



MATERIAL SAFETY DATA SHEET

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

SECTION 1. PRODUCT IDENTIFICATION

PRODUCT NAME: < 2.0% SULFUR DIOXIDE IN NITROGEN
PRODUCT USE: Environmental Calibration and Auditing Gas
MANUFACTURER: SPECTRA GASES, INC.
ADDRESS: 3434 Route 22 West
 Branchburg, NJ 08876, U.S.A.
PHONE: 908/252-9300
FAX: 908/252-0811
WEB SITE: www.spectra-gases.com
SPECTRA GASES EMERGENCY CONTACT: 800/932-0624 8:00 am - 6:00 pm (EST)
24 HOUR EMERGENCY CONTACT, CHEMTREC: 800/424-9300, 703/527-3887

SECTION 2. COMPOSITION and INFORMATION ON INGREDIENTS

CHEMICAL NAME: Mixture of Sulfur Dioxide (< 2.0%) and Nitrogen (Balance)
SYNONYMS: Not Applicable
FORMULA: Sulfur Dioxide = SO₂; Nitrogen = N₂
COMPOSITION: Sulfur Dioxide < 2.0%, Balance Nitrogen
CAS NUMBER: Sulfur Dioxide: 7446-09-5
 Nitrogen: 7727-37-9
EINECS NUMBER: Sulfur Dioxide: 231-195-2
 Nitrogen: 231-783-9

EXPOSURE LIMITS:

	OSHA PELs:	ACGIH TLVs:	NIOSH RELs:
Sulfur Dioxide:	TWA = 5 ppm	TWA = 2 ppm STEL = 5 ppm	TWA = 2 ppm STEL = 5 ppm IDLH = 100 ppm

Nitrogen:

There are no exposure limits for Nitrogen, Nitrogen is a simple asphyxiant.

SECTION 3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: This is a colorless, non-flammable gas mixture, with a sulfurous odor, irritating odor, shipped under pressure. This gas mixture can produce significant, adverse health effects, due to the Sulfur Dioxide content, which can reach exposure limits at the percentage in this mixture. This gas mixture may be toxic by inhalation, if duration of exposure is prolonged. Symptoms of such overexposure may not become apparent for up to 72 hours (see below for more information). In the presence of water or moisture, Sulfur Dioxide forms corrosive sulfurous acid. A water spray can be used to control and direct a release. Additionally, releases of this gas mixture may produce oxygen-deficient atmospheres; individuals in such atmospheres may be asphyxiated. Emergency Responders must protect themselves from inhalation exposures.

ROUTES OF ENTRY, SYMPTOMS OF ACUTE EXPOSURE: WARNING - If rescue personnel need to enter an area suspected of having a toxic level of Nitric Oxide, they should be equipped with Self-Contained Breathing Apparatus (SCBA), and, if available, a full-body chemically resistant suit. Acute overexposure to this gas mixture may cause the following health effects:

EYE CONTACT: If the gas mixture contaminates the eyes, moderate to severe injury and swelling of the eye tissue may occur, depending on duration of exposure. Symptoms can include tearing, severe pain or burns. Release of a high-pressure gas may result in airborne objects.

SKIN CONTACT: This gas mixture may moderately to severely irritate the skin, depending on the duration and concentration of exposure. Symptoms may include scratchiness, pain, and redness, or burns, if contact is prolonged. Due to the presence of Sulfur Dioxide, if skin contact occurs in presence of moisture or water, burns may occur, due to formation of sulfurous acid.

INGESTION: Ingestion of this gas mixture is not a likely route of industrial exposure.

SECTION 3. HAZARD IDENTIFICATION (Continued)

INHALATION: At low levels, irritation of the respiratory system may occur. Sensitivity varies among people, however, short exposure (1-6 hours) to concentrations of Sulfur Dioxide as low as 1 ppm may produce a reversible decrease in lung function. A 10 to 30 minute exposure to concentrations as low as 5 ppm has produced constriction of the bronchiole tubes. A 20-minute exposure to 8 ppm has produced reddening of the throat and mild nose and throat irritation. About 20 ppm is objectionably irritating, although people have been reported to work in concentrations exceeding 20 ppm. 500 ppm is so objectionable that a person cannot inhale a single deep breath. In severe cases where very high concentrations of SO₂ have been produced in closed spaces, SO₂ has caused severe airways obstruction, hypoxemia (insufficient oxygenation of the blood), pulmonary edema (a life threatening accumulation of fluid in the lungs), and death in minutes. The effects of pulmonary edema include coughing and shortness of breath that can be delayed until hours or days after the exposure. These symptoms are aggravated by physical exertion. As a result of severe exposures, permanent lung injury may occur.

