

Product Safety Assessment

Gaseous Nitrogen

General

Nitrogen is colorless, odorless and tasteless. It is nonflammable, will not support combustion and is not life-supporting. The gas is slightly lighter than air and is only slightly soluble in water. When liquid nitrogen is vaporized and then heated it consumes a large amount of heat, making it an ideal coolant.

Nitrogen is present in the atmosphere at a concentration of 78.1%. Nitrogen is recovered from air in an Air Separation Unit (ASU) where it is drawn off as a cryogenic liquid at about -321 °F. Nitrogen can then be distributed as a cryogenic liquid or as a gas in cylinders. Nitrogen can also be generated onsite, using various techniques.

Applications

Nitrogen has many commercial and technical applications. Liquid nitrogen's cooling properties are used to freeze food, blood and other materials; modify metal properties; control reaction temperatures; cool concrete and simulate cold operating conditions. Nitrogen gas is used to blanket, purge or stir many chemicals or molten metals. The gas can also be used to pressurize devices or pneumatically convey materials, while keeping out contaminants like oxygen or water.

Health Effects

Nitrogen is odorless, colorless, tasteless, and nonirritating, which means it has no warning properties. Humans possess no senses that can detect the presence of nitrogen.

Contact with rapidly expanding nitrogen near the point of release may cause frostbite, with redness, skin color change to gray or white, and blistering.

No adverse ingestion effects are anticipated, but nitrogen is a simple asphyxiant. Effects of oxygen deficiency resulting from simple asphyxiates may include rapid breathing, diminished mental alertness, impaired muscular coordination, faulty judgment, depression of all sensations, emotional instability, and fatigue. As asphyxiation progresses, nausea, vomiting, prostration, and loss of consciousness may result, eventually leading to convulsions, coma, and death.

At low oxygen concentrations, unconsciousness and death may occur in seconds and without warning.

Oxygen deficiency during pregnancy has produced developmental abnormalities in humans and experimental animals.

First aid measures are not required for gas. If frostbite is suspected, flush eyes with cool water for 15 minutes and obtain immediate medical attention. For frostbite, immerse skin in lukewarm water. DO NOT USE HOT WATER. Obtain medical attention.

Ingestion is unlikely since nitrogen is a gas at room temperature. In cases of inhalation and overexposure, prompt medical attention is required. Rescue personnel should be equipped with self-contained breathing apparatus. Victims should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, and if breathing has stopped, administer artificial resuscitation and supplemental oxygen. Further treatment should be symptomatic and supportive.

Table 1 Gaseous Nitrogen Physical and Chemical Properties

Chemical Formula	N ₂
Molecular Weight	28
Boiling Point (BP) @ 1 atm	-321.5 °F (-196 °C)
Freezing Point @ 1 atm	-346.0 °F (-210 °C)
Critical Temperature	-232.5 °F (-146.9 °C)
Critical Pressure	492 psia (34 atm)
Density, Liquid, @ BP, 1 atm	50.5 lb/scf
Density, Gas @ 68 °F (20 °C), 1 atm	0.07 lb/scf
Specific Gravity, Liquid (water=1) @ 68 °F (20 °C), 1 atm	0.81
Specific Volume @ 68 °F (20 °C), 1 atm	13.8 scf/lb
Latent Heat of Vaporization	2399 Btu/lb mole
Expansion Ratio, Liquid to Gas, BP to 68 °F (20 °C)	1 to 694

Containers

Gaseous nitrogen is shipped and stored in high-pressure cylinders, tubes, or tube trailers, which are designed and manufactured according to applicable codes and specifications for the pressures and temperatures involved. These vessels are manufactured according to Department of Transportation (DOT) regulations, which specify the material of construction, method of manufacture, testing, and with what products they are permitted to be filled, as well as other details. The quantity of product a container can hold is determined by its pressure rating and internal volume.

Permanent gaseous storage vessels are constructed to ASME codes, which specify the material of construction, method of manufacture, testing, and with what products they are permitted to be filled, as well as other details.

