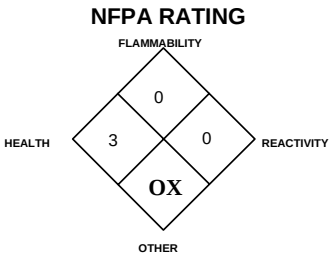


MATERIAL SAFETY DATA SHEET

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: **NITROGEN DIOXIDE - NO_2**
Document Number: NO2

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 10, 1999

2. COMPOSITION and INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS #	mole %	EXPOSURE LIMITS IN AIR					
			ACGIH		OSHA			
			TLV ppm	STEL ppm	PEL ppm	STEL ppm	IDLH ppm	OTHER
Nitrogen Dioxide	10102-44-0	> 99.5%	3, A4 (Not Classifiable as a Human Carcinogen)	5	NE	5 C 1 ST (Vacated 1989 PEL)	20	NIOSH REL: 1 ppm ST DFG MAK 5 ppm
Maximum Impurities		< 0.5%	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: Nitrogen Dioxide is a non-flammable, toxic, yellow-brown liquid to red-brown gas with an acid, suffocating odor. Nitrogen Dioxide is extremely toxic by inhalation, and symptoms of overexposure may not become apparent for up to 72 hours. The gas is an oxidizer and will support and enhance combustion. Exposure to the rapidly expanding gas can cause frostbite. Nitric oxide can react with oxygen (in air) to generate nitrogen dioxide. Emergency Responders must protect themselves from inhalation. A water spray can be used to control and direct a release.

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

INHALATION: Exposure to Nitrogen Dioxide gas in low concentrations produces an irritating effect on the mucous membranes of the eyes, nose, throat, and lungs. 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, delayed pulmonary edema. High concentrations of Nitrogen Dioxide gas may cause an oxygen deficient atmosphere. Exposure to high concentrations may cause unconsciousness, and under some circumstances, death. Typical symptoms of overexposure are:

CONCENTRATION	**SYMPTOMS of OVEREXPOSURE**
25 ppm:	Delayed (5-72 hours) pulmonary irritation after 8 hour exposure.
100 - 150 ppm:	Delayed (5-48 hours) pulmonary edema after exposure for 30 - 60 minutes.
200 - 700 ppm:	Delayed (5-8 hours) severe pulmonary damage after only a few breaths.

After inhalation of a few breaths of Nitrogen Dioxide, there is no immediate reaction, or only a very slight respiratory discomfort, headache, dizziness, or lassitude. After 5-8 hours (frequently after the employee has left the workplace and returned home), it is noticed that the victim's lips and ears have a blue (cyanotic) color. There then follows rapidly increasing symptoms of breathing difficulty, irregular respiration, choking, dizziness, headache, increasing cyanosis, tightness in the chest, nausea, vomiting, lassitude, and palpitations. Left untreated, death frequently occurs. Physical examination immediately following overexposure reveals an accelerated respiratory rate, decreased vital capacity, generally suppressed breathing sounds, low blood pressure, and a platelet count elevated by 10-100%.

HAZARDOUS MATERIAL INFORMATION SYSTEM

HEALTH	(BLUE)	3
FLAMMABILITY	(RED)	0
REACTIVITY	(YELLOW)	0
PROTECTIVE EQUIPMENT		D

EYES	RESPIRATORY	HANDS	BODY
	See Section 8		See Section 8

For routine industrial applications

See Section 16 for Definition of Ratings

SKIN and EYE CONTACT: Prolonged exposure may cause potentially harmful amounts of Nitrogen Dioxide to enter the body via absorption through the skin. The gas may be irritating to the skin, especially in a moist environment, for prolonged periods. Symptoms of skin overexposure may include scratchiness, pain, and redness. If Nitrogen Dioxide contaminates the eyes, severe injury and swelling of the eye tissue may occur. Contact with 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 Nitrogen Dioxide can damage the tissues of the mouth, throat, esophagus, and other tissues of the digestive system. Ingestion of Nitrogen Dioxide can be fatal. Additionally, aspiration by inhalation is possible, causing pulmonary edema or death.

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in **Lay Terms**. Overexposure to Nitrogen 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, delayed pulmonary damage and breathing difficulty may occur. Overexposure to this gas may be fatal. Contact with rapidly expanding gases may cause frostbite.