An additional health hazard associated with this gas mixture is asphyxiation after inhalation of oxygen-deficient environments. If large volumes of this gas mixture are released or if this gas mixture is released in poorly-ventilated areas (i.e., enclosed or confined spaces), an oxygen-deficient environment may occur. Individuals breathing an oxygen-deficient atmosphere may experience symptoms that include headaches, ringing in ears, dizziness, drowsiness, unconsciousness, nausea, vomiting, and depression of all the senses. The following effects associated with various levels of oxygen are as follows:

**CONCENTRATION
of OXYGEN****EXPOSURE SYMPTOM**

20.9% Oxygen:	Normal oxygen concentration in air.
15-19% Oxygen:	Decreased ability to perform tasks. May impair coordination and may induce early symptoms in persons with heart, lung, or circulatory problems.
12-15% Oxygen:	Breathing increases, especially in exertion. Pulse up. Impaired coordination, perception, and judgment.
10-12% Oxygen:	Breathing further increases in rate and depth, poor coordination and judgment, lips slightly blue.
Less than 10% Oxygen:	Mental failure, inability to perform various movements, loss of consciousness without warning, convulsions, death.

WARNING: Exposure to atmospheres containing 8-10% or less oxygen will bring about unconsciousness without warning and so quickly that individuals cannot help or protect themselves. Lack of sufficient oxygen may cause serious injury or death.

SKIN CONTACT: Not applicable.

HMIS RATINGS: HEALTH HAZARD: = 2; FLAMMABILITY HAZARD: = 0; PHYSICAL HAZARD: = 0;

ROUTES OF ENTRY, SYMPTOMS OF CHRONIC EXPOSURE:

ROUTE OF ENTRY: Inhalation, skin contact.

TARGET ORGANS: Respiratory system, olfactory system, skin and teeth.

SYMPTOMS: Prolonged or repeated overexposures to this gas mixture may cause bronchitis, hacking cough, nasal irritation and discharge, increased fatigue, and alteration in the senses of taste and smell. Repeated exposure to the skin may cause dermatitis. Repeated overexposures to this gas mixture can also result in dental erosion and gum disorders. There are two case reports of individuals developing skin eruptions after repeated inhalation of high concentrations of Sulfur Dioxide. In later tests, it was found that as little as a 30-minute exposure to 10 ppm Sulfur Dioxide or a 1-hour exposure to 4 ppm Sulfur Dioxide could produce the skin eruptions. The eruptions disappeared after removal from exposure. These particular reactions are probably rare as there are no other reports of this type of reaction. See Section 11 (Toxicological Information) for additional information.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE: Acute or chronic respiratory conditions and cardiac conditions may be aggravated by over-exposure to this gas mixture.

CARCINOGENICITY: Sulfur Dioxide is listed as an IARC-3 and ACGIH TLV-A4 compound. See Section 11 (Toxicological Information) for additional information.

SECTION 7. HANDLING AND STORAGE

STORAGE: Cylinders should be stored upright (with valve protection caps or plugs in place) and firmly secured to prevent falling or being knocked over. Cylinders should be stored in dry, well-ventilated areas. Protect from salt or other corrosive materials. Storage should be away from heavily traveled areas, walkways, elevators, platform edges or other objects or situations that could damage the cylinder wall. Do not store in a manner that will block emergency exits, fire extinguishers or other safety equipment. Do not allow storage temperature to exceed 125°F (52°C). Use a first-in, first-out inventory system to prevent full containers from being stored for long periods of time. Store empty cylinders away from full cylinders. Consideration should be taken to install leak detection and alarm equipment for storage areas. **NOTE:** Use only DOT or ASME code cylinders designed for compressed gas storage. Cylinders must not be recharged except by or with the consent of owner.

HANDLING: This mixture can be dangerous and should only be handled by trained personnel. Before using this gas, meticulous leak checking using inert gas is strongly recommended, particularly after new connections are made. Cylinder valves should be inspected regularly for physical damage or corrosion (apparent by discoloration or rust). Care should be taken to inspect the following valve locations for corrosion: neck (where valve inserts into cylinder); bonnet nut (where handle attaches to valve body). Close valve after each use and when empty.

. Do not drag, roll, slide or drop cylinder. Use a suitable hand truck designed for cylinder movement. Never attempt to lift a cylinder by its cap. Secure cylinders at all times while in use. Use a pressure regulator to safely discharge product from cylinder. Use a check valve to prevent reverse flow into cylinder. Once cylinder has been connected to properly purged process, open cylinder valve slowly and carefully. If user experiences any difficulty operating cylinder valve, discontinue use and contact supplier. Never insert an object (e.g., wrench, screwdriver, etc.) into valve cap openings; doing so may damage valve, causing a leak to occur. Use an adjustable strap-wrench to remove over-tight or rusted caps.

Do not heat cylinders by any means to increase the discharge rate of product from the cylinder. Never apply flame or localized heat directly to any part of the cylinder. Cylinders should not be artificially cooled as certain types of steel undergo property changes when cryogenically cooled, thus making the cylinder unstable.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Purge gas handling equipment with inert gas and relieve pressure before attempting repairs.

SPECIAL PRECAUTIONS: Be aware of any signs of dizziness or fatigue; exposures to fatal concentrations of this gas mixture could occur without any significant warning symptoms. All work operations should be monitored in such a way that emergency personnel can be immediately contacted in the event of a release. Always store and handle compressed gas cylinders in accordance with Compressed Gas Association, Inc. (telephone 703-412-0900) pamphlet CGA P-1, *Safe Handling of Compressed Gases in Containers*. Local regulations may require specific equipment for storage and use.

SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Forced ventilation systems for the general work area should be provided. Spectra Gases, Inc. recommends that cylinders in use be secured within a ventilated enclosure such as a gas cabinet. Employee exposure should be monitored and reduced to the lowest practical levels using ventilation or other appropriate engineering controls. If appropriate, install automatic monitoring equipment to detect the level of Sulfur Dioxide. (Spectra Gases is not aware of any workplace situation with good gas delivery system design where exposure to any amount of this gas mixture is necessary under normal operating conditions. Ventilation is important for mitigating gas concentrations released in leak situations.)

The following information on appropriate Personal Protective Equipment is provided to assist employers in complying with OSHA regulations found in 29 CFR Subpart I (beginning at 1910.132) or equivalent standard of Canada, or standards of EC member states (including EN 149 for respiratory PPE, and EN 166 for face/eye protection). Please reference applicable regulations and standards for relevant details.

RESPIRATORY PROTECTION: Maintain exposure levels of Sulfur Dioxide below the levels listed in Section 2 (Composition / Information on Ingredients) and oxygen levels above 19.5% in the workplace. Use supplied air respiratory protection if Sulfur Dioxide levels exceed exposure limits, if oxygen level is below 19.5%, or during emergency response to a release of this product. If respiratory protection is required, follow the requirements of the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), or equivalent U.S. State standards, standards of Canada, the European Standard EN166, and EC member states.

SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION (Continued)

RESPIRATORY PROTECTION (continued): The following NIOSH respiratory protection recommendations are for Sulfur Dioxide.

<u>CONCENTRATION of SULFUR DIOXIDE</u>	<u>RESPIRATORY EQUIPMENT</u>
Up to 20 ppm:	Any Chemical Cartridge Respirator with cartridge(s) providing protection against Sulfur Dioxide, or any Supplied-Air Respirator (SAR).
Up to 50 ppm:	Any SAR operated in a continuous-flow mode, or any Powered, Air-Purifying Respirator (PAPR) with cartridge(s) providing protection against the compound of concern.
Up to 100 ppm:	Any Chemical Cartridge Respirator with a full facepiece and cartridge(s) providing protection against the compound of concern, or any Air-Purifying, Full-Facepiece Respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against Sulfur Dioxide, or any PAPR with a tight-fitting facepiece and cartridge(s) providing protection against Sulfur Dioxide or any SAR that has a tight-fitting facepiece and is operated in a continuous-flow mode, or any Self-Contained Breathing Apparatus (SCBA) with a full facepiece, or any SAR with a full facepiece.
Emergency or Planned	Entry into Unknown Concentrations or IDLH Conditions: Any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode, or any SAR that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode.
Escape:	Any Air-Purifying, Full-Facepiece Respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against Sulfur Dioxide, or any appropriate escape-type, SCBA.

EYE PROTECTION: Use approved safety goggles or safety glasses, when cylinders are not closed and capped. Be aware that particles or objects propelled by high pressure gas can fly significant distances. Eyewear should be as described in OSHA 29 CFR 1910.133 or by the European Standard EN166. Be aware that particles or objects propelled by high pressure gas can fly significant distances. Eyewear should be as described in OSHA 29 CFR 1910.133 or by the European Standard EN166. Eye wash stations/safety showers should be available.

SKIN PROTECTION: Work (such as leather) gloves are recommended when handling cylinders of this gas mixture. Wear chemically-resistant gloves when using this gas. Recommended (resistance to breakthrough longer than 8 hours) glove types are Responder™, Tychem™, BTychem™, Tychem™. Thin Natural rubber and neoprene are attacked by Sulfur Dioxide and should not be used when handling this gas mixture. Use chemical-resistant gloves in emergency situations. Use triple gloves for spill response. If necessary, refer to U.S. OSHA 29 CFR 1910.138 or appropriate Standards of Canada and those of EC Member States.

OTHER PROTECTIVE EQUIPMENT: Use body protection appropriate for task. Safety shoes are recommended when handling cylinders. Transfer of large quantities under pressure may require use of chemically impervious clothing. Information on general protective measures can be found in U.S. OSHA 29 CFR 1910.136.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES
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The following information is for Nitrogen, the component of greatest percentage:

MOLECULAR WEIGHT: 28.01
GAS DENSITY @ 21.1°C (70°F): 0.072 lb./ft³ (1.153 kg/m³)
BOILING POINT @ 1 atm: -195.8°C (-320.4°F)
FREEZING/MELTING POINT @ 1 atm: -210°C (-345.8°F)
SPECIFIC GRAVITY (air = 1) @ 21.1°C (70°F): 0.906
SOLUBILITY IN WATER vol/vol at 0°C (32°F) and 1 atm: 0.023
SPECIFIC VOLUME @ 21.1°C (70°F): 13.8 lb/ft³ (0.867 m³/kg)
CRITICAL PRESSURE: 492.9 psia (3399 kPa abs)
COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.

The following information is for the Sulfur Dioxide component of this gas mixture.

