

Nitric oxide

sc-224169

Material Safety Data Sheet



The Power is Question

Hazard Alert Code Key:

EXTREME

HIGH

MODERATE

LOW

Section 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME

Nitric oxide

STATEMENT OF HAZARDOUS NATURE

CONSIDERED A HAZARDOUS SUBSTANCE ACCORDING TO OSHA 29 CFR 1910.1200.

NFPA



SUPPLIER

Company: Santa Cruz Biotechnology, Inc.

Address:

2145 Delaware Ave
Santa Cruz, CA 95060

Telephone: 800.457.3801 or 831.457.3800

Emergency Tel: **CHEMWATCH: From within the US and Canada:**
877-715-9305

Emergency Tel: **From outside the US and Canada: +800 2436 2255**
(1-800-CHEMCALL) or call +613 9573 3112

PRODUCT USE

■ The use of a quantity of material in an unventilated or confined space may result in increased exposure and an irritating atmosphere developing. Before starting consider control of exposure by mechanical ventilation. Used in the manufacture of nitric acid, in the bleaching of rayon and as a stabiliser (to prevent free-radical decomposition) for propylene, methyl ether etc. Incidental exposure to nitric oxide occurs after inhalation of industrial gases, fumes resulting from the welding process, vapours arising from the contact of nitric acid with organic materials, from the exhaust of metal cleaning processes, vapours associated with electroplating, engraving and photogravure operations, dynamite blasting, diesel engine exhaust and in polluted air resulting from fuel use by the internal combustion engine. Nitrogen oxide is a principal component of photochemical smog -concentrations can reach as high as 2.65 ppm in urban air - and a decomposition product of nitrogen trioxide (N₂O₃), nitric acid anhydride (N₂O₅) and nitrous acid (HNO₂). Although nitric oxide is spontaneously converted in air to nitrogen dioxide (NO₂) this occurs only slowly when concentrations are below 50 ppm.

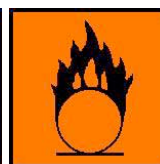
SYNONYMS



NO, "mononitrogen monoxide", "nitrogen monoxide", "mon oxide", "nitrogen oxide"

Section 2 - HAZARDS IDENTIFICATION

CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability:	1	Min/Nil=0 Low=1 Moderate=2 High=3 Extreme=4
Toxicity:	3	
Body Contact:	3	



Reactivity: 3 
Chronic: 2 

CANADIAN WHMIS SYMBOLS



EMERGENCY OVERVIEW

RISK

Risk of explosion by shock, friction, fire or other sources of ignition.
Contact with combustible material may cause fire.
Toxic by inhalation.
Causes burns.
Risk of serious damage to eyes.
Risk of explosion if heated under confinement.

POTENTIAL HEALTH EFFECTS

ACUTE HEALTH EFFECTS

SWALLOWED

- The material can produce chemical burns within the oral cavity and gastrointestinal tract following ingestion.
- Not normally a hazard due to physical form of product.
- Considered an unlikely route of entry in commercial/industrial environments.

EYE

- The material can produce chemical burns to the eye following direct contact. Vapors or mists may be extremely irritating.
- If applied to the eyes, this material causes severe eye damage.
- Not considered to be a risk because of the extreme volatility of the gas.

SKIN

- The material can produce chemical burns following direct contact with the skin.
- Skin contact is not thought to produce harmful health effects (as classified using animal models). Systemic harm, however, has been identified following exposure of animals by at least one other route and the material may still produce health damage following entry through wounds, lesions or abrasions. Good hygiene practice requires that exposure be kept to a minimum and that suitable gloves be used in an occupational setting.
- Open cuts, abraded or irritated skin should not be exposed to this material.
- Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.

INHALED

- If inhaled, this material can irritate the throat and lungs of some persons.
- Material is highly volatile and may quickly form a concentrated atmosphere in confined or unventilated areas. Vapor is heavier than air and may displace and replace air in breathing zone, acting as a simple asphyxiant. This may happen with little warning of overexposure.
- Inhalation of the vapor is hazardous and may even be fatal.
- Inhalation of toxic gases may cause:
 - Central Nervous System effects including depression, headache, confusion, dizziness, stupor, coma and seizures;
 - respiratory: acute lung swellings, shortness of breath, wheezing, rapid breathing, other symptoms and respiratory arrest;
 - heart: collapse, irregular heartbeats and cardiac arrest;
 - gastrointestinal: irritation, ulcers, nausea and vomiting (may be bloody), and abdominal pain.
- A single acute exposure to nitric oxide (NO) may be fatal. No symptoms may occur at the time of exposure, with the exception of slight fatigue, cough or nausea. Only very high vapour concentrations induce prompt or immediate symptoms except perhaps for a slight transient cough, mild fatigue and brief nausea. Slowly evolving but progressive inflammation of the lungs may arise 5-72 hours following exposure; this results in profuse exudation in alveolar spaces. Fluid loss from the blood may produce massive pulmonary oedema. Because of impaired gas exchange, breathing becomes rapid and cyanosis becomes intense. Death may result from asphyxia. The typical reaction to nitrous fume is delayed and insidious because the oxides are largely absorbed by, and react with, alveolar structures and terminal respiratory bronchi. The upper respiratory tract is largely spared because the gas has relatively low solubility in mucous fluids. Warning properties, as a result, are largely absent. NO reacts with haemoglobin to produce nitrosylhaemoglobin (NO-Hb). The affinity for the haem group is 1400 times greater than that of carbon monoxide. Blood levels of NO-Hb are below predictions based on affinity binding experiments in vitro. This may be due to rapid metabolism of NO or may reflect its inability to reach the haem group in vivo or the NO-Hb-complex itself being rapidly metabolised. Either nitric oxide or the NO-Hb complex are likely to produce nitrite after metabolism, giving rise to methaemoglobinaemia. The conversion of NO-Hb to methaemoglobin has been demonstrated in vitro in the presence of molecular oxygen. Following exposure of mice to an atmosphere of 80 ppm NO, blood methaemoglobin exceeded 15%; several other reports indicate that NO can produce significant methaemoglobinaemia. Symptoms of methaemoglobinaemia include cyanosis (a bluish discolouration of skin and mucous membranes) and breathing difficulties. Symptoms may not be evident until several hours after exposure. At about 15% concentration of blood methaemoglobin there is observable cyanosis of the lips, nose and earlobes. Symptoms may be absent although euphoria, flushed face and headache are commonly experienced. At 25-40%, cyanosis is marked but little disability occurs other than that produced on physical exertion. At 40-60%, symptoms include weakness, dizziness, lightheadedness, increasingly severe headache, ataxia, rapid shallow respiration, drowsiness, nausea, vomiting, confusion, lethargy and stupor. Above 60% symptoms include dyspnea, respiratory depression, tachycardia or bradycardia, and convulsions. Levels exceeding 70% may be fatal. NO is a highly unorthodox messenger molecule which can readily diffuse

through cell membranes to exert its biological action in a variety of mammalian cells. NO plays a significant role in neurotransmission, regulation of cerebral blood flow, vasodilation, inhibition of platelet aggregation and antiproliferative action of cytokines. NO is also reported to play an important role in neuromorphogenesis and synaptic plasticity.

