

Praxair Material Safety Data Sheet

1. Chemical Product and Company Identification

Product Name: Nitric oxide, compressed (MSDS No. P-4632-D)	Trade Name: Nitric Oxide
Chemical Name: Nitric Oxide	Synonyms: Nitrogen (II) oxide, nitrogen monoxide, mononitrogen, monoxide
Formula: NO	Chemical Family: Nitrogen oxides (NO _x)
Telephone:	Company Name: Praxair, Inc.
Emergencies: 1-800-645-4633*	39 Old Ridgebury Road
CHEMTREC: 1-800-424-9300*	Danbury, CT 06810-5113
Routine: 1-800-PRAXAIR	

* Call emergency numbers 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier, Praxair sales representative, or call 1-800-PRAXAIR (1-800-772-9247).

2. Composition/Information on Ingredients

See section 16 for important information about mixtures.

INGREDIENT	CAS NUMBER	CONCENTRATION	OSHA PEL	ACGIH TLV-TWA (2002)
Nitric Oxide	10102-43-9	>99%*	25 ppm	25 ppm

*The symbol > means "greater than."

3. Hazards Identification

EMERGENCY OVERVIEW



DANGER! Toxic, oxidizing, corrosive, high-pressure gas.

May be fatal if inhaled.

May cause lung damage.

May cause eye and skin burns.

Symptoms may be delayed.

Vigorously accelerates combustion.

Self-contained breathing apparatus and protective clothing must be worn by rescue workers.

Odor: Pungent, irritating



THRESHOLD LIMIT VALUE: 25 ppm TLV (ACGIH, 2002). TLV-TWAs should be used as a guide in the control of health hazards and not as fine lines between safe and dangerous concentrations.

EFFECTS OF A SINGLE (ACUTE) OVEREXPOSURE:

INHALATION—Nitric oxide readily converts to nitrogen dioxide in air. Overexposure may irritate mucous membranes, sinuses, pharynx, and bronchia, causing pain, headache, cyanosis, irregular

respiration, choking, dizziness, and possibly pulmonary edema (fluid in the lungs). There are often no pulmonary symptoms at time of exposure, but symptoms may appear within 5 to 72 hours. High vapor concentrations may cause pain, choking, bronchoconstriction, reflex slowing of the heart, and possibly asphyxiation. Lack of oxygen can kill.

SKIN CONTACT—Severe irritant; may cause burns.

SWALLOWING—An unlikely route of exposure. This product is a gas at normal temperature and pressure.

EYE CONTACT—May cause severe conjunctivitis, producing marked redness and swelling of the conjunctiva. May cause corneal injury with opacification.

EFFECTS OF REPEATED (CHRONIC) OVEREXPOSURE: Repeated inflammation may cause bronchitis or emphysema. Repeated skin contact may produce cumulative dermatitis.

OTHER EFFECTS OF OVEREXPOSURE: None known.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE: Inhalation may aggravate asthma and inflammatory or fibrotic pulmonary disease. The skin irritating properties of the material may aggravate dermatitis.

SIGNIFICANT LABORATORY DATA WITH POSSIBLE RELEVANCE TO HUMAN HEALTH

HAZARD EVALUATION: Nitric oxide has been shown to cause mutations in bacteria, and to cause mutations, sister-chromatid exchanges, and chromosomal aberrations in mammalian cells. Although not demonstrated with nitric oxide, repeated or prolonged maternal hypoxia induced by overexposure to other chemical asphyxiants has produced embryofetal toxicity in laboratory animals.

CARCINOGENICITY: Nitric oxide is not listed by NTP, OSHA, or IARC.

4. First Aid Measures

NOTE: *In case of contact or suspicion of contact with nitric oxide, prompt medical attention is absolutely necessary.*

INHALATION: Immediately remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, qualified personnel may give oxygen. Call a physician immediately.

SKIN CONTACT: Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Discard clothing and shoes. Call a physician.

SWALLOWING: An unlikely route of exposure. This product is a gas at normal temperature and pressure.

EYE CONTACT: Immediately flush eyes thoroughly with cool water for at least 15 minutes. Hold the eyelids open and away from the eyeballs to ensure that all surfaces are flushed thoroughly. See a physician, preferably an ophthalmologist, immediately.