ODOR THRESHOLD: 1-5 ppm
VAPOR DENSITY @ 32°C (90°F): 0.1810 lb/ft³ (2.927 kg/m³)
VAPOR PRESSURE @ 20°C (68°F): 32.3 psig

Information for gas mixture:

APPEARANCE, ODOR AND STATE: Colorless, with irritating, sulfurous odor.

WARNING PROPERTIES FOR THIS GAS MIXTURE: The odor of this gas mixture is not a good warning property, as the odor threshold for Sulfur Dioxide is on the same level as the TLV. It is recommended that a monitor for Sulfur Dioxide be used.

SECTION 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: This gas mixture will be stable at standard temperature and pressure.

CONDITIONS TO AVOID: Cylinders should not be exposed to temperatures in excess of 125°F (52°C).

MATERIALS WITH WHICH GAS MIXTURE IS INCOMPATIBLE: Due to the presence of Sulfur Dioxide, this gas mixture may be incompatible with bases (e.g. sodium hydroxide), chlorates (e.g. potassium chlorate), fluorine, interhalogens (e.g. bromine pentafluoride, chlorine trifluoride), powdered metals, metal oxides (e.g. cesium oxide, stannous (tin) oxide), metal acetylides (e.g. monocation acetylide, monopotassium acetylide), sodium hydride, cesium azide, silver azide, diethyl zinc.

REACTIVITY:

A) HAZARDOUS DECOMPOSITION PRODUCTS: Upon exposure to water or moisture, Sulfur Dioxide will form corrosive sulfurous acid.

B) HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11. TOXICOLOGICAL INFORMATION

TOXICITY DATA ON COMPONENTS:

SULFUR DIOXIDE:

D.O.T. LC₅₀ = 2520 ppm (liquefied Sulfur Dioxide)
 Standard Draize Test (Eye-Rabbit)6 ppm/4 hours/32 days: Mild
 LC₅₀ (Inhalation-Rat) 2520 ppm/1 hour
 LC₅₀ (Inhalation-Mouse) 3000 ppm/30 minutes: Behavioral: convulsions or effect on seizure threshold, changes in motor activity (specific assay)
 LCLo (Inhalation-Human) 1000 ppm/10 minutes: Lungs, Thorax, or Respiration: respiratory depression
 LCLo (Inhalation-Human) 3000 ppm/5 minutes
 LCLo (Inhalation-Guinea Pig) 1039 ppm/24 hours
 LCLo (Inhalation-Frog)1 pph/15 minutes
 LCLo (Inhalation-Mammal-species unspecified) 3000 ppm/5 minutes
 TCLo (Inhalation-Human) 3 ppm/5 days: Lungs, Thorax, or Respiration: other changes
 TCLo (Inhalation-Human) 12 ppm/1 hour: Lungs, Thorax, or Respiration: other changes
 TCLo (Inhalation-Rat) 4910 µg/m³/6 hours/17 weeks-intermittent: Blood: pigmented or nucleated red blood cells; Biochemical: Enzyme inhibition, induction, or change in blood or tissue levels: cytochrome oxidases (including oxidative phosphorylation), Enzyme inhibition, induction, or change in blood or tissue levels-dehydrogenases
 TCLo (Inhalation-Rat) 500 µg/m³/96 days-intermittent: Brain and Covering: changes in surface EEG; Behavioral: changes in motor activity (specific assay); Biochemical: Metabolism (Intermediary): xanthine, purine or nucleotides including urate
 TCLo (Inhalation-Rat) 400 ppm/3 hours/6 weeks-intermittent: Lungs, Thorax, or Respiration: structural or functional change in trachea or Bronchi

SULFUR DIOXIDE (continued):

TCLo (Inhalation-Rat) 10 ppm/24H/14 days-intermittent: Behavioral: food intake (animal); Liver: other changes; Biochemical: Metabolism (Intermediary): lipids including transport
 TCLo (Inhalation-Rat) 4 mg/ m³/24 hours: female 72 day(s) pre-mating: Reproductive: Maternal Effects: menstrual cycle changes or disorders, parturition; Reproductive: Fertility: female fertility index (e.g. # females pregnant per # sperm positive females; # females pregnant per # females mated)
 TCLo (Inhalation-Rat) 4 mg/ m³/24 hours: female 72 day(s) pre-mating: Reproductive: Effects on Newborn: growth statistics (e.g.%, reduced weight gain), delayed effects
 TCLo (Inhalation-Rat) 4970 µg/m³/12 hours: female 12 week(s) pre-mating: Reproductive: Maternal Effects: menstrual cycle changes or disorders; Effects on Newborn: growth statistics (e.g.%, reduced weight gain)
 TCLo (Inhalation-Rat) 30 ppm/6 hours: male 21 week(s) pre-mating: Reproductive: Paternal Effects: testes, epididymis, sperm duct
 TCLo (Inhalation-Mouse) 25 ppm/7 hours: female 6-15 day(s) after conception: Reproductive: Effects on Embryo or Fetus - fetotoxicity (except death, e.g., stunted fetus)
 TCLo (Inhalation-Mouse) 25 ppm/7 hours: female 6-15 day(s) after conception: Reproductive: Specific Developmental Abnormalities: musculoskeletal system
 TCLo (Inhalation-Mouse) 32 ppm/24 hours: female 7-18 day(s) after conception: Reproductive: Effects on Newborn: growth statistics (e.g.%, reduced weight gain), behavioral
 TCLo (Inhalation-Mouse) 500 ppm/5 minutes/30 weeks-intermittent: Tumorigenic: equivocal tumorigenic agent by RTECS criteria; Lungs, Thorax, or Respiration: tumors