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

3. HAZARD IDENTIFICATION (Continued)

CHRONIC (continued): Nitrogen Dioxide has been shown to cause genetic damage and fetal toxicity in animal or bacterial studies. See Section 11 (Toxicological Information) for additional information.

TARGET ORGANS: Respiratory system, skin, eyes.

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 NITROGEN 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 Nitrogen 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.

NOTICE! Delayed onset of life-threatening symptoms is very likely to occur. **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). Medical care providers should refer to Section 11 (Toxicology Information) of this MSDS for additional information.

5. FIRE-FIGHTING MEASURES

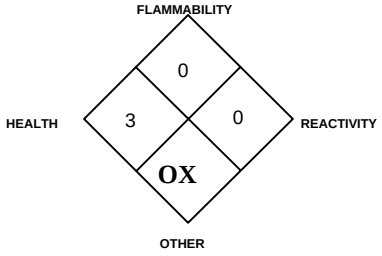
FLASH POINT: Not applicable.
AUTOIGNITION TEMPERATURE: Not applicable.
FLAMMABLE LIMITS (in air by volume, %):

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
Dry Chemical: YES Halon: YES
Foam: YES Other: Any "ABC" Class.

NFPA RATING



See Section 16 for Definition of Ratings

UNUSUAL FIRE AND EXPLOSION HAZARDS: Nitrogen Dioxide is toxic and presents an extreme health hazard to firefighters. In the event of fire, cool containers of Nitrogen Dioxide with water to prevent failure. Nitrogen Dioxide can slowly react with water to from a corrosive solution of nitrogen dioxide. Nitrogen dioxide is corrosive to skin and metal. Corrosive and toxic gases, vapors, and mists may spread from the point of release. Nitrogen Dioxide is a strong oxidizer and can support or enhance combustion.

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 fire 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 Nitrogen Dioxide. If Nitrogen Dioxide is involved in a fire, fire runoff water should be contained to prevent possible environmental damage. 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. If 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 fire-fighters 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 (Neoprene rubber gloves and nitrile gloves, over latex or N-Dex™ gloves), chemical resistant suit and boots, hard-hat, and Self-Contained Breathing Apparatus.** Monitor the surrounding area for Nitrogen Dioxide and oxygen levels. A colorimetric tube is available for Nitrogen Dioxide. If a colorimetric tube is used to indicate the concentration of Nitrogen Dioxide, the reading obtained should be lower than the limits indicated in Section 2 (Composition and Information on Ingredients) before non-emergency personnel are allowed to enter area. While starch-iodide paper will respond to the presence of Nitrogen Dioxide, the limit of detection is too high to be of appreciable value, and its use is not recommended. The atmosphere must have at least 19.5 percent oxygen before personnel can be allowed in the area without Self-Contained Breathing Apparatus.

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 AN EXTREMELY 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 Nitrogen Dioxide ON YOU. Wash hands after handling chemicals. Do not eat or drink while handling chemicals. All work practices should minimize the release of Nitrogen Dioxide. Be aware of any signs of exposure as indicated in Section 3 (Hazard Identification); exposures to fatal concentrations of Nitrogen 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 Nitrogen Dioxide. Store cylinders 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 Nitrogen Dioxide-handling equipment. Anhydrous Nitrogen Dioxide is not corrosive to steel and other common structural materials. In the presence of air or moisture, however, corrosive conditions will develop. If piping and accessories cannot be maintained free of air or moisture, stainless steel is recommended. 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 Nitrogen 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. Nitrogen Dioxide emergency equipment should be available near the point of use.

- Workers who handle Nitrogen Dioxide should wear protective clothing, as listed in Section 8 (Exposure Controls and 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 following rules are applicable to situations in which cylinders are being used:

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 in-place (where provided) 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.

7. HANDLING and STORAGE (Continued)

After Use: Close main cylinder valve. Replace valve protection cap (where provided). Mark empty cylinders "EMPTY".

NOTE: Use only DOT or ASME code containers. Earth-ground and bond all lines and equipment associated with Nitrogen Dioxide. 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*".