NOTES TO PHYSICIAN: *In case of overexposure, keep patient under medical observation for at least 72 hours to observe for pulmonary edema. Patient may have second acute pulmonary reaction 2-6 weeks after the first one. The hazards of this material are mainly due to its severe irritant and corrosive properties on the skin and mucosal surfaces. There is no specific antidote, and treatment should be directed at the control of the symptoms and the clinical condition.*

5. Fire Fighting Measures

FLASH POINT (test method):

Not applicable

AUTOIGNITION TEMPERATURE:	Not applicable	
FLAMMABLE LIMITS IN AIR, % by volume:	LOWER: Not applicable	UPPER: Not applicable

EXTINGUISHING MEDIA: Oxidizing agent; vigorously accelerates combustion. Use media appropriate for surrounding fire.

SPECIAL FIRE FIGHTING PROCEDURES:

DANGER! Toxic, oxidizing, corrosive high-pressure gas (see section 3). Immediately evacuate all personnel from danger area. Do not approach area without self-contained breathing apparatus and protective clothing. Immediately cool cylinders with water spray from maximum distance; then move them away from fire if without risk. If cylinders are leaking, reduce toxic vapors with water spray or fog. Shut off leak if without risk. Reverse flow into cylinders may cause rupture. (See section 16.) On-site fire brigades must comply with OSHA 29 CFR 1910.156.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Oxidizing agent; may accelerate combustion. Contact with flammables may cause fire or explosion. Heat of fire can build pressure in cylinder and cause it to rupture. Nitric oxide cylinders are not equipped with a pressure relief device. No part of the cylinder should be subjected to a temperature higher than 125°F (52°C).

HAZARDOUS COMBUSTION PRODUCTS: Thermal decomposition produces highly toxic nitrogen oxides. (See section 10.)

6. Accidental Release Measures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:

DANGER! Toxic, oxidizing, corrosive high-pressure gas (see section 3). Immediately evacuate all personnel from danger area. Do not approach area without self-contained breathing apparatus and protective clothing. Contact with flammables may cause fire or explosion. Reverse flow into cylinder may cause rupture. (See section 16.) Reduce vapors with fog or fine water spray. Shut off flow if without risk. Ventilate area or move cylinder to a well-ventilated area. Toxic, corrosive vapors may spread from spill. Before entering area, especially a confined area, check atmosphere with an appropriate device.

WASTE DISPOSAL METHOD: Prevent waste from contaminating the surrounding environment. Keep personnel away. Discard any product, residue, disposable container, or liner in an environmentally acceptable manner, in full compliance with federal, state, and local regulations. If necessary, call your local supplier for assistance.

7. Handling and Storage

PRECAUTIONS TO BE TAKEN IN STORAGE: Store and use with adequate ventilation, away from oil, grease, and other flammable materials. Firmly secure cylinders upright to keep them from falling or being knocked over. Screw valve protection cap firmly in place by hand. Store only where temperature will not exceed 125°F (52°C). Store full and empty cylinders separately. Use a first-in, first-out inventory system to prevent storing full cylinders for long periods. Visually inspect stored cylinders at least once a week for indications of leaks or other problems.

PRECAUTIONS TO BE TAKEN IN HANDLING: Protect cylinders from damage. Use a suitable hand truck to move cylinders; do not drag, roll, slide, or drop. Never attempt to lift a cylinder by its cap; the cap is intended solely to protect the valve. Never insert an object (e.g., wrench, screwdriver, pry bar) into cap openings; doing so may damage the valve and cause a leak. Use an adjustable strap wrench to

remove over-tight or rusted caps. Open valve slowly. If valve is hard to open, discontinue use and contact your supplier. For other precautions in using nitric oxide, see section 16.

For additional information on storage and handling, refer to Compressed Gas Association (CGA) pamphlet P-1, *Safe Handling of Compressed Gases in Containers*, available from the CGA. Refer to section 16 for the address and phone number along with a list of other available publications.

8. Exposure Controls/Personal Protection

VENTILATION/ENGINEERING CONTROLS:

LOCAL EXHAUST—A corrosion-resistant system is acceptable. (See SPECIAL.)

MECHANICAL (general)—Inadequate; see SPECIAL, below.

SPECIAL—Use only in a closed system. A corrosion-resistant, forced-draft fume hood is preferred.

OTHER—See SPECIAL.

RESPIRATORY PROTECTION: Select per OSHA 29 CFR 1910.134 and ANSI Z88.2. Use any NIOSH/MHSA-approved air-supplied respirator for concentrations up to 10 times the applicable permissible exposure limit. For concentrations from 10 to 100 times the PEL, use the above respirator fitted with a full facepiece, or use a self-contained breathing apparatus. For higher concentrations, a full-face, self-contained breathing apparatus operated in the pressure demand mode is required.

PROTECTIVE GLOVES: Wear work gloves for cylinder handling; butyl rubber or polyvinyl chloride when changing out cylinders or wherever contact with product is possible.