SULFUR DIOXIDE (continued):

TCLo (Inhalation-Dog) 1 ppm/90M/1 years-intermittent: Lungs, Thorax, or Respiration: structural or functional change in trachea or Bronchi
 TCLo (Inhalation-Dog) 500 ppm/2 hours/21 weeks-intermittent: Lungs, Thorax, or Respiration: structural or functional change in trachea or bronchi, respiratory depression
 TCLo (Inhalation-Rabbit) 200 mg/m³/3 hours/13 weeks-intermittent: Cardiac: other changes; Liver: other changes; Blood: hemorrhage
 TCLo (Inhalation-Rabbit) 70 ppm/7 hours: female 6-18 day(s) after conception: Reproductive: Specific Developmental Abnormalities: musculoskeletal system
 TCLo (Inhalation-Guinea Pig)10 ppm/1 hour/30 days-intermittent: Liver: other changes; Kidney, Ureter, Bladder: other changes; Biochemical: Metabolism (Intermediary): lipids including transport
 DNA Damage (Human-Lymphocyte) 5700 ppb
 DNA Inhibition (Human-Lymphocyte) 5700 ppb
 Mutation in Microorganisms (Microorganism-not otherwise specified)10 mmol/L
 Mutation in Microorganisms (Yeast-Saccharomyces cerevisiae) 5 µmol/L
 Sex Chromosome Loss and Nondisjunction (Oral-Drosophila melanogaster)200 µmol/L
 Mutation Test Systems-not otherwise specified (Human-Lymphocyte) 5700 ppb
 Mutation Test Systems-not otherwise specified (Cattle Cells-not otherwise specified) 2500 µmol/L
 Mutation Test Systems-not otherwise specified (Bacteria-Escherichia coli) 2 mmol/L
 Sister Chromatid Exchange (Multiple routes-Human) 42 mg/m³
 Cytogenetic Analysis (Multiple routes-Human) 42 mg/m³
 Cytogenetic Analysis (Mammal-domestic Cells-not otherwise specified) 5 mmol/L
 Cytogenetic Analysis (Cattle Cells-not otherwise specified) 2500 µmol/L
NITROGEN: Nitrogen is a simply asphyxiant.

CARCINOGENICITY: Sulfur Dioxide is listed by the following agencies tracking the carcinogenic potential of chemical compounds, as follows:

ACGIH TLV-A4 (Not Classifiable as a Human Carcinogen); IARC-3 (Unclassifiable as to Carcinogenicity in Humans)

IRRITANCY OF PRODUCT: This gas mixture irritates the respiratory system, eyes and may irritate the skin. Depending on duration and concentration, the irritation may be severe. In addition, contact with rapidly expanding gases can cause frostbite to exposed tissue.

SECTION 11. TOXICOLOGICAL INFORMATION (Continued)

SENSITIZATION OF PRODUCT: Exposure to 4.3 ppm Sulfur Dioxide 8 hours/day for 5 days has enhanced allergic sensitization to inhaled ovalbumin (a known allergen) in guinea pigs. Further research has shown that this effect can be blocked if the animals are pre-treated with anti-inflammatory drugs.

REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the effects of this gas mixture and its components on the human reproductive system.

Mutagenicity: The components of this gas mixture are not reported to cause mutagenic effects in humans. Conflicting results have been reported in tests involving the Sulfur Dioxide component on cultured human lymphocytes (white blood cells) taken from workers exposed to Sulfur Dioxide over several years. In all of the studies, there were serious confounding factors such as exposure to other chemicals and poorly defined control groups. Sulfur Dioxide induced morphological transformation of Syrian hamster embryo cells (in-vitro). Bisulfite induced both transformation and SCE, but not gene mutation, chromosomal aberrations or DNA repair synthesis in cultured mammalian cells. Sulfur Dioxide and its aqueous forms gave both positive and negative results in bacterial tests.

Embryotoxicity: The components of this gas mixture are not reported to cause embryotoxic effects in humans. In animal studies involving the Sulfur Dioxide component, slight signs of fetotoxicity (reduced birth weight and delayed righting reflex) were seen in mice exposed to 32, 65, 125 or 250 ppm. The authors reported no maternal toxicity. However, other studies indicated that these doses would cause significant irritation. Slight embryotoxicity (decreased fetal body weight, delayed bone development) was seen when pregnant mice were exposed to 25 ppm during days 6-15 of pregnancy. Slight embryotoxicity (minor bone variations) was also seen when pregnant rabbits were exposed to 70 ppm during days 6-15 of pregnancy. Mild maternal toxicity was seen in the pregnant mice and rabbits.

Teratogenicity: The components of this gas mixture are not reported to cause teratogenic effects in humans.