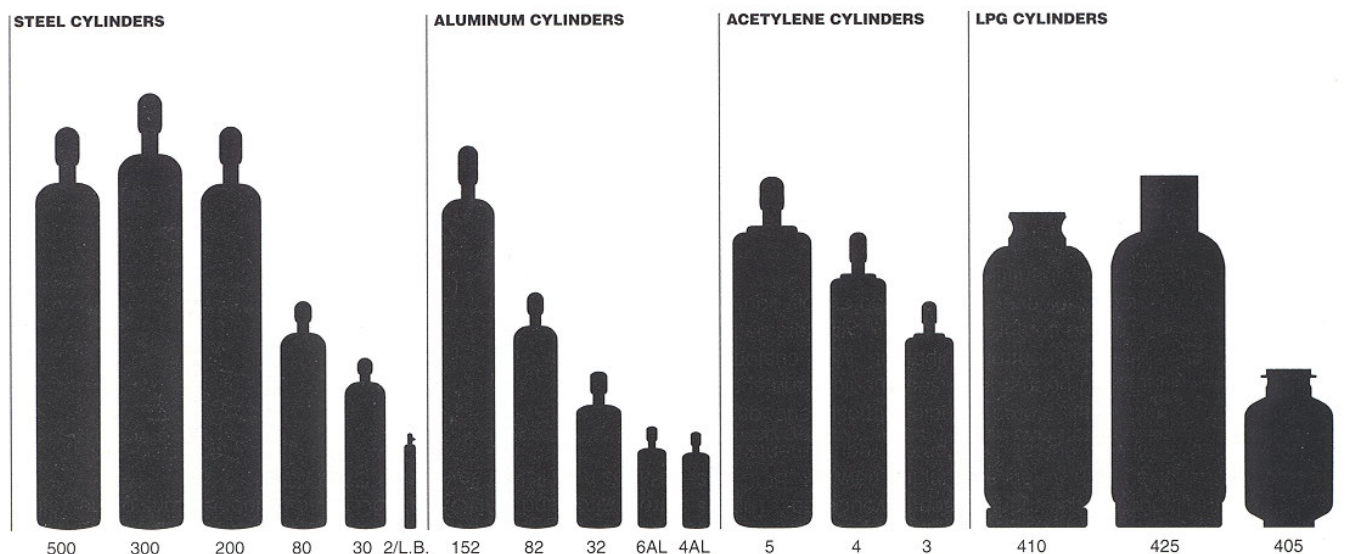
Cylinders

The most commonly used high-pressure cylinders are designed to hold gases at pressures up to 2200 psig; some ultra-high pressure commercial cylinders will contain gas at pressures up to 6000 psig.

High-pressure cylinders come in a variety of pressure ratings and capacities. The most commonly used cylinders for oxygen, nitrogen, argon, and helium are rated at 2200 psig. Other commonly used cylinders are 2485 psig and 2640 psig cylinders.

The common 2200 psig, nitrogen cylinder weighs about 150 lb, depending on the grade of steel used in the cylinder body. Each cylinder has a valve on top and a steel cap that screws over the valve to protect it from damage. Each valve has a safety device designed to release pressure if the cylinder pressure becomes too high.

If the valve of a high-pressure gas cylinder is broken off, the contents of the cylinder may jet from a hole about 1/4" in diameter. The escaping gas could have enough thrust to turn the cylinder into a rocket, depending on the cylinder's size and weight.



Tubes

A tube is a pipe tapered at both ends. Each end is threaded to allow the installation of valves, connections, or relief devices.

Tubes for transportation are manufactured according to DOT regulations. Tubes manufactured for permanent storage are made to ASME codes. Tubes are generally mounted on a truck-trailer chassis or railcar bed, or placed at stationary locations when large amounts of nitrogen are needed.

Valve Connections

The Compressed Gas Association (CGA) recommends different connections for nitrogen, depending on the pressure rating of the container, or type of service industry, such as medical or semiconductor. The following table shows these different connections (for detailed drawings of these connections, consult CGA Pamphlet V-1).

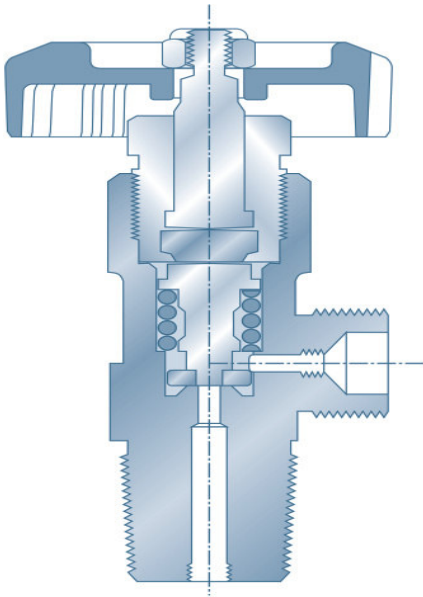


Table Nitrogen Service Connections

<u>Cylinder Service</u>	<u>CGA Connection</u>
Nitrogen < 3,000 psig	580
Nitrogen at 3,001 to 5,500 psig	680
Nitrogen at 5,501 to 7,500 psig	677
Semiconductor	718

WARNING: Do NOT use adapters to make cylinder connections!

Pressure-Relief Devices

Nitrogen containers are equipped with pressure-relief devices to protect from over pressurization and possible rupture. Cylinders less than 65" long use a rupture disk device. Cylinders over 65" use a combination device consisting of a rupture disk backed by a fusible alloy. Combination devices require that both the temperature and pressure requirements be reached before the device will relieve.

For ASME tubes, pressure relief valves are also used to protect from over-pressurization.

Container Stampings

Each cylinder or tube is identified by stampings in the metal of the shoulder. These markings refer to its service pressure rating, date of manufacture, and testing.



Key to Cylinder Stampings

1. Cylinder Specification

- DOT—Department of Transportation, which is the regulatory body that governs the use of cylinders.
- Specification of the cylinder type of material of construction (e.g., 3AA).
- Service or working pressure in pounds per square inch (e.g., 2,015 psi).