EYE PROTECTION: Wear safety glasses when handling cylinders; vapor-proof goggles and a face shield during cylinder changeout or wherever contact with product is possible. Select per OSHA 29 CFR 1910.133.

OTHER PROTECTIVE EQUIPMENT: Metatarsal shoes for cylinder handling and protective clothing where needed. Select per OSHA 29 CFR 1910.132 and 1910.133. Regardless of protective equipment, never touch live electrical parts.

9. Physical and Chemical Properties

MOLECULAR WEIGHT:	30.006
SPECIFIC GRAVITY (Air = 1) at 70°F (21.1°C) and 1 atm:	1.04
GAS DENSITY at 70°F (21.1°C) and 1 atm:	0.0777 lb/ft ³ (1.245 kg/m ³)
SOLUBILITY IN WATER , vol/vol at 32°F (0°C) and 1 atm:	0.0734
PERCENT VOLATILES BY VOLUME:	100
BOILING POINT at 1 atm:	-241.24°F (-151.80°C)
MELTING POINT at 1 atm:	-262.6°F (-163.6°C)

APPEARANCE, ODOR, AND STATE: Colorless gas at normal temperature and pressure, yellow-green liquid; slightly irritating odor. Can become reddish-brown with formation of nitrogen tetroxide on contact with air.

10. Stability and Reactivity

STABILITY: Unstable Stable

INCOMPATIBILITY (materials to avoid): Air, oxygen, flammable materials, combustible materials, powdered aluminum, boron, chlorine monoxide, chromium, fluorine, nitrogen trichloride, ozone, oxygen and phosphorus, oxidizing agents, halogens, iron, sodium monoxide, magnesium, manganese, uranium, tungsten carbide.

HAZARDOUS DECOMPOSITION PRODUCTS: Thermal decomposition will produce highly toxic fumes of nitrogen oxides.

HAZARDOUS POLYMERIZATION: May Occur Will Not Occur

CONDITIONS TO AVOID: Nitric oxide is thermodynamically unstable at room temperature, slowly undergoing disproportionation: $4NO \rightarrow N_2O_3 + N_2O$.

11. Toxicological Information

See section 3.

12. Ecological Information

Nitric oxide does not contain any Class I or Class II ozone-depleting chemicals. This product is not listed as a marine pollutant by DOT.

13. Disposal Considerations

WASTE DISPOSAL METHOD: Do not dispose of unused quantities. Return cylinder to supplier. See section 6 for emergency leak or spill instructions.

14. Transport Information

DOT/IMO SHIPPING NAME: Nitric oxide, compressed

HAZARD CLASS: 2.3 **IDENTIFICATION NUMBER:** UN 1660 **PRODUCT RQ:** 10 lb (4.54 kg)

SHIPPING LABEL(s): POISON GAS, OXIDIZER, CORROSIVE*

PLACARD (when required): POISON GAS, OXIDIZER, CORROSIVE*

*The words in the POISON GAS diamond are INHALATION HAZARD.

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure, upright position, in a well-ventilated vehicle. Cylinders transported in an enclosed, nonventilated compartment of a vehicle can present serious safety hazards.

Additional Marking Requirement: INHALATION HAZARD

Shipment of compressed gas cylinders that have been filled without the owner's consent is a violation of federal law [49 CFR 173.301(b)].

15. Regulatory Information

The following selected regulatory requirements may apply to this product. Not all such requirements are identified. Users of this product are solely responsible for compliance with all applicable federal, state, and local regulations.

U.S. FEDERAL REGULATIONS:**EPA (ENVIRONMENTAL PROTECTION AGENCY)**

CERCLA: COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 (40 CFR Parts 117 and 302):

Reportable Quantity (RQ): 10 lb (4.54 kg)

SARA: SUPERFUND AMENDMENT AND REAUTHORIZATION ACT:

SECTIONS 302/304: Require emergency planning based on Threshold Planning Quantity (TPQ) and release reporting based on Reportable Quantities (RQ) of Extremely Hazardous Substances (EHS) (40 CFR Part 355):

Threshold Planning Quantity (TPQ): 100 lb (45.4 kg)

EHS RQ (40 CFR 355): 10 lb (4.54 kg)

SECTIONS 311/312: Require submission of MSDSs and reporting of chemical inventories with identification of EPA hazard categories. The hazard categories for this product are as follows:

IMMEDIATE: Yes

PRESSURE: Yes

DELAYED: Yes

REACTIVITY: Yes

FIRE: No

SECTION 313: Requires submission of annual reports of release of toxic chemicals that appear in 40 CFR Part 372.

Nitric oxide does not require reporting under Section 313.