Reproductive Toxicity: The components of this gas mixture are not reported to cause adverse reproductive effects in humans.

*A **mutagen** is a chemical that causes permanent changes to genetic material (DNA) such that the changes will propagate through generational lines. An **embryotoxin** is a chemical that 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 that causes damage to a developing fetus, but the damage does not propagate across generational lines. A **reproductive toxin** is any substance that interferes in any way with the reproductive process.*

BIOLOGICAL EXPOSURE INDICES (BEIs): Currently, Biological Exposure Indices (BEIs) are not applicable for the components of this gas mixture.

SECTION 12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: This gas mixture will be dissipated rapidly in well-ventilated areas. The following environmental data are applicable to the components of this gas mixture. Complex reactions of Sulfur Dioxide occur in the atmosphere which contribute to air pollution.

NITRIC OXIDE: Water solubility = 7.34 cc/100 cc at 0°C, 2.3 ml

SULFUR DIOXIDE:

Atmospheric Fate: Direct surface uptake of Sulfur Dioxide is the most important dry removal process for atmospheric sulfur. Deposition by precipitation (wet deposition) is the result of both in cloud and below cloud capture of Sulfur Dioxide and particulate sulfate. In cloud processes include sulfate particles serving as condensation nuclei, coagulation, and diffusional uptake of Sulfur Dioxide. Below cloud processes include interception of particles by falling drops and diffusional uptake of Sulfur Dioxide. In cloud scavenging processes are more important in clean air, i.e. where Sulfur Dioxide levels below the clouds are low. Wet deposition is, in general, much more easily measured than is dry deposition. Routine measurement of wet deposition is determined from sulfate concentration in precipitation samples and precipitation amount. Typically, the removal rate for particulate sulfate is of the order of 40% per hour, and for Sulfur Dioxide, an order of magnitude less. The overall efficiency of wet removal depends on many factors: precipitation type, intensity, duration, frequency, the relative amounts of Sulfur Dioxide and sulfate present, and the size distribution of particulate sulfate.

Terrestrial Fate: Although snow covered surfaces are inefficient receptors of gaseous and particulate sulfur compounds, the spring melt of the accumulated winter snow-pack can result in rapid, short term inputs of high sulfate, low pH water to freshwater systems with resulting disastrous effects on fish. Sulfur Dioxide uptake is dependent upon soil pH and moisture content.

EFFECT OF MATERIAL ON PLANTS or ANIMALS: Any adverse effect on plants would be related to oxygen-deficient environments or frost from rapidly expanding gases, unless exposure occurs in a confined space. Because Sulfur Dioxide produces corrosive sulfurous acid, upon contact with air or moisture, plants may be damaged or destroyed.

EFFECT OF CHEMICAL ON AQUATIC LIFE: This gas mixture may have adverse effects on aquatic life as contact with water will result in formation of sulfurous acid.

MOBILITY: The components of this gas mixture will not be mobile in the soil.

PERSISTENCE AND BIODEGRADABILITY: Persistence: Nitrogen and Sulfur Dioxide present no hazard of persistence. Biodegradation: Nitrogen is fully biodegradable. Sulfur Dioxide reacts with water to form sulfurous acid.

SECTION 12. ECOLOGICAL INFORMATION (Continued)

POTENTIAL TO BIOACCUMULATE: The components of this gas mixture do not have bioaccumulation or food chain contamination potential.

OZONE-DEPLETION POTENTIAL: The components of this gas mixture are not Class I or Class II ozone depleting chemicals (40 CFR Part 82).

SECTION 13. DISPOSAL CONSIDERATIONS
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UNUSED PRODUCT / EMPTY CONTAINER: Do not dispose of residual product. Return residual product in cylinders to: Spectra Gases, Inc., 80 Industrial Drive, Alpha, NJ 08865 or Spectra Gases, Inc., 1261 Activity Drive, Vista, CA 92083.

DISPOSAL INFORMATION: Residual product in the system may be disposed in wet caustic scrubber if done with care by trained personnel. This shall be done in accordance with U.S. Federal, State and local regulations, regulations of the provinces of Canada or EC member states.

SECTION 14. TRANSPORT INFORMATION
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U.S. SHIPPING INFORMATION:

U.S. DOT PROPER SHIPPING NAME: Compressed gases, n.o.s. (Nitrogen, Sulfur Dioxide)

HAZARD CLASS NUMBER and DESCRIPTION: 2.2 (Non-Flammable Gas)

UN IDENTIFICATION NUMBER: UN 1956

U.S. DOT SHIPPING LABEL(S) REQUIRED: Non-Flammable Gas

PLACARD (When required): Not Applicable

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure position. (Transport in passenger compartment of a vehicle is **not** recommended). Ensure cylinder valve is properly closed, valve outlet cap has been reinstalled, and valve protection cap is secured before shipping cylinder.

CAUTION: Compressed gas cylinders shall not be refilled except by qualified producers of compressed gases. Shipment of a compressed gas cylinder which has not been filled by the owner or with the owner's written consent is a violation of Federal law (49 CFR 173.301).