2. Cylinder Serial Number

3. Registered Owner Symbol

- Symbol used to indicate the original owner of the cylinders.
- ARCO or AGA is a Registered Owner Symbol for Linde.

4. Date of Manufacture

- This date (month-year) also indicates the original hydrostatic test.

5. Neck Ring Identification

- The cylinder neck ring displays the name of the current owner of the cylinder.

6. Retest Markings

- The format for a retest marking is: Month—Facility—Year—Plus Rating— Star Stamp.
- The + symbol (Plus Rating) indicates that the cylinder qualifies for 10% overfill.
- The . symbol (Star Stamp) indicates that the cylinder meets the requirements for 10-year retest.

7. Cylinder Manufacturer's Inspection Marking

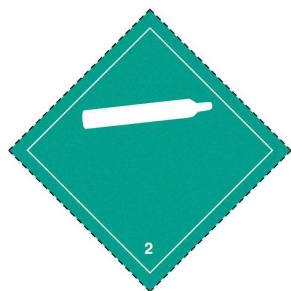
Shipment of Gaseous Nitrogen

All shipments of compressed nitrogen must comply with DOT regulations. This applies to motor freight, rail, air, and water shipments. For air shipments all packages must not only comply with DOT regulations but also comply with International Air Transport Association/International Civil Air Organization (IATA/ICAO) Dangerous Goods regulations. Water vessel shipments must also be prepared in accordance with the International Maritime Organization (IMO) regulations. All packaging used to transport nitrogen must be either "UN/DOT Specification" or "UN/DOT Authorized" and in proper condition for transport. DOT Code of Federal Regulations, Title 49, also specifies the following labeling and identification requirements:

DOT Shipping Name: Nitrogen, Compressed

DOT Hazard Class: 2.2

DOT Shipping Label: Nonflammable Gas



Identification Number: UN1066

Safety Considerations

Asphyxiation and the high pressure of the gas in containers and systems are hazards associated with nitrogen.

Buildings

Provide adequate ventilation where nitrogen is being used, and test the atmosphere in confined work areas for oxygen content. A 19.5% oxygen concentration in the air is the minimum recommended for working without special breathing equipment.

Personal Protective Equipment (PPE)

Personnel must be thoroughly familiar with properties and safety considerations before being allowed to handle nitrogen and its associated equipment. Safety glasses, safety shoes, and leather work gloves are recommended when handling cylinders.

Only trained and certified emergency responders should respond to emergency situations.**First Aid**

First aid measures are not required for gas. If frostbite is suspected, flush eyes with cool water for 15 minutes and obtain immediate medical attention. For frostbite, immerse skin in lukewarm water. DO NOT USE HOT WATER. Obtain medical attention.

Self-contained breathing apparatus (SCBA) may be required to prevent asphyxiation of rescue personnel.

Fire Fighting

Nitrogen is nonflammable. A cylinder may vent rapidly or rupture violently from pressure when involved in a fire situation.

Although most cylinders are designed to vent contents when exposed to elevated temperatures, note that pressure in a container can build up due to heat and it may rupture if a pressure relief device should fail to function.

Firefighters should wear respiratory protection (SCBA) and full turnout or Bunker gear. Continue to cool fire-exposed containers until well after flames are extinguished.

Handling and Storage

Nitrogen is noncorrosive and may be used with all common structural materials. Use only in well-ventilated areas. Use local exhaust in combination with general ventilation as necessary to prevent accumulation of high concentrations and maintain air oxygen level at or above 19.5%.

Do not allow the temperature where cylinders are stored to exceed 125°F (52°C). Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Use a "first in-first out" inventory system to prevent full cylinders being stored for excessive periods of time.

Valve protection caps must remain in place unless container is secured with valve protection outlet piped to use point.

Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement.

Use a pressure reducing regulator when connecting cylinder to lower pressure piping or systems.

Do not heat cylinder by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder.

Protect cylinders from physical damage. Do not insert any object (i.e.: screwdriver) into valve cap openings as this can damage the valve causing leakage.

Never carry a compressed gas cylinder or a container of a gas in cryogenic liquid form in an enclosed space such as a car trunk, van or station wagon. A leak can result in a fire, explosion, asphyxiation or a toxic exposure.

For additional recommendations, consult Compressed Gas Association Pamphlets P-1, G-10.1, P-8.1, P-8.2, P-9, P-16, P-18, and Safety Bulletin SB-2.

Emergency Response System

Product Safety Information

- Call: 1-800-424-9300 (Continental U.S. and Puerto Rico)
- Call: 1-703-527-3887 (other locations)
- 24 hours a day, 7 days a week

For assistance involving Linde, Inc. products

For MSDS, Product Safety Assessment, and Product Safety Information,
www.linde.com

Information Sources

- www.us.lindegas.com
- Compressed Gas Association (CGA)
www.cganet.com

For More Information

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Murray Hill, NJ 07974-2082

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