40 CFR 68: RISK MANAGEMENT PROGRAM FOR CHEMICAL ACCIDENTAL RELEASE PREVENTION: Requires development and implementation of risk management programs at facilities that manufacture, use, store, or otherwise handle regulated substances in quantities that exceed specified thresholds.

Nitric oxide is listed as a regulated substance in quantities of 10,000 lb (4536 kg) or greater.

TSCA: TOXIC SUBSTANCES CONTROL ACT: Nitric oxide is listed on the TSCA inventory.

OSHA: OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION:

29 CFR 1910.119: PROCESS SAFETY MANAGEMENT OF HIGHLY HAZARDOUS CHEMICALS: Requires facilities to develop a process safety management program based on Threshold Quantities (TQ) of highly hazardous chemicals.

Nitric oxide is listed in Appendix A as a highly hazardous chemical in quantities of 250 lb (113.5 kg) or greater.

STATE REGULATIONS:

CALIFORNIA: Nitric oxide is not listed by California under the SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (Proposition 65).

PENNSYLVANIA: Nitric oxide is subject to the PENNSYLVANIA WORKER AND COMMUNITY RIGHT-TO-KNOW ACT (35 P.S. Sections 7301-7320).

16. Other Information

Be sure to read and understand all labels and instructions supplied with all containers of this product.

OTHER HAZARDOUS CONDITIONS OF HANDLING, STORAGE, AND USE: *Toxic, oxidizing, corrosive, high-pressure gas (see section 3).* May be fatal if inhaled. Do not breathe gas. Do not get

liquid or vapors in eyes, on skin, or on clothing. (See section 3.) Have safety showers and eyewash fountains immediately available. **Use piping and equipment adequately designed to withstand pressures to be encountered.** Use only in a closed system constructed of corrosion-resistant materials. **Prevent reverse flow.** Reverse flow into cylinder may cause rupture. Use a check valve or other protective device in any line or piping from the cylinder. **Store and use with adequate ventilation at all times.** Close valve after each use; keep closed even when empty. **Never work on a pressurized system.** If there is a leak, close the cylinder valve. Blow the system down in a safe and environmentally sound manner in compliance with all federal, state, and local laws; then repair the leak. **Never place a compressed gas cylinder where it may become part of an electrical circuit.**

NOTE: Prior to using any plastics, confirm their compatibility with nitric oxide.

Recommended Equipment: In semiconductor process gas and other suitable applications, Praxair recommends the use of engineering controls such as gas cabinet enclosures, automatic gas panels (used to purge systems on cylinder changeout), excess-flow valves throughout the gas distribution system, double containment for the distribution system, and continuous gas monitors.

MIXTURES: When you mix two or more gases or liquefied gases, you can create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an industrial hygienist or other trained person when you evaluate the end product. Remember, gases and liquids have properties that can cause serious injury or death.

HAZARD RATING SYSTEMS:

NFPA RATINGS:

HEALTH = 3
 FLAMMABILITY = 0
 INSTABILITY = 0
 SPECIAL = OX

HMIS RATINGS:

HEALTH = 4
 FLAMMABILITY = 0
 PHYSICAL HAZARD = 0

STANDARD VALVE CONNECTIONS FOR U.S. AND CANADA:

THREADED:

CGA-660 connection is standard.

PIN-INDEXED YOKE:

Not applicable

ULTRA-HIGH-INTEGRITY CONNECTION:

None

Use the proper CGA connections. **DO NOT USE ADAPTERS.** Additional limited-standard connections may apply. See CGA pamphlet V-1 listed below.

Ask your supplier about free Praxair safety literature as referred to in this MSDS and on the label for this product. Further information about this product can be found in the following pamphlets published by the Compressed Gas Association, Inc. (CGA), 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923, Telephone (703) 788-2700.

P-1 *Safe Handling of Compressed Gases in Containers*
 V-1 *Compressed Gas Cylinder Valve Inlet and Outlet Connections*
 — *Handbook of Compressed Gases, Fourth Edition*

Praxair asks users of this product to study this MSDS and become aware of product hazards and safety information. To promote safe use of this product, a user should (1) notify employees, agents, and contractors of the information in this MSDS and of any other known product hazards and safety information, (2) furnish this information to each purchaser of the product, and (3) ask each purchaser to notify its employees and customers of the product hazards and safety information.

The opinions expressed herein are those of qualified experts within Praxair, Inc. We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of use of the product are not within the control of Praxair, Inc., it is the user's obligation to determine the conditions of safe use of the product.

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Address: Praxair Call Center, Praxair, Inc., PO Box 44, Tonawanda, NY 14151-0044).

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