NAERG (NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK) #: 126

CANADIAN SHIPPING INFORMATION:

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: This gas is considered as Dangerous Goods, per regulations of Transport Canada. The use of the above U.S. DOT information from the U.S. 49 CFR regulations is allowed for shipments that originate in the U.S. For shipments via ground vehicle or rail that originate in Canada, the following information is applicable.

PROPER SHIPPING NAME: Compressed gas, n.o.s. (Nitrogen, Sulfur Dioxide)

HAZARD CLASS NUMBER and DESCRIPTION: 2.2 (Non-Flammable Gas)

UN IDENTIFICATION NUMBER: UN 1956

HAZARD SHIPPING LABEL(S) REQUIRED: Class 2.2 (Non-Flammable Gas)

SPECIAL PROVISIONS: None

EXPLOSIVE LIMIT & LIMITED QUANTITY INDEX: 0.12

ERAP INDEX: None

PASSENGER CARRYING SHIP INDEX: None

PASSENGER CARRYING ROAD OR RAIL VEHICLE INDEX: 75

INTERNATIONAL AIR TRANSPORT ASSOCIATION SHIPPING INFORMATION (IATA):

IATA DESIGNATION: This gas mixture is considered as dangerous goods, per the International Air Transport Association.

PROPER SHIPPING NAME: Compressed gas, n.o.s. (Nitrogen, Sulfur Dioxide)

HAZARD CLASS NUMBER and DESCRIPTION: 2.2 (Non-Flammable Gas)

UN IDENTIFICATION NUMBER: UN 1956

HAZARD LABEL(S) REQUIRED: Class 2.2 (Non-Flammable Gas)

The following Packaging Information is applicable to this product:

PASSENGER AND CARGO AIRCRAFT				CARGO AIRCRAFT ONLY	
Limited Quantity		Packing Instruction	Max. Qty per Pkg	Packing Instruction	Max. Qty per Pkg
Packing Instruction	Max. Qty per Pkg				
//////	//////	200	75 kg	200	150 kg

SECTION 14. TRANSPORT INFORMATION (Continued)
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INTERNATIONAL MARITIME ORGANIZATION SHIPPING INFORMATION (IMO):

IMO DESIGNATION: This gas mixture is considered as dangerous goods, per the International Maritime Organization.

UN No.:	1956
PROPER SHIPPING NAME:	Compressed gas, n.o.s. (Nitrogen, Sulfur Dioxide)
HAZARD CLASS NUMBER:	2.2
SUBSIDIARY RISK:	None
PACKING GROUP:	None
SPECIAL PROVISIONS:	274
LIMITED QUANTITIES:	120 mL
PACKING INSTRUCTIONS:	P200
EmS:	F-C, S-U
STOWAGE CATEGORY:	Category D. Clear of living quarters.

MARINE POLLUTANT: The components of this gas mixture are not designated by the IMO to be Marine Pollutants.

EUROPEAN SHIPPING INFORMATION:

EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR): This gas mixture is considered by the Economic Commission for Europe to be dangerous goods. Additional information is as follows:

UN NO.:	1956
NAME and DESCRIPTOR:	Compressed gas, n.o.s. (Nitrogen, Sulfur Dioxide)
CLASS:	2
CLASSIFICATION CODE:	IA
PACKING GROUP:	Not Applicable
LABELS:	2.2
SPECIAL PROVISIONS:	274, 567
LIMITED QUANTITIES:	LQ1
PACKING INSTRUCTIONS:	P200
MIXED PACKING PROVISIONS:	MP9
HAZARD IDENTIFICATION No.:	20

SECTION 15. REGULATORY INFORMATION

U.S. FEDERAL REGULATIONS:**EPA - ENVIRONMENTAL PROTECTION AGENCY:**

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act of 1990 (40 CFR Parts 117 and 302)

Reportable Quantity (RQ): Not applicable.

SARA TITLE III: Superfund Amendment and Reauthorization Act

SECTIONS 302/304: Emergency Planning and Notification (40 CFR Part 355)

Extremely Hazardous Substances: Sulfur Dioxide is listed.

Threshold Planning Quantity (TPQ): Sulfur Dioxide = 500 lbs (227 kg)

Reportable Quantity (RQ): Sulfur Dioxide = 500 lbs (227 kg)

SECTIONS 311/312: Hazardous Chemical Reporting (40 CFR Part 370)

IMMEDIATE HEALTH: Yes PRESSURE: Yes

DELAYED HEALTH: Yes REACTIVITY: No

FIRE: No

SECTION 313: Toxic Chemical Release Reporting (40 CFR 372)

Releases of Sulfur Dioxide and Nitrogen do not require reporting under Section 313.

CLEAN AIR ACT:

SECTION 112 (r): Risk Management Programs for Chemical Accidental Release (40 CFR Part 68)

Sulfur Dioxide is listed under Table 1 as a Regulated Substance, per 40 CFR, Part 68, of the Risk Management for Chemical Release Prevention, as a flammable substance.

Threshold Planning Quantity (TPQ): Sulfur Dioxide = 5,000 lb (2,270 kg).

TSCA: Toxic Substances Control Act

The components of this gas mixture are listed on the TSCA Inventory.

