
MATERIAL SAFETY DATA SHEET

SECTION 1. PRODUCT IDENTIFICATION

PRODUCT NAME: Nitric Oxide
CHEMICAL NAME: Inorganic Oxide **FORMULA:** NO
SYNONYMS: Mononitrogen Monoxide, Nitrogen Monoxide
MANUFACTURER: Air Products and Chemicals, Inc.
ADDRESS: 7201 Hamilton Boulevard
Allentown, PA 18195-1501
PRODUCT INFORMATION: (800) 752-1597
MSDS NUMBER: 1075 **REVISION:** 4
REVIEW DATE: October 1998 **REVISION DATE:** October 1998

SECTION 2. COMPOSITION / INFORMATION ON INGREDIENTS

Nitric Oxide is sold as pure product (> 99%).

CAS NUMBER: 10102-43-9

EXPOSURE LIMITS:

OSHA: PEL = 25 ppm

ACGIH: TLV/TWA = 25 ppm

NIOSH: REL = 25 ppm

IDLH = 100 ppm

SECTION 3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW

At room temperature, Nitric Oxide is a colorless, nonflammable, poisonous, oxidizing gas with an irritating odor. Nitric Oxide is extremely toxic by inhalation, and symptoms of over-exposure may not become apparent for up to 72 hours. The gas is an oxidizer and will support and enhance combustion. Emergency responders must protect themselves from inhalation. A water spray can be used to control and direct a release. In the presence of air, Nitric Oxide forms brown fumes of nitrogen dioxide and is extremely reactive and a strong oxidizing agent. Emergency responders must wear the proper personal protective equipment suitable for the situation to which they are responding.

EMERGENCY TELEPHONE NUMBERS

(800) 523-9374

Continental U.S., Canada, and Puerto Rico

(610)481-7711

Other locations

ACUTE POTENTIAL HEALTH EFFECTS:

ROUTES OF EXPOSURE:

EYE CONTACT: If Nitric Oxide contaminates the eyes, severe injury and swelling of the eye tissue may occur.

INGESTION: Ingestion is not a likely route of exposure for Nitric Oxide.

INHALATION: Exposure to Nitric Oxide gas in low concentrations produces an irritating effect on the mucous membranes of the eyes, nose, throat and lungs, which can include choking, coughing, headache, nausea and fatigue. Severe over-exposure may cause methemoglobinemia, cyanosis, delayed pulmonary edema, mental confusion, unconsciousness and death. High concentrations of Nitric Oxide gas may cause an oxygen-deficient atmosphere; however, other more significant health effects will occur prior to those for oxygen deficiency. Nitric Oxide can react in the body to oxidize hemoglobin to methemoglobin in the blood. Coma and death can ensue when methemoglobin levels reach 70%. The inability of methemoglobin to

combine with oxygen can result in clinical effects due to tissue hypoxia. Symptoms include muscular tremors, drowsiness, a brownish-blue hue to the mucous membranes, increased heart rate, vertigo and vomiting.

SKIN CONTACT: The gas may be irritating to the skin, especially in a moist environment. Symptoms of skin over-exposure may include itchiness, pain, and redness.

POTENTIAL HEALTH EFFECTS OF REPEATED EXPOSURE:

ROUTE OF ENTRY: Inhalation, skin contact

TARGET ORGANS: Respiratory system, blood system, skin, teeth, gums and eyes.

SYMPTOMS: Chronic low-level inhalation exposure via inhalation can cause damage to the respiratory system, including chronic cough, loss of appetite, dyspepsia and gradual loss of strength. Prolonged skin exposure may cause potentially harmful amounts of Nitric Oxide to enter the body via absorption through the skin. Repeated over exposures to Nitric Oxide can also result in dental erosion and gum disorders. Nitric oxide has been shown to cause genetic damage and fetal toxicity in animal or bacterial studies.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE: Acute or chronic respiratory conditions, skin conditions, or eye disorders may be aggravated by over-exposure to Nitric Oxide.