CHRONIC HEALTH EFFECTS

■ Limited evidence suggests that repeated or long-term occupational exposure may produce cumulative health effects involving organs or biochemical systems.

Principal route of occupational exposure to the gas is by inhalation.

Repeated or prolonged inhalation of nitric oxide may produce bronchitis or emphysema.

Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS

NAME	CAS RN	%
nitric oxide	10102-43-9	>98
Reacts in air to form		
nitrogen dioxide	10102-44-0	

Section 4 - FIRST AID MEASURES

SWALLOWED

■ Not considered a normal route of entry.

EYE

- If product comes in contact with eyes remove the patient from gas source or contaminated area.
- Take the patient to the nearest eye wash, shower or other source of clean water.
- Open the eyelid(s) wide to allow the material to evaporate.
- Gently rinse the affected eye(s) with clean, cool water for at least 15 minutes. Have the patient lie or sit down and tilt the head back. Hold the eyelid(s) open and pour water slowly over the eyeball(s) at the inner corners, letting the water run out of the outer corners.
- The patient may be in great pain and wish to keep the eyes closed. It is important that the material is rinsed from the eyes to prevent further damage.
- Ensure that the patient looks up, and side to side as the eye is rinsed in order to better reach all parts of the eye(s)
- Transport to hospital or doctor.
- Even when no pain persists and vision is good, a doctor should examine the eye as delayed damage may occur.
- If the patient cannot tolerate light, protect the eyes with a clean, loosely tied bandage.
- Ensure verbal communication and physical contact with the patient.

DO NOT allow the patient to rub the eyesDO NOT allow the patient to tightly shut the eyesDO NOT introduce oil or ointment into the eye(s) without medical adviceDO NOT use hot or tepid water.

SKIN

- If skin or hair contact occurs:
- Immediately flush body and clothes with large amounts of water, using safety shower if available.
- Quickly remove all contaminated clothing, including footwear.
- Wash skin and hair with running water. Continue flushing with water until advised to stop by the Poisons Information Center.
- Transport to hospital, or doctor.

INHALED

■ Inhalation of vapors or aerosols (mists, fumes) may cause lung edema. Corrosive substances may cause lung damage (e.g. lung edema, fluid in the lungs). As this reaction may be delayed up to 24 hours after exposure, affected individuals need complete rest (preferably in semi-recumbent posture) and must be kept under medical observation even if no symptoms are (yet) manifested. Before any such manifestation, the administration of a spray containing a dexamethasone derivative or beclomethasone derivative may be considered. This must definitely be left to a doctor or person authorized by him/her. (ICSC13719).

- Following exposure to gas, remove the patient from the gas source or contaminated area.
- NOTE: Personal Protective Equipment (PPE), including positive pressure self-contained breathing apparatus may be required to assure the safety of the rescuer.
- Prostheses such as false teeth, which may block the airway, should be removed, where possible, prior to initiating first aid procedures.
- If the patient is not breathing spontaneously, administer rescue breathing.
- If the patient does not have a pulse, administer CPR.
- If medical oxygen and appropriately trained personnel are available, administer 100% oxygen.
- Summon an emergency ambulance. If an ambulance is not available, contact a physician, hospital, or Poison Control Center for further instruction.
- Keep the patient warm, comfortable and at rest while awaiting medical care.
- MONITOR THE BREATHING AND PULSE, CONTINUOUSLY.
- Administer rescue breathing (preferably with a demand-valve resuscitator, bag-valve mask-device, or pocket mask as trained) or CPR if necessary.

NOTES TO PHYSICIAN

■ Treat symptomatically.

For intoxication due to nitrogen oxides:

- If patient encountered shortly after exposure, instruct the patient to breathe deeply.

- Enforce complete rest for 24-48 hours even when the patient is not symptomatic.
- During the presymptomatic period inhalation of sodium bicarbonate-sodium chloride aerosol has been suggested as a prophylactic measure. Vitamin E (an antioxidant), in the form of mixed tocopherols, can be given by mouth in doses of several hundred milligrams. N-acetylcysteine (Mycomyst) by aerolization or direct installation may be worthwhile.
- When patient commences coughing or feels slightly fatigued commence oxygen therapy. Nasal prongs or the use of oxygen with continuous distending airway pressure may be appropriate. (Hyperbaric oxygen increased the risk of pulmonary edema when given together with NO₂ in dogs.)
- Removal of frothy exudate from the respiratory tract may be a major therapeutic problem. Suction, postural draining and other methods may be useful.
- Bronchospasm is corrected by inhalation of aerosols of albuterol, isoetharine, metaproterenol or terbutaline.
- Atropine, adrenaline, expectorants, emetics, sedatives (other than small doses of morphine) and, usually, cardiac glycosides are ineffective. In a few instances rapid digitalization with a drug like ouabain may be advisable.
- The role of venesection and blood replacement by isotonic saline is the subject of debate although venesection should certainly be avoided once circulatory collapse has become established.
- Artificial ventilation is seldom effective.
- In the presence of severe, confirmed methemoglobinemia, a cautious trial of methylene blue may be justified even though the safety and efficacy of the procedure has not been established in nitrogen oxides poisoning.
- Steroid therapy, to minimize inflammatory reaction, remains controversial.
- Patients should be observed closely, for at least 6 weeks, to observe, for example, pulmonary edema.

Gosselin, Smith and Hodge: Clinical Toxicology of Commercial Products: 5th Edition

Patients suspected of excessive exposure should be kept under observation.

Depending on the degree of exposure, periodic medical examination is indicated. The symptoms of lung edema often do not manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation is therefore essential. Immediate administration of an appropriate spray, by a doctor or a person authorized by him/her should be considered. (ICSC24419/24421.