SECTION 15. REGULATORY INFORMATION (Continued)

U.S. FEDERAL REGULATIONS (continued):**OSHA - OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION:**

29 CFR Part 1910.119: Process Safety Management of Highly Hazardous Chemicals.

Threshold Planning Quantity (TPQ): Sulfur Dioxide (as a liquid) = 1000 lb (450 kg)

U.S. STATE REGULATORY INFORMATION:

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): No component of this gas mixture is a listed substance which the State of California requires warning under this statute.

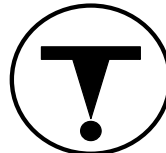
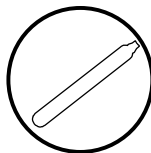
CANADIAN FEDERAL REGULATIONS:

CANADIAN DSL INVENTORY STATUS: The components of this gas mixture are listed on the Canadian DSL Inventory.

OTHER CANADIAN REGULATIONS: This gas mixture is categorized as a Controlled Product, Hazard Classes A, and D2B as per the Controlled Product Regulations. The components of this product are not on the CEPA Priorities Substances Lists.

CANADIAN WHMIS SYMBOLS: **Class A:** Compressed Gas

Class D2B: Toxic Material/Materials Causing Other Toxic Effects

**EUROPEAN ECONOMIC COMMUNITY REGULATIONS:**

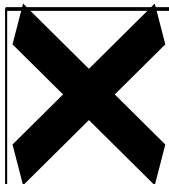
EC LABELING AND CLASSIFICATION: This product does not meet the definition of any hazard class as defined by the European Community Council Directive 67/548/EEC.

EC CLASSIFICATION: Xi (Irritant)

EC RISK PHRASES: [R: 36/37/38]: Irritating to eyes, respiratory system and skin.

EC SAFETY PHRASES: [S: 2½-]: Keep locked-up and out of reach of children. (*This safety phrase can be omitted from the label when the substance or preparation is sold for industrial use only.*) [S: 9]: Keep container in a well-ventilated place. [S: 26]: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice [S: 36/37/39]: Wear suitable protective clothing, gloves and eye/face protection. [S: 45]: In case of accident or if you feel unwell, seek medical advice immediately (show label where possible).

EUROPEAN COMMUNITY ANNEX II HAZARD SYMBOL: Xi

**EUROPEAN COMMUNITY INFORMATION FOR COMPONENTS:****NITROGEN:**

EC EINECS/ELINCS NUMBER: 231-783-9

EC CLASSIFICATION: An official classification for this substance has not been published in Commission Directives.

SECTION 15. REGULATORY INFORMATION (Continued)

EUROPEAN COMMUNITY INFORMATION FOR COMPONENTS (continued):

SULFUR DIOXIDE:

EC EINECS/ELINCS NUMBER: 231-195-2

HAZARD CLASSIFICATION: [T]: Toxic; [C]: Corrosive.

RISK PHRASES: [R 23]: Toxic by inhalation. [R 24]: Toxic by skin contact. [R: 34]: Causes burns.

AT CONCENTRATIONS GREATER THAN OR EQUAL TO 5% TO < 20%:

HAZARD CLASSIFICATION: [Xn] Harmful.

RISK PHRASES: [R: 20]: Harmful by inhalation. [R: 34]: Causes burns.

AT CONCENTRATIONS EQUAL TO OR MORE THAN 0.5% AND LESS THAN 5%:

HAZARD CLASSIFICATION: [Xi] Irritant.

RISK PHRASES: [R: 36/37/38]: Irritating to eyes, respiratory system and skin.

SAFETY PHRASES: [S: 2½-]: Keep locked-up and out of reach of children. (*This safety phrase can be omitted from the label when the substance or preparation is sold for industrial use only.*) [S: 9]: Keep container in a well-ventilated place. [S: 26]: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice [S: 36/37/39]: Wear suitable protective clothing, gloves and eye/face protection. [S: 45]: In case of accident or if you feel unwell, seek medical advice immediately (show label where possible).

SECTION 16. OTHER INFORMATION

Information contained in this Material Safety Data Sheet is provided to our customers so they may comply with 29 CFR 1910.1200, Hazard Communication Standard, the Canadian WHMIS Standard, and the requirements of the European Community Directives. The intent of this Material Safety Data Sheet is to provide end users of this product with the health and physical hazards associated with possible exposure to this product. All statements, technical data and recommendations are based on readily available texts and data that Spectra Gases, Inc., believes to be reliable and accurate. Spectra Gases, Inc., makes no warranties, guarantees or representations of any kind with respect to this product or this data. It is the responsibility of the user to obtain and use the most recent version of this MSDS.

For Definition of Terms used in Spectra MSDSs see Spectra Gases, Inc. website: www.spectra-gases.com or contact your Customer Service Representative.

Further information about compressed gases can be found in the following pamphlets published by: Compressed Gas Association Inc. (CGA), 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202-4102. Telephone: (703) 412-0900.

P-1 "Safe Handling of Compressed Gases in Containers"
 AV-1 "Safe Handling and Storage of Compressed Gases"
 "Handbook of Compressed Gases"

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