CARCINOGENICITY: Nitric Oxide is not found on the FEDERAL OSHA Z LIST, NTP, CAL/OSHA, or IARC Carcinogenicity lists.

SECTION 4. FIRST AID MEASURES

NOTICE! Delayed onset of life-threatening symptoms is very likely to occur. Victim(s) must be taken for medical attention.

EYE CONTACT: If contact with Nitric Oxide and the eyes results in irritation, 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 must seek immediate medical attention from an ophthalmologist.

INGESTION: Ingestion is not a likely route of exposure to Nitric Oxide.

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

SKIN CONTACT: Nitric Oxide can absorb through the skin and is very toxic by this route of exposure. If Nitric Oxide 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.

NOTES TO PHYSICIANS: Absorption of this chemical may lead to the formation of methemoglobin, which, if present in sufficient quantities, causes cyanosis. As reversion to hemoglobin occurs spontaneously with termination of exposure, supportive measures such as rest and oxygen may be sufficient for moderate exposures. For severe cyanosis, injection of methylene blue (1 mg/kg of body weight) may be helpful, and Vitamin B-12 (1 mg intramuscularly) will speed recovery. Intravenous fluids and blood transfusions may be indicated in very severe exposures.

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. 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 Nitric Oxide contaminates the eye, use an optic anesthetic to reduce pain. The victim should be promptly examined by an ophthalmologist.

SECTION 5. FIRE FIGHTING MEASURES

FLASH POINT:

Not flammable

AUTOIGNITION:

Not applicable

FLAMMABLE RANGE:

Not applicable

EXTINGUISHING MEDIA: Non-flammable gas. Use extinguishing media appropriate for surrounding fire.

SPECIAL FIRE-FIGHTING PROCEDURES: Evacuate all personnel from area. In the event of fire, cool containers of this product 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. Nitric Oxide can slowly react with water to form a corrosive solution of nitrogen dioxide. Nitrogen dioxide is corrosive to skin and metal. Stop the leak or discharge, if possible. For small releases, if it is not possible to stop the leak, and it does not endanger personnel, let

the fire burn itself out. Incipient fire responders should wear eye protection. Structural fire fighters must wear Self-Contained Breathing Apparatus and full protective equipment, including chemical and fire resistant clothing. If this product is involved in a fire, fire run-off water should be contained to prevent possible environmental damage. If necessary, decontaminate fire-response equipment with soap and water solution.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Corrosive and toxic gases, vapors, and mists may spread from the point of release. Nitric Oxide is an oxidizer and can support or enhance combustion. Most cylinders are designed to vent contents when exposed to elevated temperatures. Pressure in a cylinder can build-up due to heat and it may rupture if pressure relief devices should fail to perform.

HAZARDOUS COMBUSTION PRODUCTS: If Nitric Oxide is involved in a fire, it will produce nitrogen oxides.

SECTION 6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: Evacuate immediate area. Shut off source of leak, if possible. Isolate any leaking cylinder. If leak is from container, pressure relief device or its valve, contact your supplier. If leak is in user's system, close cylinder valve, safely vent pressure and purge with inert gas before attempting repairs. Protection of all personnel and the area must be maintained. All responders must be adequately protected from exposure. The atmosphere must contain levels of Nitric Oxide below levels indicated in Section 2 (Composition / Information on Ingredients) before personnel can be allowed in the area without Self-contained breathing apparatus. While starch-iodide paper will respond to the presence of nitric oxide, the limit of detection is too high to be of appreciable value, and its use is not recommended. Colorimetric tubes are available for Nitric Oxide.

SECTION 7. HANDLING AND STORAGE

STORAGE: Store cylinders in a well-ventilated, secure area, protected from the weather. Cylinders should be stored up-right with valve outlet seals and valve protection caps in place. Do not allow storage temperature to exceed 125°F (52 °C). As an oxidizer, Nitric Oxide should be stored separate from combustible materials. Oxidizer storage should be separated from flammables by a minimum distance of 20 ft. or by a barrier of non-combustible material at least 5 ft. high, having a fire-resistance rating of at least 1/2 hour. Storage should be away from heavily traveled areas and emergency exits. Full and empty cylinders should be segregated. Use a first-in, first-out inventory system to prevent full containers from being stored for long periods of time.