Section 5 - FIRE FIGHTING MEASURES

Vapour Pressure (mmHG):	Not available
Upper Explosive Limit (%):	Not applicable
Specific Gravity (water=1):	1.27 (liquid)
Lower Explosive Limit (%):	Not applicable

EXTINGUISHING MEDIA

■ FOR SMALL FIRE:

- USE FLOODING QUANTITIES OF WATER.
- DO NOT use dry chemicals, CO₂ or foam.

FOR LARGE FIRE:

- Flood fire area with water from a protected position.

FIRE FIGHTING

■

-----GENERAL

- Alert Emergency Responders and tell them location and nature of hazard.
- May be violently or explosively reactive.
- Wear full body protective clothing with breathing apparatus.
- Fight fire from a safe distance, with adequate cover.
- If safe, switch off electrical equipment until vapor fire hazard removed.
- Use water delivered as a fine spray to control fire and cool adjacent area.
- Do not approach cylinders suspected to be hot.
- Cool fire exposed cylinders with water spray from a protected location.
- If safe to do so, remove cylinders from path of fire.
- Equipment should be thoroughly decontaminated after use.

-----FIRE-FIGHTING PROCEDURES:

- Excessive pressures may develop in a gas cylinder exposed in a fire; this may result in explosion.
- Cylinders with pressure relief devices may release their contents as a result of fire and the released gas may constitute a further source of hazard for the fire-fighter.
- Cylinders without pressure-relief valves have no provision for controlled release and are therefore more likely to explode if exposed to fire.

-----FIRE FIGHTING REQUIREMENTS:

- Positive pressure, self-contained breathing apparatus is required for fire-fighting of hazardous materials.
- Full structural fire-fighting (bunker) gear is the minimum acceptable attire.
- The need for proximity, entry and special protective clothing should be determined for each incident, by a competent fire-fighting safety professional.

GENERAL FIRE HAZARDS/HAZARDOUS COMBUSTIBLE PRODUCTS

■

- Will not burn but increases intensity of fire.

- May explode from friction, shock, heat or containment.
- Heating may cause expansion or decomposition leading to violent rupture of containers.
- Heat affected containers remain hazardous.
- Contact with combustibles such as wood, paper, oil or finely divided metal may produce spontaneous combustion or violent decomposition.
- May emit irritating, poisonous or corrosive fumes.
- Combustion/decomposition may produce acrid/toxic fumes of carbon monoxide (CO).

Decomposition may produce toxic fumes of: nitrogen oxides (NOx).

Contains low boiling substance: Closed containers may rupture due to pressure buildup under fire conditions.

Material contains oxidizing agent/organic peroxide. Oxygen provided makes fire fierce and self sustaining. Smothering action may not be effective for established fire. Intense heat may cause spontaneous decomposition (detonation). Due to possibility of reignition, extinguished residues must be thoroughly cooled before approaching.

Vented gas is more dense than air and may collect in pits, basements.

FIRE INCOMPATIBILITY

- Avoid storage with reducing agents.

PERSONAL PROTECTION

Glasses:

Full face- shield.

Gloves:

Respirator:

Type BE Filter of sufficient capacity

Section 6 - ACCIDENTAL RELEASE MEASURES

MINOR SPILLS

■

- Avoid breathing vapor and any contact with liquid or gas. Protective equipment including respirator should be used.
- DO NOT enter confined spaces where gas may have accumulated.
- Increase ventilation.
- Clear area of personnel.
- Stop leak only if safe to do so.
- Remove leaking cylinders to safe place. release pressure under safe controlled conditions by opening valve.
- Keep area clear of personnel until gas has dispersed.

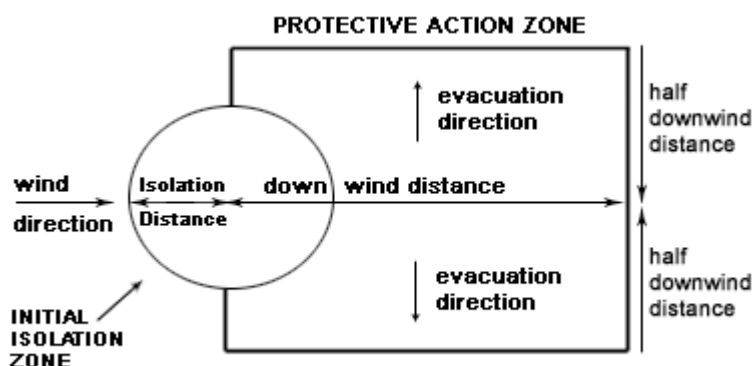
Cover liquid nitric oxide spills with soda ash or slaked lime, mixed and sprayed with water. Water spray or fog may be used to disperse vapour.

MAJOR SPILLS

■

- Clear area of all unprotected personnel and move upwind.
- Alert Emergency Authority and advise them of the location and nature of hazard.
- Wear full body clothing with breathing apparatus.
- Prevent by any means available, spillage from entering drains and water-courses.
- Consider evacuation.
- Increase ventilation.
- No smoking or naked lights within area.
- Stop leak only if safe to do so.
- Water spray or fog may be used to disperse vapor.
- DO NOT enter confined space where gas may have collected.
- Keep area clear until gas has dispersed.
- Remove leaking cylinders to a safe place.
- Fit vent pipes. Release pressure under safe, controlled conditions
- Burn issuing gas at vent pipes.
- DO NOT exert excessive pressure on valve; DO NOT attempt to operate damaged valve.

PROTECTIVE ACTIONS FOR SPILL



From US Emergency Response Guide 2000 Guide 124

From IERG (Canada/Australia)

Isolation Distance 100 meters

Downwind Protection Distance 800 meters

SMALL SPILLS

Name	Isolation Distance	Downwind Day	Protection Night
Nitric oxide	100 ft (30 m)	0.2 mile (0.3 km)	0.8 mile (1.3 km)

LARGE SPILLS

Name	Isolation Distance	Downwind Day	Protection Night
Nitric oxide	500 ft (155 m)	0.8 mile (1.3 km)	2.2 mile (3.5 km)

FOOTNOTES

1 PROTECTIVE ACTION ZONE is defined as the area in which people are at risk of harmful exposure. This zone assumes that random changes in wind direction confines the vapour plume to an area within 30 degrees on either side of the predominant wind direction, resulting in a crosswind protective action distance equal to the downwind protective action distance.

2 PROTECTIVE ACTIONS should be initiated to the extent possible, beginning with those closest to the spill and working away from the site in the downwind direction. Within the protective action zone a level of vapour concentration may exist resulting in nearly all unprotected persons becoming incapacitated and unable to take protective action and/or incurring serious or irreversible health effects.

