parts of material per million parts of air or water; **mg/m³** concentration expressed in weight of substance per volume of air; **mg/kg** quantity of material, by weight, administered to a test subject, based on their body weight in kg. Data from several sources are used to evaluate the cancer-causing potential of the material. The sources are: **IARC** - the International Agency for Research on Cancer; **NTP** - the National Toxicology Program, **RTECS** - the Registry of Toxic Effects of Chemical Substances, **OSHA** and **CAL/OSHA**. IARC and NTP rate chemicals on a scale of decreasing potential to cause human cancer with rankings from 1 to 4. Subrankings (2A, 2B, etc.) are also used. Other measures of toxicity include **TDLo**, the lowest dose to cause a symptom and **TCLo** the lowest concentration to cause a symptom; **TD₀₁**, **LDLo**, and **LD₀₁**, or **TC**, **TCo**, **LCLo**, and **LCo**, the lowest dose (or concentration) to cause lethal or toxic effects. **BEI** - Biological Exposure Indices, represent the levels of determinants which are most likely to be observed in specimens collected from a healthy worker who has been exposed to chemicals to the same extent as a worker with inhalation exposure to the TLV. Ecological Information: EC is the effect concentration in water.

REGULATORY INFORMATION:

This section explains the impact of various laws and regulations on the material. **EPA** is the U.S. Environmental Protection Agency. **WHMIS** is the Canadian Workplace Hazardous Materials Information System. **DOT** and **TC** are the U.S. Department of Transportation and the Transport Canada, respectively. Superfund Amendments and Reauthorization Act (**SARA**); the Canadian Domestic/Non-Domestic Substances List (**DSL/NDL**); the U.S. Toxic Substance Control Act (**TSCA**); Marine Pollutant status according to the **DOT**; the Comprehensive Environmental Response, Compensation, and Liability Act (**CERCLA** or **Superfund**); and various state regulations.