TANK CAR SHIPMENTS: Tank cars carrying Nitrogen Dioxide should be loaded and unloaded in strict accordance with tank-car owner'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 Nitrogen 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. Always use product in areas where adequate ventilation is provided.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation. Local exhaust ventilation is preferred, because it prevents Nitrogen Dioxide dispersion into the work place by eliminating it at its source. If appropriate, install automatic monitoring equipment to detect the level of Nitrogen Dioxide. Eye wash stations/safety showers should be near areas where Nitrogen Dioxide is used or stored. Employee exposure should be monitored and reduced to the lowest practical levels using ventilation or other, appropriate, engineering controls. If necessary, Nitrogen Dioxide cylinders should be placed in a ventilated gas cabinet.

RESPIRATORY PROTECTION: Maintain Nitrogen Dioxide levels and 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 Nitrogen Dioxide. If respiratory protection is required, follow the requirements of the Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), or equivalent State standards. Employee exposure should be monitored and reduced to the lowest practical levels using ventilation or other, appropriate, engineering controls. If exposures in excess of 3 ppm cannot be avoided, employees should be provided with supplied air or powered air purifying respirators. If the concentration is above 50 ppm (IDLH) or unknown, Self Contained Breathing Apparatus (SCBA) or other supplied air respiratory protection must be used. The following NIOSH recommendations for Nitrogen Dioxide concentrations in air are in place.

CONCENTRATION	**RESPIRATORY EQUIPMENT**
Up to 20 ppm:	Supplied Air Respirator (SAR) operated in a continuous-flow mode; or full facepiece Self-Contained Breathing Apparatus (SCBA); or full facepiece SAR.
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 Nitrogen Dioxide is 20 ppm.

EYE PROTECTION: Splash goggles or safety glasses, and face-shields should be used.

HAND PROTECTION: Wear mechanical resistant gloves when handling cylinders of Nitrogen Dioxide. Wear chemical resistant gloves when using this gas. Neoprene gloves are recommended.

BODY PROTECTION: Use body protection appropriate for task. Transfer of large quantities under pressure may require protective equipment appropriate to the task.

9. PHYSICAL and CHEMICAL PROPERTIES

VAPOR DENSITY: 3.39 kg/m^3 (0.2116 lb/ft^3)
EVAPORATION RATE (nBuAc = 1): Not applicable.
SPECIFIC GRAVITY (air = 1): 2.62
FREEZING POINT: -11.2°C (11.8°F)
SOLUBILITY IN WATER: 7.4%.
BOILING POINT @ 1 atm: 21.2°C (70.1°F)
VAPOR PRESSURE(psia): 14.7
pH: Not applicable.
EXPANSION RATIO: Not available.
ODOR THRESHOLD: 2 mg/m^3
COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.
SPECIFIC VOLUME (ft^3/lb): 4.7
APPEARANCE AND COLOR: Red-brown gas with an irritating odor.

9. PHYSICAL and CHEMICAL PROPERTIES

HOW TO DETECT THIS SUBSTANCE (warning properties): Though the odor is strong and irritating, it does not serve as a reliable warning property for Nitrogen Dioxide. 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. The dense, red to brown color of the gas is characteristic. Area monitoring should be performed using appropriate equipment.

10. STABILITY and REACTIVITY

STABILITY: Stable.

DECOMPOSITION PRODUCTS: Will react with water or moist air to form nitric and nitrous acids. Above 160°C (320°F), the gas decomposes to nitric oxide and oxygen.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Nitrogen Dioxide is not compatible with the following materials: air, oxygen, flammable or combustible materials, powdered aluminum, boron, chlorine monoxide, chromium, fluorine, nitrogen trichloride, ozone, phosphorous, oxidizing agents, halogens, powdered iron, sodium monoxide, magnesium, manganese, uranium, and tungsten carbide.

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Contact with air, 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 Nitrogen Dioxide.

Mutation in Microorganism System (Salmonella typhimurium) 6 ppm
Sister Chromatid Exchange (hamster lung) 5 ppm for 10 months
TDLo (inhalation, mouse) 22 ppm, Reproductive effects
TCLo (inhalation, rat) 0.85 mg/m^3, Teratogenic effects
LCLo (inhalation, human) 200 ppm for 1 month
TCLo (inhalation, man) 6.2 ppm for 10 months, pulmonary effects
TCLo (inhalation, 90 ppm for 40 minutes, pulmonary effects
LC_{50} (inhalation, rat) 88 ppm for 4 hours
LC_{50} (inhalation, rat) 115-168 ppm for 1 hour
LC_{50} (inhalation, rat) 174 ppm for 30 minutes
LC_{50} (inhalation, rat) 201-420 ppm for 15 minutes
LC_{50} (inhalation, rat) 416-833 ppm for 5 minutes
LC_{50} (inhalation, mouse) 1000 ppm for 10 minutes
LCLo (inhalation, dog) 123 mg/m^3
LCLo (inhalation, monkey) 123 mg/m^3 for 8 hours
LC_{50} (inhalation, rabbit) 315 ppm for 15 minutes
LC_{50} (inhalation, guinea pig) 30 ppm for 1 hour