3 INITIAL ISOLATION ZONE is determined as an area, including upwind of the incident, within which a high probability of localised wind reversal may expose nearly all persons without appropriate protection to life-threatening concentrations of the material.

4 SMALL SPILLS involve a leaking package of 200 litres (55 US gallons) or less, such as a drum (jerrican or box with inner containers). Larger packages leaking less than 200 litres and compressed gas leaking from a small cylinder are also considered "small spills". LARGE SPILLS involve many small leaking packages or a leaking package of greater than 200 litres, such as a cargo tank, portable tank or a "one-tonne" compressed gas cylinder.

5 Guide 124 is taken from the US DOT emergency response guide book.

6 IERG information is derived from CANUTEC - Transport Canada.

ACUTE EXPOSURE GUIDELINE LEVELS (AEGL) (in ppm)

AEGL 1: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL 2: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL 3: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

Section 7 - HANDLING AND STORAGE

PROCEDURE FOR HANDLING

- Consider use in closed pressurized systems, fitted with temperature, pressure and safety relief valves which are vented for safe dispersal.
- Check regularly for spills or leaks. Keep valves tightly closed but do not apply extra leverage to hand wheels or cylinder keys.
- Test for leakage with brush and detergent - NEVER use a naked flame.
- Leaking gland nuts may be tightened if necessary.
- If a cylinder valve will not close completely, remove the cylinder to a well ventilated location (e.g. outside) and, when empty, tag as FAULTY and return to supplier.
- Obtain a work permit before attempting any repairs. DO NOT attempt repair work on lines, vessels under pressure.

- Atmospheres must be tested and O.K. before work resumes after leakage.
- DO NOT transfer gas from one cylinder to another.

RECOMMENDED STORAGE METHODS

- Cylinder
- Ensure the use of equipment rated for cylinder pressure.
- Ensure the use of compatible materials of construction.
- Valve protection cap to be in place until cylinder is secured, connected.
- Cylinder must be properly secured either in use or in storage.
- Cylinder valve must be closed when not in use or when empty.
- Segregate full from empty cylinders.

WARNING: Suckback into cylinder may result in rupture. Use back-flow preventive device in piping. Nitric acid is non-corrosive and most common structural materials may be used. However in the presence of moisture and oxygen corrosive conditions will develop as a result of the formation of nitric and nitrous oxide. Where air contamination cannot be eliminated, stainless steel should be used to contain or store the gas.

STORAGE REQUIREMENTS

- Cylinders should be stored in a purpose-built compound with good ventilation, preferably in the open.
- Such compounds should be sited and built in accordance with statutory requirements.
- The storage compound should be kept clear and access restricted to authorized personnel only.
- Cylinders stored in the open should be protected against rust and extremes of weather.
- Cylinders in storage should be properly secured to prevent toppling or rolling.
- Cylinder valves should be closed when not in use.
- Where cylinders are fitted with valve protection this should be in place and properly secured.
- Gas cylinders should be segregated according to the requirements of the Dangerous Goods Act(s).
- Preferably store full and empty cylinders separately.
- Cylinders containing oxidants must be kept a minimum distance from gases. Alternately a fire resistant partition may be used.
- Check storage areas for hazardous concentrations of gases prior to entry.
- Full cylinders should be arranged so that the oldest stock is used first.
- Cylinders in storage should be checked periodically for general condition and leakage.

SAFE STORAGE WITH OTHER CLASSIFIED CHEMICALS



X: Must not be stored together

O: May be stored together with specific precautions

+: May be stored together

Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE CONTROLS

ENDOELTABLE

Source	Material	TWA ppm	TWA mg/m ³	STEL ppm	STEL mg/m ³	Peak ppm	Peak mg/m ³	Notes
Canada - Alberta Occupational Exposure Limits	nitric oxide (Nitric oxide)	25	31					
Canada - British Columbia Occupational Exposure Limits	nitric oxide (Nitric oxide)	25						
Canada - Ontario Occupational Exposure Limits	nitric oxide (Nitric oxide)	25	31					
US OSHA Permissible Exposure Levels (PELs) - Table Z1	nitric oxide (Nitric oxide)	25	30					

US ACGIH Threshold Limit Values (TLV)	nitric oxide (Nitric oxide)	25				TLV Basis: hypoxia/cyanosis; nitrosylhemoglobin formation; upper respiratory tract irritation. BEI-M
US NIOSH Recommended Exposure Limits (RELs)	nitric oxide (Nitric oxide)	25	30			
US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants	nitric oxide (Nitric oxide)	25	30			
US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants	nitric oxide (Nitric oxide)	25	30			
US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants	nitric oxide (Nitric oxide)	25	30			
US - Minnesota Permissible Exposure Limits (PELs)	nitric oxide (Nitric oxide)	25	30			
US - California Permissible Exposure Limits for Chemical Contaminants	nitric oxide (Nitric oxide; NO)	25	30			
US - Idaho - Limits for Air Contaminants	nitric oxide (Nitric oxide)	25	30			
US - Hawaii Air Contaminant Limits	nitric oxide (Nitric oxide)	25	30	35	45	
US - Alaska Limits for Air Contaminants	nitric oxide (Nitric oxide)	25	30			
US - Michigan Exposure Limits for Air Contaminants	nitric oxide (Nitric oxide)	25	30			
Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances	nitric oxide (Nitric oxide)	25	30	35	45	
US - Washington Permissible exposure limits of air contaminants	nitric oxide (Nitric oxide)	25		38		
Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits	nitric oxide (Nitric oxide)	25		38		
Canada - Prince Edward Island Occupational Exposure Limits	nitric oxide (Nitric oxide)	25				TLV Basis: hypoxia/cyanosis; nitrosylhemoglobin formation; upper respiratory tract irritation. BEI-M
US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants	nitric oxide (Nitric oxide)	25	30			
Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)	nitric oxide (Nitrogen monoxide)	25	31			
US - Oregon Permissible Exposure Limits (Z-1)	nitric oxide (Nitric oxide)	25	30			
Canada - Northwest Territories Occupational Exposure Limits (English)	nitric oxide (Nitric oxide)	25	31	35	43	

