Praxair Material Safety Data Sheet

1. Chemical Product and Company Identification

Product Name: Dinitrogen tetroxide (MSDS No. P-4633-E)	**Trade Names:** Nitrogen Dioxide
Chemical Name: Nitrogen dioxide and dinitrogen tetroxide in equilibrium	**Synonyms:** Dinitrogen tetroxide, nitrito, nitrogen oxide, nitrogen peroxide, nitrogen tetroxide, NTO, red oxide of nitrogen
Chemical Family: Nitrogen oxides (NOx)	**Product Grades:** 2.5

Telephone: **Emergencies:** 1-800-645-4633* **Company Name:** Praxair, Inc.
CHEMTREC: 1-800-424-9300* 39 Old Ridgebury Road
Routine: 1-800-PRAXAIR Danbury, CT 06810-5113

**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. Hazards Identification

EMERGENCY OVERVIEW

DANGER! Poisonous, corrosive, 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.
Self-contained breathing and protective clothing must be worn by rescue workers.
Under ambient conditions, this is a reddish-brown gas with an irritating odor.

OSHA REGULATORY STATUS: This material is considered hazardous by the OSHA Hazard Communications Standard (29 CFR 1910.1200).

POTENTIAL HEALTH EFFECTS:

Effects of a Single (Acute) Overexposure

Inhalation. Overexposure may irritate the mucous membranes, sinuses, pharynx, and bronchia, with pain, headache, cyanosis, irregular respiration, choking, dizziness, and possibly pulmonary edema. Pulmonary symptoms may be delayed from 5 to 72 hours. High concentrations of vapor 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. Prolonged or widespread skin contact may result in absorption of harmful amounts of nitrogen dioxide.

A vertical line in the left margin indicates revised or new material.

Swallowing. A highly unlikely route of exposure; this product is a gas at normal temperature and pressure. May cause burns of the mouth, esophagus, and stomach.

Eye Contact. May cause severe conjunctivitis, seen as marked excess redness and swelling of the conjunctiva, and corneal injury with opacification.

Effects of Repeated (Chronic) Overexposure. Repeated inhalation may cause bronchitis or emphysema; repeated skin contact may cause dermatitis.

Other Effects of Overexposure. None known.

Medical Conditions Aggravated by Overexposure. Inhalation may aggravate asthma and inflammatory or fibrotic pulmonary disease. Skin irritating properties may aggravate dermatitis.

CARCINOGENICITY: Nitrogen dioxide is not listed by NTP, OSHA, or IARC.

POTENTIAL ENVIRONMENTAL EFFECTS: None known. For further information, see section 12, Ecological Information.

3. Composition/Information on Ingredients

See section 16 for important information about mixtures.

COMPONENT	CAS NUMBER	CONCENTRATION
Nitrogen Dioxide	10102-44-0	>99%*
Dinitrogen Tetroxide	10544-72-6	Trace

**The symbol > means "greater than."*

4. First Aid Measures

INHALATION: Remove to fresh air. If not breathing, give artificial respiration. **WARNING: Rescuer could receive chemical burns from giving mouth-to-mouth.** Rescuer should avoid breathing air exhaled by victim. If breathing is difficult, qualified personnel may give oxygen. Keep patient warm. Call a physician immediately. Keep under medical observation. Symptoms may be delayed.

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 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 a second acute pulmonary reaction 2 to 6 weeks after the first. The hazards of this material are due chiefly to its severe irritant and corrosive properties on the skin and mucosal surfaces. There is no specific antidote. Treatment of overexposure should be directed at the control of symptoms and the clinical condition of the patient.*

Contact the Poison Control Center in your area for additional information on patient management and follow-up.

5. Fire Fighting Measures

FLAMMABLE PROPERTIES: Oxidizing agent; may accelerate combustion. Contact with flammable materials may cause fire or explosion.

SUITABLE EXTINGUISHING MEDIA: Oxidizing agent; may accelerate combustion. Use media appropriate for surrounding fire.

PRODUCTS OF COMBUSTION: Not applicable. Decomposition due to heating may produce toxic fumes. (See section 10.)

PROTECTION OF FIREFIGHTERS: DANGER! Poisonous, corrosive, oxidizing liquid and gas under pressure. Evacuate all personnel from danger area. Do not approach area without self-contained breathing apparatus and protective clothing. Immediately spray cylinders with water from maximum distance until cool; then move them away from fire area if without risk. Remove ignition sources if without risk. If cylinders are leaking, reduce vapors with water spray or fog. Do not spray water directly onto leak; this may only increase the leak. Reverse flow into cylinder may cause it to rupture. Shut off leak if without risk. On-site fire brigades must comply with OSHA 29 CFR 1910.156.