EYE IRRITATION: At 70 ppm, nitrogen dioxide (NO_2) gas caused irritation in animals. Cloudiness of the cornea (opacity) was not observed in rabbits exposed to 20 ppm for 4 hours, but was observed following exposure to 70 ppm for 8 hours.

EFFECTS OF SHORT-TERM (ACUTE) INHALATION: Short-term exposure of animals to 40 ppm or higher at first produces symptoms such as nose irritation and severe respiratory distress. Higher concentrations have resulted in death, usually from pulmonary edema (accumulation of fluid in the lungs). Although, a small number of deaths have been caused by asphyxiation (lack of oxygen), due to spasm of the larynx. Structural changes in the respiratory tissue, including increased growth (hyperplasia) of some cell types and loss of cilia in the small airways, have been observed in rats exposed to 10-20 ppm for 24-36 hours. Increased sensitivity to allergens was observed in guinea pigs exposed to 40- 70 ppm. More deaths from bacterial infections resulted after mice were exposed to 5 ppm NO2 for 3 days. After a 7-day exposure to 4 ppm, guinea pigs had increased reactivity of the respiratory tract (bronchial hyper-reactivity) to inhaled substances.

EFFECTS OF LONG-TERM (CHRONIC) INHALATION: Long-term exposure to NO_2 has affected the function and structure of the respiratory system, as well as natural mechanisms of defense against foreign bodies (physical and immune system responses). Rats continuously exposed to NO2 over several months showed loss of cilia in the small airways (at 0.5 ppm) and elevated respiratory rates (at 0.8 ppm). Mice exposed to 0.5 ppm for 6, 18, or 24 hours/day for 3-12 months showed early signs of emphysema (a lung disease). Long-term exposure to greater than 10 ppm has produced emphysema. Several studies have shown that mice exposed to 0.25-5 ppm have developed harmful changes in their immune systems. Monkeys exposed to 1 ppm for 1 year show a slightly decreased immune response. Monkeys exposed to 5 ppm for 2 months, or 10 ppm for 1 month, showed a marked decrease in resistance to infections. A small number of studies using rodents indicate that repeated exposure to NO2 may cause effects on the nervous system, for example, delayed response to stimuli (0.32 ppm) and subtle behavioral effects (5.0-7.5 ppm).

SUSPECTED CANCER AGENT: Nitrogen 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. Additional information on carcinogenicity is available as follows:

Conflicting results have been obtained in the available studies. An increase in lung tumors was reported in mice exposed to 10 ppm NO2 for 6 months (a relatively short exposure duration). No increase in lung tumors was observed in rats exposed to 0.04, 0.4 or 4 ppm NO2 for 17 months.

IRRITANCY OF PRODUCT: Nitrogen Dioxide is irritating to the eyes, and may be irritating to the skin.

SENSITIZATION TO THE PRODUCT: Nitrogen Dioxide is not known to cause sensitization in humans upon repeated or prolonged exposure.

11. TOXICOLOGICAL INFORMATION (Continued)

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

Mutagenicity: No mutagenicity effects on humans have been described for Nitrogen Dioxide. Nitrogen Dioxide has been shown to cause genetic damage in bacterial studies. Additional information is available on mutagenicity as follows:

Positive results (gene mutations and chromosomal aberrations) were observed in lung cells of rats exposed to 8-27 ppm NO2 for 3 hours. In another study, negative results (in chromosomal abnormalities in sperm) were obtained in mice exposed to 10 ppm NO2. Positive results have been obtained in bacteria and cultured hamster cells (chromosomal aberrations).

Embryotoxicity: Nitrogen Dioxide is not expected to cause embryotoxic effects in humans.