Canada - Nova Scotia Occupational Exposure Limits	nitric oxide (Nitric oxide)	25						TLV Basis: hypoxia/cyanosis; nitrosylhemoglobin formation; upper respiratory tract irritation. BEI-M
Canada - British Columbia Occupational Exposure Limits	nitrogen dioxide (Nitrogen dioxide)					1		
Canada - Ontario Occupational Exposure Limits	nitrogen dioxide (Nitrogen dioxide)	3	5.6	5	9.4			
US - Minnesota Permissible Exposure Limits (PELs)	nitrogen dioxide (Nitrogen dioxide)			1	1.8			
US ACGIH Threshold Limit Values (TLV)	nitrogen dioxide (Nitrogen dioxide)	3		5				TLV Basis: upper & lower respiratory tract irritation
US NIOSH Recommended Exposure Limits (RELs)	nitrogen dioxide (Nitrogen dioxide)			1	1.8			
Canada - Alberta Occupational Exposure Limits	nitrogen dioxide (Nitrogen dioxide)	3	5.6	5	9.4			
US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants	nitrogen dioxide (Nitrogen dioxide)			1	1.8			
US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants	nitrogen dioxide (Nitrogen dioxide)	(C)5	(C)9					
US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants	nitrogen dioxide (Nitrogen dioxide)			1	1.8			
US - California Permissible Exposure Limits for Chemical Contaminants	nitrogen dioxide (Nitrogen dioxide)			1	1.8			
US - Idaho - Limits for Air Contaminants	nitrogen dioxide (Nitrogen dioxide)					5	9	
US OSHA Permissible Exposure Levels (PELs) - Table Z1	nitrogen dioxide (Nitrogen dioxide)					5	9	
US - Hawaii Air Contaminant Limits	nitrogen dioxide (Nitrogen dioxide)	3	6	5	9.4			
US - Alaska Limits for Air Contaminants	nitrogen dioxide (Nitrogen dioxide)			1	1.8			
US - Michigan Exposure Limits for Air Contaminants	nitrogen dioxide (Nitrogen dioxide)			1	1.8			
Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances	nitrogen dioxide (Nitrogen dioxide)	5	9	-	-			
US - Washington Permissible exposure limits of air contaminants	nitrogen dioxide (Nitrogen dioxide)			1				
Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits	nitrogen dioxide (Nitrogen dioxide)	3		5				

Canada - Prince Edward Island Occupational Exposure Limits	nitrogen dioxide (Nitrogen dioxide)	3	5			TLV Basis: upper & lower respiratory tract irritation
US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants	nitrogen dioxide (Nitrogen dioxide)			5	9	
Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)	nitrogen dioxide (Nitrogen dioxide)	3	5.6			
US - Oregon Permissible Exposure Limits (Z-1)	nitrogen dioxide (Nitrogen dioxide)			5	9	
Canada - Northwest Territories Occupational Exposure Limits (English)	nitrogen dioxide (Nitrogen dioxide)	3	6	5	9.4	
Canada - Nova Scotia Occupational Exposure Limits	nitrogen dioxide (Nitrogen dioxide)	3		5		TLV Basis: upper & lower respiratory tract irritation

EMERGENCY EXPOSURE LIMITS

Material	Revised IDLH Value (mg/m3)	Revised IDLH Value (ppm)
nitric oxide		100 [Unch]
nitrogen dioxide		20

MATERIAL DATA

NITRIC OXIDE:

■ For nitric oxide:

Odour Threshold: 0.3 to 1 ppm.

NOTE: Detector tubes for nitrogen oxide, measuring in excess of 10 ppm, are commercially available.

Experimental animal data indicates that nitric oxide is one-fifth as toxic as nitrogen dioxide. The recommended TLV-TWA takes account of this relationship. Exposure at or below the recommended TLV-TWA is thought to reduce the potential for immediate injury, adverse physiological effects, pulmonary disease (including the risk of increased airway resistance) from prolonged daily exposure

Odour Safety Factor (OSF)

OSF=7.7 (nitric oxide).

ES TWA: simple asphyxiant TLV TWA: simple asphyxiant. Simple asphyxiants are gases which, when present in high concentrations, reduce the oxygen content in air below that required to support breathing, consciousness and life; i.e. loss of consciousness, with death by suffocation may rapidly occur in an oxygen deficient atmosphere. CARE: Most simple asphyxiants are odorless and there is no warning on entry into an oxygen deficient atmosphere. If there is any doubt, oxygen content can be checked simply and quickly. It may not be appropriate to only recommend an exposure standard for simple asphyxiants rather it is essential that sufficient oxygen be maintained. Air normally has 21 percent oxygen by volume, with 18 percent regarded as minimum under normal atmospheric pressure to maintain consciousness / life. At pressures significantly higher or lower than normal atmospheric pressure, expert guidance should be sought.

PERSONAL PROTECTION



Consult your EHS staff for recommendations

EYE

- Chemical goggles.
- Full face shield.
- Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

HANDS/FEET

- When handling sealed and suitably insulated cylinders wear cloth or leather gloves.

OTHER

- Overalls.
- PVC Apron.
- PVC protective suit may be required if exposure severe.
- Eyewash unit.

- Ensure there is ready access to a safety shower.
- Some plastic personal protective equipment (PPE) (e.g. gloves, aprons, overshoes) are not recommended as they may produce static electricity.
- For large scale or continuous use wear tight-weave non-static clothing (no metallic fasteners, cuffs or pockets), non sparking safety footwear.

RESPIRATOR

■

- Positive pressure, full face, air-supplied breathing apparatus should be used for work in enclosed spaces if a leak is suspected or the primary containment is to be opened (e.g. for a cylinder change)
- Air-supplied breathing apparatus is required where release of gas from primary containment is either suspected or demonstrated.

RESPIRATOR

■ Selection of the Class and Type of respirator will depend upon the level of breathing zone contaminant and the chemical nature of the contaminant. Protection Factors (defined as the ratio of contaminant outside and inside the mask) may also be important.

Breathing Zone Level ppm (volume)	Maximum Protection Factor	Half-face Respirator	Full-Face Respirator
1000	10	BE-1	-
1000	50	-	BE-1
5000	50	Airline*	-
5000	100	-	BE-2
10000	100	-	BE-3
	100+		Airline* *

* - Continuous Flow ** - Continuous-flow or positive pressure demand.

The local concentration of material, quantity and conditions of use determine the type of personal protective equipment required.

Use appropriate NIOSH-certified respirator based on informed professional judgement. In conditions where no reasonable estimate of exposure can be made, assume the exposure is in a concentration IDLH and use NIOSH-certified full face pressure demand SCBA with a minimum service life of 30 minutes, or a combination full facepiece pressure demand SAR with auxiliary self-contained air supply. Respirators provided only for escape from IDLH atmospheres shall be NIOSH-certified for escape from the atmosphere in which they will be used.