HANDLING: Workers who handle Nitric Oxide 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. 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 reducing regulator to safely discharge gas from cylinder. Use a check valve to prevent reverse flow into cylinder. Use piping and equipment adequately designed to withstand pressures to be encountered. Never apply flame or localized heat directly to any part of the cylinder. Once cylinder has been connected to 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.

SPECIAL PRECAUTIONS: Be aware of any signs of dizziness or fatigue; exposures to fatal concentrations of Nitric Oxide could occur without any significant warning symptoms. 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

ENGINEERING CONTROLS: Consider installation of leak detection and alarm for storage and use areas. Nitric Oxide emergency equipment should be available near the point of use.

VENTILATION: Use with adequate ventilation. Local exhaust ventilation is preferred, because it prevents dispersion of this gas into the work place by eliminating it at its source. Employee exposure should be monitored and reduced to the lowest practical levels using ventilation or other, appropriate, engineering controls. If

necessary, Nitric Oxide cylinders should be placed in a ventilated gas cabinet. If appropriate, install automatic monitoring equipment to detect the level of Nitric Oxide.

RESPIRATORY PROTECTION: Maintain exposure levels of Nitric Oxide 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 Nitric Oxide levels exceed exposure limits or during emergency response to a release of this product. 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 are NIOSH respiratory protection recommendations for Nitric Oxide concentrations in air. Up to 100 ppm - SAR (Supplied-Air Respirator) operated in a continuous-flow mode; or full-facepiece chemical cartridge respirator with cartridge(s); or powered air-purified respirator with cartridge(s); or gas mask with canister; or SAR; or full-facepiece SCBA.

Emergency Use: 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. Escape - Gas mask with canister to protect against nitric oxide; or escape- type SCBA. The IDLH concentration for Nitric Oxide is 100 ppm.

EYE PROTECTION: Safety glasses, and face-shields should be used. Ensure eyewash/safety shower stations are available near areas where this product is used.

SKIN PROTECTION: Work gloves are recommended when handling cylinders. Neoprene gloves are recommended during use of this product. Use double gloves for spill response.

OTHER PROTECTIVE EQUIPMENT: Chemical resistant protective clothing is recommended when handling this material due to its toxicity and corrosivity. Safety shoes are recommended when handling cylinders.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE, ODOR AND STATE: Colorless gas with an irritating odor.

MOLECULAR WEIGHT: 30.006

BOILING POINT (1 atm): -241.2 °F (-151.8 °C)

SPECIFIC GRAVITY (also called vapor density) (air = 1): 1.04

FREEZING/MELTING POINT: -262.6 °F (-1163.6 °C)

VAPOR PRESSURE: Not applicable

GAS DENSITY (At 70 °F (21.1 °C) and 1 atm): 0.0777 lb/ft³

SOLUBILITY IN WATER (vol/vol at 32 °F (0 °C) and 1 atm): 0.0734

SECTION 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Normally stable. Nitric Oxide is unstable at higher pressures and temperatures and has been know to cause rupture of a container with an adequate energy input.

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

INCOMPATIBILITY (Materials to Avoid): Nitric Oxide 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.

REACTIVITY:

A) HAZARDOUS DECOMPOSITION PRODUCTS: Nitric Oxide will thermally decompose to primarily nitrogen and oxygen, with limited formation of other oxides of nitrogen.

B) HAZARDOUS POLYMERIZATION: Will not occur

SECTION 11. TOXICOLOGICAL INFORMATION

TCLo, or LC₅₀, or LCLo (Inhalation): Rat LC₅₀ 870 ppm/4 hours; Mouse LCLo: 320 ppm; Dog LCLo: 5000 ppm/25 minutes; Rat TCLo: 41 ppm/6 hours/7weeks-intermittent; Rat TCLo 2.4 ppm/24 hours/16days-continous; Mouse LCLo 10 ppm/2 hours/30-weeks-intermittent. Lung, blood and brain/CNS effects were observed in these studies.