Teratogenicity: No teratogenicity effects on humans have been described for Nitrogen Dioxide. Additional information is available for teratogenicity, embryotoxicity, and fetotoxicity as follows:

No conclusions can be drawn from the available studies, due to inadequate evaluation of maternal toxicity or insufficient details for evaluation. Mice continuously exposed to 22 or 45 ppm NO2 on days 7-18 of pregnancy had offspring with significantly reduced birth weight and reduced neuromuscular coordination (e.g. righting reflexes). No visible signs of maternal toxicity were apparent, although it was not clear that a complete evaluation of maternal toxicity was conducted. In another study, offspring were monitored for 2 months following exposure to 0.03, 0.05, 0.5 or 5 ppm, 6 hours/day throughout pregnancy. Postnatal biochemical changes in the liver and subtle effects on neuromotor and physical development were marginally apparent at 0.5 ppm and clearly apparent at 5 ppm. Maternal toxicity was not discussed. Another study which reports embryotoxic and fetotoxic effects in the offspring of rats continuously exposed to 0.045 or 0.43 ppm NO2 throughout pregnancy cannot be evaluated. The study is not available in English, and therefore the results cannot be confirmed. Maternal toxicity was not discussed in the review.

Reproductive Toxicity: No reproductive toxicity effects on humans have been described for Nitrogen Dioxide. Nitrogen Dioxide has been shown to cause and fetal toxicity in animal studies. Additional information is available for reproductive toxicity as follows:

Female rats exposed 12 hours/day to 1.25 ppm, but not animals exposed to 0.07 ppm, for 3 months had longer estrus (fertility) cycles. This effect was reversible when exposure ended. Fertility was not affected. Effects on the testes were not observed in male rats exposed to 1 ppm NO2 for 21 days.

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 Nitrogen Dioxide. See Section 3 (Hazard Identification) for information on these conditions.

RECOMMENDATIONS TO PHYSICIANS: Administer oxygen as soon as possible following exposure. If possible, have victim breathe as deeply and rapidly as possible to help flush gas from the lungs. Enforce bed rest for 24 - 48 hours, whether or not symptoms have appeared. Start oxygen therapy at the first sign of symptoms. Provide medication to reduce anxiety and dyspnea, as needed. Keep respiratory tract clear of mucous and exudate. Atropine, epinephrine, expectorants, emetics, most sedatives and most cardiac glycosides are usually ineffective and possibly harmful. Surgical intervention to assist breathing may be necessary. Respiratory infection should be controlled as soon as it is detected. Prednisone has been reported to be effective during recovery, in amounts of 3-8 x 10-6 kg daily, in divided doses. If Nitrogen Dioxide contaminates the eye, use an optic anesthetic to reduce pain. The victim should be promptly examined by an ophthalmologist. If necessary, administer lung function tests, chest x-ray, blood methemoglobin level.

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

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: This gas will be dissipated rapidly in well-ventilated areas. Complex reactions of Nitrogen Dioxide occur in the atmosphere 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 Nitrogen Dioxide produces corrosive nitric acid upon contact with air or moisture, plants may be damaged or destroyed.

EFFECT OF CHEMICAL ON AQUATIC LIFE: Nitrogen Dioxide hydrolyzes to nitrogen dioxide when in contact with water. If a release of Nitrogen Dioxide occurs near a river or other body of water, the release has the potential to kill fish and other aquatic life.

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 Airgas Inc. 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: Dinitrogen tetroxide, liquefied
(Note: This is the Proper Shipping Name for Nitrogen Dioxide)
HAZARD CLASS NUMBER and DESCRIPTION: 2.3 (Poison Gas)
UN IDENTIFICATION NUMBER: UN 1067
PACKING GROUP: Not Applicable
DOT LABEL(S) REQUIRED: Poison gas; Oxidizer; Corrosive
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (1996): 124

14. TRANSPORTATION INFORMATION

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

MARINE POLLUTANT: Nitrogen 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 following above for the preparation of Canadian Shipments. Additional information for Canadian shipments is as follows: Proper Shipping Name: Nitrogen Dioxide, liquefied ***or*** Dinitrogen tetroxide, liquefied; Hazard Class: add 5.1 (Oxidizer), 8 (Corrosive); Special Provision: 79, 102.

15. REGULATORY INFORMATION

U.S. SARA REPORTING REQUIREMENTS: Nitrogen 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)
Nitrogen Dioxide	YES	YES	NO

U.S. SARA THRESHOLD PLANNING QUANTITY: Nitrogen Dioxide = 100 lb.