ENGINEERING CONTROLS

■

- Areas where cylinders are stored require good ventilation and, if enclosed, need discrete/ controlled exhaust ventilation.
- Secondary containment and exhaust gas treatment may be required by certain jurisdictions
- Local exhaust ventilation is required in work areas.
- Consideration should be given to the use of doubly-contained piping; diaphragm or bellows-sealed, soft-seat valves; backflow prevention devices; and flow- monitoring or limiting devices.
- Gas cabinets, with appropriate exhaust treatment, are recommended, as is automatic monitoring of the secondary enclosures and workplaces, for potential release.
- Automated alerting systems with automatic shutdown of gas-flow may be appropriate and may in fact be mandatory in certain jurisdictions.
- Respiratory protection in the form of air-supplied or self-contained breathing equipment must be worn if the oxygen concentration in the workplace air is less than 19%.
- Cartridge respirators do NOT give protection and may result in rapid suffocation.

Air contaminants generated in the workplace possess varying "escape" velocities which, in turn, determine the "capture velocities" of fresh circulating air required to effectively remove the contaminant.

Type of Contaminant:	Air Speed:
gas discharge (active generation into zone of rapid air motion)	1-2.5 m/s (200-500 f/min.)
Within each range the appropriate value depends on:	
Lower end of the range	Upper end of the range
1: Room air currents minimal or favorable to capture	1: Disturbing room air currents
2: Contaminants of low toxicity or of nuisance value only.	2: Contaminants of high toxicity
3: Intermittent, low production.	3: High production, heavy use
4: Large hood or large air mass in motion	4: Small hood-local control only

Simple theory shows that air velocity falls rapidly with distance away from the opening of a simple extraction pipe. Velocity generally decreases with the square of distance from the extraction point (in simple cases). Therefore the air speed at the extraction point should be adjusted, accordingly, after reference to distance from the contaminating source. The air velocity at the extraction fan, for example, should be a minimum of 1-2.5 m/s (200-500 f/min.) for extraction of gases discharged 2 meters distant from the extraction point. Other mechanical considerations, producing performance deficits within the extraction apparatus, make it essential that theoretical air velocities are multiplied by factors of 10 or more when extraction systems are installed or used.

Prior to use, systems that contain nitrogen oxide must first be purged with inert gas.

CAUTION: On contact with air, nitric oxide is converted to highly poisonous nitrogen dioxide, dinitrogen tetroxide or both. Gas masks plus adequate ventilation are mandatory when handling even small amounts in the laboratory.

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL PROPERTIES

Gas.

Does not mix with water.
Sinks in water.
Corrosive.
Toxic or noxious vapors/ gas.

State	Compressed gas	Molecular Weight	30.01
Melting Range (°F)	-262.48	Viscosity	Not Applicable
Boiling Range (°F)	-241.06	Solubility in water (g/L)	Partly miscible
Flash Point (°F)	Not applicable	pH (1% solution)	Not available
Decomposition Temp (°F)	Not Available	pH (as supplied)	Not applicable
Autoignition Temp (°F)	Not applicable	Vapour Pressure (mmHG)	Not available
Upper Explosive Limit (%)	Not applicable	Specific Gravity (water=1)	1.27 (liquid)
Lower Explosive Limit (%)	Not applicable	Relative Vapor Density (air=1)	1.04
Volatile Component (%vol)	100	Evaporation Rate	Not available

APPEARANCE

Colourless gas which turns brown in air (forming NO₂); does not mix well with water (4.6 ml/100 ml H₂O, 20 deg C). Bluish white snow when solid; deep blue as liquid.

Section 10 - CHEMICAL STABILITY

CONDITIONS CONTRIBUTING TO INSTABILITY

-
- Presence of incompatible materials.
- Product is considered stable.
- Hazardous polymerization will not occur.

STORAGE INCOMPATIBILITY

- Nitric oxide:
 - is reactive with alkalis, flammable and combustible materials, organic compounds and solvents, reducing agents, copper and aluminium.
 - forms nitric / nitrous acid in contact with water and is therefore 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.
 - Inorganic reducing agents react with oxidizing agents to generate heat and products that may be flammable, combustible, or otherwise reactive. Their reactions with oxidizing agents may be violent.
 - Incidents involving interaction of active oxidants and reducing agents, either by design or accident, are usually very energetic and examples of so-called redox reactions.
 - In presence of moisture, the material is corrosive to aluminium, zinc and tin producing highly flammable hydrogen gas.
 - Reacts vigorously with alkalis

WARNING:

May decompose violently or explosively on contact with other substances.

- This substance is one of the relatively few compounds which are described as "endothermic" i.e. heat is absorbed into the compound, rather than released from it, during its formation.
- The majority of endothermic compounds are thermodynamically unstable and may decompose explosively under various circumstances of initiation.
- Many but not all endothermic compounds have been involved in decompositions, reactions and explosions and, in general, compounds with significantly positive values of standard heats of formation, may be considered suspect on stability grounds.

BREITHERICK L.: Handbook of Reactive Chemical Hazards.

- Inorganic oxidising agents can react with reducing agents to generate heat and products that may be gaseous (causing pressurization of closed containers). The products may themselves be capable of further reactions (such as combustion in the air).
- Organic compounds in general have some reducing power and can in principle react with compounds in this class. Actual reactivity varies greatly with the identity of the organic compound.
- Inorganic oxidising agents can react violently with active metals, cyanides, esters, and thiocyanates.
- Compressed gases may contain a large amount of kinetic energy over and above that potentially available from the energy of reaction produced by the gas in chemical reaction with other substances

Avoid storage with reducing agents.

For incompatible materials - refer to Section 7 - Handling and Storage.

Section 11 - TOXICOLOGICAL INFORMATION

NITRIC OXIDE

TOXICITY AND IRRITATION

■ unless otherwise specified data extracted from RTECS - Register of Toxic Effects of Chemical Substances.

TOXICITY	IRRITATION
----------	------------

Inhalation (rat) LC50: 1068 mg/m³/4h

Nil Reported

■ Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS. RADS (or asthma) following an irritating inhalation is an infrequent disorder with rates related to the concentration of and duration of exposure to the irritating substance. Industrial bronchitis, on the other hand, is a disorder that occurs as result of exposure due to high concentrations of irritating substance (often particulate in nature) and is completely reversible after exposure ceases. The disorder is characterised by dyspnea, cough and mucus production.

Rat cell mutagen.