LD₅₀, (Oral): No data currently available.

LD₅₀ (Dermal): No data currently available.

SKIN CORROSIVITY: Nitric Oxide may cause irritation and possibly burns.
CARCINOGENICITY: Currently, Nitric Oxide has not been found to be carcinogenic.
ADDITIONAL NOTES: Nitric Oxide has been shown to cause mutations in bacteria and in cultured mammalian cells.

SECTION 12. ECOLOGICAL INFORMATION

AQUATIC TOXICITY: Currently, no aquatic toxicity data are available for Nitric Oxide.
MOBILITY: Nitric Oxide is not expected to be mobile in soil, as it will biodegrade to other nitrogen oxide compounds upon exposure to air and water.
PERSISTENCE AND BIODEGRADABILITY: Persistence: Will disperse in atmosphere fairly rapidly. Nitric Oxide rapidly converts in air to nitrogen dioxide. Nitric Oxide forms nitrous acid in water.
POTENTIAL TO BIOACCUMULATE: Nitric Oxide will not bioaccumulate.
REMARKS: Nitric Oxide is not a Class I or Class II ozone depleting chemical (40 CFR Part 82).

SECTION 13. DISPOSAL CONSIDERATIONS

UNUSED PRODUCT / EMPTY CONTAINER: Return container and unused product to supplier. Do not attempt to dispose of residual or unused quantities.
DISPOSAL INFORMATION: Shall be done in accordance with Federal, State and local regulations. Wastes containing this material may be classified by EPA as a hazardous waste by characteristic (such as Ignitability, Corrosivity, Toxicity, Reactivity). Waste streams must be characterized by the user to meet Federal, State and local requirements.

SECTION 14. TRANSPORT INFORMATION

DOT PROPER SHIPPING NAME: Nitric Oxide, Compressed
HAZARD CLASS NUMBER and DESCRIPTION: 2.3 (Poison Gas)
UN IDENTIFICATION NUMBER: UN 1660
DOT SHIPPING LABEL(S) REQUIRED: Poison Gas, Oxidizer, Corrosive
PLACARD (When required): Poison Gas

SPECIAL SHIPPING INFORMATION: Nitric Oxide is poisonous by inhalation. Shipments must be properly described as inhalation hazards, ZONE A. Cylinders should be transported in a secure upright position in a well-ventilated truck. Never transport in passenger compartment of a vehicle. 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) #: 124

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): 10 lbs (45 kg)

SARA TITLE III: Superfund Amendment and Reauthorization Act

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

Extremely Hazardous Substances: Nitric Oxide is listed.

Threshold Planning Quantity (TPQ): 100 lbs (455 kg)

Reportable Quantity (RQ): 10 lbs (45 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 Nitric Oxide do not require reporting under Section 313.

CLEAN AIR ACT:

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

Nitric Oxide is subject to the requirements of Section 112(r) of the Clean Air Act.
Threshold Planning Quantity (TPQ): 10,000 lbs (4,553 kg)

TSCA: Toxic Substances Control Act

Nitric Oxide is listed on the TSCA Inventory.

OSHA - OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION:

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

Nitric Oxide is listed in Appendix A, as a highly hazardous chemical.
Threshold Planning Quantity (TPQ): 250 lbs (113 kg)

STATE REGULATIONS:

CALIFORNIA:

Proposition 65: Nitric Oxide is not a listed substance which the State of California requires warning under this statute.

SECTION 16. OTHER INFORMATION

NFPA RATINGS:

HEALTH: = 3
FLAMMABILITY: = 0
REACTIVITY: = 0
SPECIAL: OX - Oxidizer

HMIS RATINGS:

HEALTH: = 3
FLAMMABILITY: = 0
REACTIVITY: = 0