Specific Physical and Chemical Hazards. Heat of fire can build pressure in cylinder and cause it to rupture. To provide maximum containment up to cylinder burst pressure, nitrogen dioxide cylinders are not equipped with a pressure-relief device. No part of a cylinder should be subjected to a temperature higher than 125°F (52°C). Vapors are irritating; contact may cause skin and eye burns.

Protective Equipment and Precautions for Firefighters. Firefighters should wear self-contained breathing apparatus and full fire-fighting turnout gear.

6. Accidental Release Measures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:

DANGER! Poisonous, corrosive, oxidizing liquid and gas under pressure.

Personal Precautions. Immediately evacuate all personnel from danger area. Use self-contained breathing apparatus and protective clothing where needed. Reduce vapors with fog or fine water spray. Reverse flow into cylinder may cause it to rupture. Shut off flow if without risk. Ventilate area or move leaking cylinder to well-ventilated area. Toxic, corrosive vapors may spread from spill. Before entering area, especially confined areas, check atmosphere with an appropriate device.

Environmental Precautions. 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 HANDLING: May be fatal if inhaled. Do not breathe gas. Do not get vapors or liquid in eyes, on skin, or on clothing. Keep away from oxidizing agents and from other flammables. Have safety showers and eyewash fountains immediately available. Protect cylinders from damage. Use a suitable hand truck to move cylinders; do not drag, roll, slide, or drop. All piped systems and associated equipment must be grounded. Electrical equipment must be non-sparking or explosion-proof. Leak check with soapy water;

never use a flame. 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. Close valve after each use; keep closed even when empty. If valve is hard to open, discontinue use and contact your supplier. For other precautions in using nitrogen dioxide, see section 16.

PRECAUTIONS TO BE TAKEN IN STORAGE: Store and use with adequate ventilation, away from oil, grease, and combustibles. Firmly secure cylinders upright to keep them from falling or being knocked over. Nitrogen dioxide cylinders designed to accept a valve protection cap must be provided with a cap. Screw 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.

RECOMMENDED PUBLICATIONS: For further information on storage, handling, and use, see Praxair publication P-14-153, *Guidelines for Handling Gas Cylinders and Containers*. Obtain from your local supplier.

8. Exposure Controls/Personal Protection

COMPONENT	OSHA PEL	ACGIH TLV-TWA (2007)
Nitrogen Dioxide	5 ppm (c)*	3 ppm; 5 ppm, 15 min STEL
Dinitrogen Tetroxide	Values above are for equilibrium mixture.	

*(c) – ceiling. Ceiling values are not Time-Weighted-Average (TWA).

TLV-TWAs should be used as a guide in the control of health hazards and not as fine lines between safe and dangerous concentrations.

IDLH = 20 ppm

ENGINEERING CONTROLS:

Local Exhaust. Use a corrosion-resistant local exhaust system.

Mechanical (General). Inadequate. See SPECIAL.

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

Other. None

PERSONAL PROTECTIVE EQUIPMENT:

Skin Protection. Wear work gloves when handling cylinders; neoprene gloves where contact with product may occur. Metatarsal shoes for cylinder handling, protective clothing where needed. Select in accordance with OSHA 29 CFR 1910.132 and 1910.133. Regardless of protective equipment, never touch live electrical parts.

Eye/Face Protection. Select in accordance with OSHA 29 CFR 1910.133

Respiratory Protection. Use an air-supplied respirator or a full-face, positive-pressure, self-contained breathing apparatus. Respiratory protection must conform to OSHA 29 CFR 1910.134. Select per OSHA 29 CFR 1910.134 and ANSI Z88.2.

9. Physical and Chemical Properties

APPEARANCE:	Reddish-brown gas
ODOR:	Irritating
ODOR THRESHOLD:	Not available.
PHYSICAL STATE:	Gas at normal temperature and pressure
pH:	Acid when dissolved in H_2O.
MELTING POINT at 1 atm**:**	11.8°F (-11.2°C)
BOILING POINT at 1 atm**:**	70.16°F (21.20°C)
FLASH POINT (test method)**:**	Not applicable.
EVAPORATION RATE (Butyl Acetate = 1)**:**	High
FLAMMABILITY:	Nonflammable.
FLAMMABLE LIMITS IN AIR, % by volume**:**	**LOWER:** Not applicable. **UPPER:** Not applicable.
VAPOR PRESSURE at 70°F (21.1°C):	14.7 psia (101.4 kPa abs)
VAPOR DENSITY at 70°F (21.1°C) and 1 atm**:**	Not available.
SPECIFIC GRAVITY (H_2O = 1) at 68°/39.9°F (20°/4°C)**:**	1.448
SPECIFIC GRAVITY (Air = 1) at 70°F (21.1°C) and 1 atm**:**	2.62
SOLUBILITY IN WATER:	Reacts; forms nitric and nitrous acids.
PARTITION COEFFICIENT: n-octanol/water:	Not available.
AUTOIGNITION TEMPERATURE:	Not applicable.
DECOMPOSITION TEMPERATURE:	>320°F (160°C)
PERCENT VOLATILES BY VOLUME:	100
MOLECULAR WEIGHT:	NO_2 = 46.0055, N_2O_4 = 92.0011
MOLECULAR FORMULA:	NO_2 & N_2O_4 in equilibrium

10. Stability and Reactivity

CHEMICAL STABILITY: ☐ Unstable ☒ Stable

CONDITIONS TO AVOID: None known.