SKIN

nitric oxide	Canada - Alberta Occupational Exposure Limits - Skin	Substance Interaction	1
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Section 12 - ECOLOGICAL INFORMATION

Refer to data for ingredients, which follows:

NITROGEN DIOXIDE:

NITRIC OXIDE:

■ DO NOT discharge into sewer or waterways.

■ For oxides of nitrogen:

Environmental fate

Oxides of nitrogen are part of the biogeochemical cycling of nitrogen, and are found in air, soil and water.

In the atmosphere, oxides of nitrogen are rapidly oxidised to nitrogen dioxide (half-life about 50 days), which dissolves in water to produce dilute nitric acid and precipitates in rain. An increased rate of formation of oxides of nitrogen therefore contributes to 'acid rain'.

In the stratosphere, oxides of nitrogen play a crucial role in maintaining the level of ozone. Ozone is formed through the photochemical reaction of nitrogen dioxide and oxygen. However, too little nitrogen dioxide results in too little ozone being formed. On the other hand, too much nitric oxide reduces the level of ozone because of an increase in the reaction of ozone to convert nitric oxide to nitrogen dioxide.

In the lower atmosphere, oxides of nitrogen play a major role in the formation of photochemical smog in a complex set of reactions that lead to the formation of a variety of nitrated organic compounds (from volatile organic matter) and excessive levels of ozone.

Environmental transport The oxides of nitrogen travel as gases through soil and the atmosphere, and in solution in water in soils, rivers and lakes, and rain and snow.

NITRIC OXIDE:

NITROGEN DIOXIDE:

Ecotoxicity

Ingredient	Persistence: Water/Soil	Persistence: Air	Bioaccumulation	Mobility
nitric oxide			LOW	
nitrogen dioxide			LOW	

Section 13 - DISPOSAL CONSIDERATIONS

US EPA Waste Number & Descriptions

A. General Product Information

Ignitability characteristic: use EPA hazardous waste number D001 (waste code I)

Corrosivity characteristic: use EPA hazardous waste number D002 (waste code C)

B. Component Waste Numbers

When nitric oxide is present as a solid waste as a discarded commercial chemical product, off-specification species, as a container residue, or a spill residue, use EPA waste number P076 (waste code T).

When nitrogen dioxide is present as a solid waste as a discarded commercial chemical product, off-specification species, as a container residue, or a spill residue, use EPA waste number P078 (waste code T).

Disposal Instructions

All waste must be handled in accordance with local, state and federal regulations.

!

- Evaporate residue at an approved site.
- Return empty containers to supplier.
- Ensure damaged or non-returnable cylinders are gas-free before disposal.

Place leaking nitrogen oxide cylinder in a fume hood or safe outdoor area.

When slow release of gas to air is unacceptable, attach needle valve and tube to run gas into an excess of 5 to 10% aqueous sodium hydroxide solution (with caution!) at a moderate rate, then neutralise for disposal.

All waste solutions are to be neutralised before disposal.

Bury neutralised waste solutions and any residues in an authorised landfill.

Section 14 - TRANSPORTATION INFORMATION



Air Transport IATA:

ICAO/IATA Class:	2.3	ICAO/IATA Subrisk:	5.1, 8
UN/ID Number:	1660	Packing Group:	-
Special provisions:	A2		
Cargo Only			
Packing Instructions:	Forbidden	Maximum Qty/Pack:	Forbidden
Passenger and Cargo		Passenger and Cargo	
Packing Instructions:	Forbidden	Maximum Qty/Pack:	Forbidden
Passenger and Cargo Limited Quantity		Passenger and Cargo Limited Quantity	
Packing Instructions:	-	Maximum Qty/Pack:	-

Shipping Name: NITRIC OXIDE, COMPRESSED

Maritime Transport IMDG:

IMDG Class:	2.3	IMDG Subrisk:	5.1, 8
UN Number:	1660	Packing Group:	None
EMS Number:	F-C , S-W	Special provisions:	None
Limited Quantities:	0		

Shipping Name: NITRIC OXIDE, COMPRESSED

NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS: DOT

Section 15 - REGULATORY INFORMATION



REGULATIONS

ND

Ingredient	CAS	RQ
nitrogen dioxide	10102-44-0	10 lb (4.54 kg)

nitric oxide (CAS: 10102-43-9) is found on the following regulatory lists;

"Canada - Alberta Occupational Exposure Limits", "Canada - British Columbia Occupational Exposure Limits", "Canada - Northwest Territories Occupational Exposure Limits (English)", "Canada - Nova Scotia Occupational Exposure Limits", "Canada - Ontario Occupational Exposure Limits", "Canada - Prince Edward Island Occupational Exposure Limits", "Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)", "Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits", "Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances", "Canada Domestic Substances List (DSL)", "Canada Environmental Protection Act (CEPA) 1999 - Schedule 1 Toxic Substances List", "Canada Ingredient Disclosure List (SOR/88-64)", "Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (English)", "OECD Representative List of High Production Volume (HPV) Chemicals", "US - Alaska Limits for Air Contaminants", "US - California Occupational Safety and Health Regulations (CAL/OSHA) - Hazardous Substances List", "US - California Permissible Exposure Limits for Chemical Contaminants", "US - Connecticut Hazardous Air Pollutants", "US - Hawaii Air Contaminant Limits", "US - Idaho - Limits for Air Contaminants", "US - Massachusetts Oil & Hazardous Material List", "US - Michigan Exposure Limits for Air Contaminants", "US - Minnesota Hazardous Substance List", "US - Minnesota Permissible Exposure Limits (PELs)", "US - New Jersey Right to Know Hazardous Substances", "US - Oregon Hazardous Materials", "US - Oregon Permissible Exposure Limits (Z-1)", "US - Pennsylvania - Hazardous Substance List", "US - Rhode Island Hazardous Substance List", "US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants", "US - Vermont Hazardous Constituents", "US - Vermont Hazardous Waste - Acutely Hazardous Wastes", "US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants", "US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants", "US - Washington Dangerous waste constituents list", "US - Washington Discarded Chemical Products List - ""P"" Chemical Products", "US - Washington Permissible exposure limits of air contaminants", "US - Wyoming List of Highly Hazardous Chemicals, Toxics and Reactives", "US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants", "US ACGIH Threshold Limit Values (TLV)", "US Department of Homeland Security Chemical Facility Anti-Terrorism Standards - Chemicals of Interest", "US Department of Transportation (DOT) List of Hazardous Substances and Reportable Quantities - Hazardous Substances Other Than Radionuclides", "US DOE Temporary Emergency