U.S. CERCLA REPORTABLE QUANTITY (RQ): 10 lb.

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

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

OTHER U.S. FEDERAL REGULATIONS: Nitrogen Dioxide (anhydrous) is not subject to the reporting requirements of Section 112(r) of the Clean Air Act. Compliance with the OSHA Process Safety Standard (29 CFR 1910.119) may be applicable to operations involving the use of Nitrogen Dioxide. Under this regulation Nitrogen Dioxide is listed in Appendix A, with a Threshold Quantity of 250 lb.

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

Alaska - Designated Toxic and Hazardous Substances: Nitrogen Dioxide.
California - Permissible Exposure Limits for Chemical Contaminants: Nitrogen Dioxide.
Florida - Substance List: Nitrogen Dioxide.
Illinois - Toxic Substance List: Nitrogen Dioxide.
Kansas - Section 302/313 List: Nitrogen Dioxide.
Massachusetts - Substance List: Nitrogen Dioxide.
Michigan - Critical Materials Register: No.
Minnesota - List of Hazardous Substances: Nitrogen Dioxide.
Missouri - Employer Information/Toxic Substance List: Nitrogen Dioxide**.**
New Jersey - Right to Know Hazardous Substance List: Nitrogen Dioxide.
North Dakota - List of Hazardous Chemicals, Reportable Quantities: Nitrogen Dioxide.
Pennsylvania - Hazardous Substance List: Nitrogen Dioxide**.**
Rhode Island - Hazardous Substance List: Nitrogen Dioxide**.**
Texas - Hazardous Substance List: Nitrogen Dioxide.
West Virginia - Hazardous Substance List: Nitrogen Dioxide.
Wisconsin - Toxic and Hazardous Substances: Nitrogen Dioxide.

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

15. REGULATORY INFORMATION (Continued)

LABELING:

DANGER:

POISONOUS, OXIDIZING LIQUID AND GAS UNDER PRESSURE.
MAY BE FATAL IF INHALED.
CAN CAUSE SEVERE LUNG DAMAGE.
CAN CAUSE EYE AND SKIN BURNS.
SYMPTOMS MAY BE DELAYED.
VIGOROUSLY ACCELERATES COMBUSTION.

Do not breath gas.
Store and use with adequate ventilation, and use in closed systems.
Do not get in eyes, on skin or clothing.
Keep oil, grease, and combustibles away.
Use with equipment cleaned for nitrogen dioxide service.
Cylinder temperature should not exceed 52°C (125°F).
Close valve after each use and when empty.
WHEN RETURNING CYLINDER, INSTALL VALVE OUTLET CAP OR PLUG, LEAK TIGHT
Use in accordance with the Material Safety Data Sheet.

POISON

CALL A PHYSICIAN

FIRST-AID:

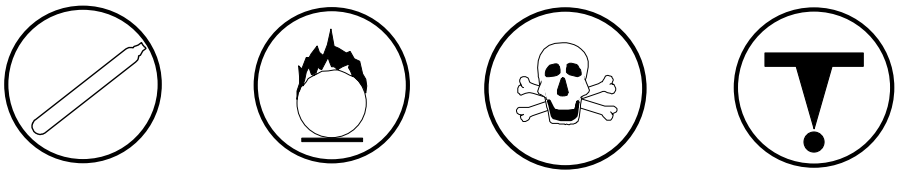
IF INHALED, remove to fresh air. If not breathing, give artificial respiration. (Rescuer may receive chemical burns as a result of giving mouth-to-mouth). If breathing, give oxygen. Call a physician, even if no symptoms are present. Keep under medical observation. Symptoms may be delayed.

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 C: Oxidizing Material
Class D1A: Toxic Material/Immediate and Serious Effects
Class D2A/D2B: Other Toxic Effects



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 Gas & 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 Gas & 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. **O**ccupational **S**afety and **H**ealth **A**dministration (**OSHA**). NIOSH issues exposure guidelines called **R**ecommended **E**xposure **L**evels (**REL**s). 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: **LD_{50}** - Lethal Dose (solids & liquids) which kills 50% of the exposed animals; **LC_{50}** - 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/m^3** 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; **TDo**, **LDLo**, and **LDo**, 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/NDSL)**; 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.