INCOMPATIBLE MATERIALS: Water, bases, flammable and combustible materials, copper, aluminum. Very corrosive to metals when wet. Explosions may occur on contact with ammonia, boron trichloride, carbon disulfide, cyclohexane, fluorine, formaldehyde, nitrobenzene, toluene, incompletely halogenated hydrocarbons, propylene, alcohols, and ozone.

HAZARDOUS DECOMPOSITION PRODUCTS: Above 320°F (160°C), nitrogen dioxide decomposes to form nitric oxide and oxygen. Nitrogen dioxide reacts with water to form nitric acid and nitric oxide.

POSSIBILITY OF HAZARDOUS REACTIONS: ☒ May Occur ☐ Will Not Occur

Explosions may occur on contact with ammonia, boron trichloride, carbon disulfide, cyclohexane, fluorine, formaldehyde, nitrobenzene, toluene, incompletely halogenated hydrocarbons, propylene, alcohols, and ozone. Nitrogen dioxide reacts with water to form nitric acid and nitric oxide.

11. Toxicological Information

ACUTE DOSE EFFECTS: LC_{50}, 1 hr, rat = 115 ppm

STUDY RESULTS: Nitrogen dioxide has been shown to cause mutations in bacteria and to cause mutations, sister-chromatid exchanges, and chromasomal aberrations in mammalian cells

12. Ecological Information

ECOTOXICITY: No known effects.

OTHER ADVERSE EFFECTS: Nitrogen dioxide does not contain any Class I or Class II ozone-depleting chemicals.

13. Disposal Considerations

WASTE DISPOSAL METHOD: Do not attempt to dispose of residual or unused quantities. Return cylinder to supplier.

14. Transport Information

DOT/IMO SHIPPING NAME: Dinitrogen tetroxide

HAZARD CLASS:	2.3	**PACKING GROUP/Zone:**	NA*/A	**IDENTIFICATION NUMBER:**	UN1067	**PRODUCT RQ:**	10 lb (4.54 kg)
SHIPPING LABEL(s):	POISON GAS, OXIDIZER, CORROSIVE**						
PLACARD (when required):	POISON GAS, OXIDIZER, CORROSIVE**						

**NA = Not available.*

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

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure 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)].

MARINE POLLUTANTS: Nitrogen dioxide is not listed as a marine pollutant by DOT.

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):

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
DELAYED: Yes
PRESSURE: No
REACTIVITY: No
FIRE: Yes

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

Nitrogen dioxide is not subject to 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.

Nitrogen dioxide is not listed as a regulated substance.

TSCA: TOXIC SUBSTANCES CONTROL ACT: Nitrogen dioxide 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.

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

STATE REGULATIONS:

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

PENNSYLVANIA: Nitrogen dioxide 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: Poisonous, corrosive, oxidizing liquid and gas under pressure*. Store and use with adequate ventilation at all times.* Use only in a closed system constructed only of corrosion-resistant materials. Use with equipment cleaned for oxygen service. Use piping and equipment adequately designed to withstand pressures to be encountered. ***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. ***Never work on a pressurized system.*** If there is a leak, close the cylinder valve. Blow the system down in an environmentally safe manner in compliance with all federal, state, and local laws; then repair the leak. ***When returning***

cylinder to supplier, be sure valve is closed; then install valve outlet cap or plug leak-tight. ***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 nitrogen dioxide.*

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.

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.

HAZARD RATING SYSTEMS:

NFPA RATINGS:		**HMIS RATINGS:**	
HEALTH	= 3	HEALTH	= 3
FLAMMABILITY	= 0	FLAMMABILITY	= 0
INSTABILITY	= 0	PHYSICAL HAZARD	= 1
SPECIAL	= OX		

STANDARD VALVE CONNECTIONS FOR U.S. AND CANADA:

THREADED:	CGA-660
PIN-INDEXED YOKE:	Not applicable.
ULTRA-HIGH-INTEGRITY CONNECTION:	Not applicable.

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 can be found in the following materials published by the Compressed Gas Association, Inc. (CGA), 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923, Telephone (703) 788-2700, http://www.cganet.com/Publication.asp.

AV-1	*Safe Handling and Storage of Compressed Gases*
P-1	*Safe Handling of Compressed Gases in Containers*
P-39	*Oxygen-Rich Atmospheres*
SB-2	*Oxygen-Deficient Atmospheres*
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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