Exposure Limits (TEELs),"US EPA Acute Exposure Guideline Levels (AEGLs) - Interim","US List of Lists - Consolidated List of Chemicals Subject to EPCRA, CERCLA and Section 112(r) of the Clean Air Act","US NFPA 45 Fire Protection for Laboratories Using Chemicals - Flammability Characteristics of Common Compressed and Liquefied Gases","US NIOSH Recommended Exposure Limits (RELs)","US OSHA List of Highly Hazardous Chemicals, Toxics and Reactives","US OSHA Permissible Exposure Levels (PELs) - Table Z1","US RCRA (Resource Conservation & Recovery Act) - Hazardous Constituents - Appendix VIII to 40 CFR 261","US RCRA (Resource Conservation & Recovery Act) - List of Hazardous Wastes","US SARA Section 302 Extremely Hazardous Substances","US Toxic Substances Control Act (TSCA) - Inventory","USA: Chemical Facility Anti-Terrorism Standards - List Appendix A - 6CFR 27"

Regulations for ingredients

nitrogen dioxide (CAS: 10102-44-0,10544-72-6) is found on the following regulatory lists;

"Canada - Alberta Ambient Air Quality Objectives","Canada - Alberta Occupational Exposure Limits","Canada - British Columbia Occupational Exposure Limits","Canada - Northwest Territories Occupational Exposure Limits (English)","Canada - Nova Scotia Occupational Exposure Limits","Canada - Ontario Occupational Exposure Limits","Canada - Prince Edward Island Occupational Exposure Limits","Canada - Prince Edward Island Occupational Exposure Limits - Carcinogens","Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)","Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits","Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances","Canada Domestic Substances List (DSL)","Canada Environmental Protection Act (CEPA) 1999 - Schedule 1 Toxic Substances List","Canada Environmental Quality Guidelines (EQGs) Air","Canada Ingredient Disclosure List (SOR/88-64)","Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (English)","US - Alaska Limits for Air Contaminants","US - California Occupational Safety and Health Regulations (CAL/OSHA) - Hazardous Substances List","US - California OEHHA/ARB - Acute Reference Exposure Levels and Target Organs (RELs)","US - California Permissible Exposure Limits for Chemical Contaminants","US - Hawaii Air Contaminant Limits","US - Idaho - Limits for Air Contaminants","US - Massachusetts Oil & Hazardous Material List","US - Michigan Exposure Limits for Air Contaminants","US - Minnesota Hazardous Substance List","US - Minnesota Permissible Exposure Limits (PELs)","US - New Jersey Right to Know Hazardous Substances","US - Oregon Hazardous Materials","US - Oregon Permissible Exposure Limits (Z-1)","US - Pennsylvania - Hazardous Substance List","US - Rhode Island Hazardous Substance List","US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants","US - Vermont Hazardous Constituents","US - Vermont Hazardous Waste - Acutely Hazardous Wastes","US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants","US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants","US - Washington Dangerous waste constituents list","US - Washington Discarded Chemical Products List - ""P"" Chemical Products","US - Washington Permissible exposure limits of air contaminants","US - Wyoming List of Highly Hazardous Chemicals, Toxics and Reactives","US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants","US ACGIH Threshold Limit Values (TLV)","US ACGIH Threshold Limit Values (TLV) - Carcinogens","US CERCLA Priority List of Hazardous Substances","US CWA (Clean Water Act) - List of Hazardous Substances","US CWA (Clean Water Act) - Reportable Quantities of Designated Hazardous Substances","US Department of Transportation (DOT) List of Hazardous Substances and Reportable Quantities - Hazardous Substances Other Than Radionuclides","US DOE Temporary Emergency Exposure Limits (TEELs)","US EPA Acute Exposure Guideline Levels (AEGLs) - Interim","US List of Lists - Consolidated List of Chemicals Subject to EPCRA, CERCLA and Section 112(r) of the Clean Air Act","US NFPA 1 Annex B Typical Oxidizers","US NFPA 45 Fire Protection for Laboratories Using Chemicals - Flammability Characteristics of Common Compressed and Liquefied Gases","US NIOSH Recommended Exposure Limits (RELs)","US OSHA List of Highly Hazardous Chemicals, Toxics and Reactives","US OSHA Permissible Exposure Levels (PELs) - Table Z1","US Postal Service (USPS) Hazardous Materials Table: Postal Service Mailability Guide","US RCRA (Resource Conservation & Recovery Act) - Hazardous Constituents - Appendix VIII to 40 CFR 261","US RCRA (Resource Conservation & Recovery Act) - List of Hazardous Wastes","US SARA Section 302 Extremely Hazardous Substances","US Toxic Substances Control Act (TSCA) - Inventory"

Section 16 - OTHER INFORMATION

LIMITED EVIDENCE

- Cumulative effects may result following exposure*.
 - Vapors potentially cause drowsiness and dizziness*.
- * (limited evidence).

Ingredients with multiple CAS Nos

Ingredient Name	CAS
nitrogen dioxide	10102-44-0, 10544-72-6

REPRODUCTIVE HEALTH GUIDELINES

■ Established occupational exposure limits frequently do not take into consideration reproductive end points that are clearly below the thresholds for other toxic effects. Occupational reproductive guidelines (ORGs) have been suggested as an additional standard. These have been established after a literature search for reproductive no-observed-adverse effect-level (NOAEL) and the lowest-observed-adverse-effect-level (LOAEL). In addition the US EPA's procedures for risk assessment for hazard identification and dose-response assessment as applied by NIOSH were used in the creation of such limits. Uncertainty factors (UFs) have also been incorporated.

Ingredient	ORG	UF	Endpoint	CR	Adeq TLV
nitrogen dioxide	0.18 mg/m3	10	R	NA	-

■ These exposure guidelines have been derived from a screening level of risk assessment and should not be construed as unequivocally safe limits. ORGs represent an 8-hour time-weighted average unless specified otherwise. CR = Cancer Risk/10000; UF = Uncertainty factor: TLV believed to be adequate to protect reproductive health: LOD: Limit of detection Toxic endpoints have also been identified as: D = Developmental; R = Reproductive; TC = Transplacental carcinogen Jankovic J., Drake F.: A Screening Method for Occupational Reproductive Health Risk: American Industrial Hygiene Association Journal 57: 641-649 (1996).

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- Classification of the mixture and its individual components has drawn on official and authoritative sources as well as independent review by

the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:

www.chemwatch.net/references.

■ The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

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