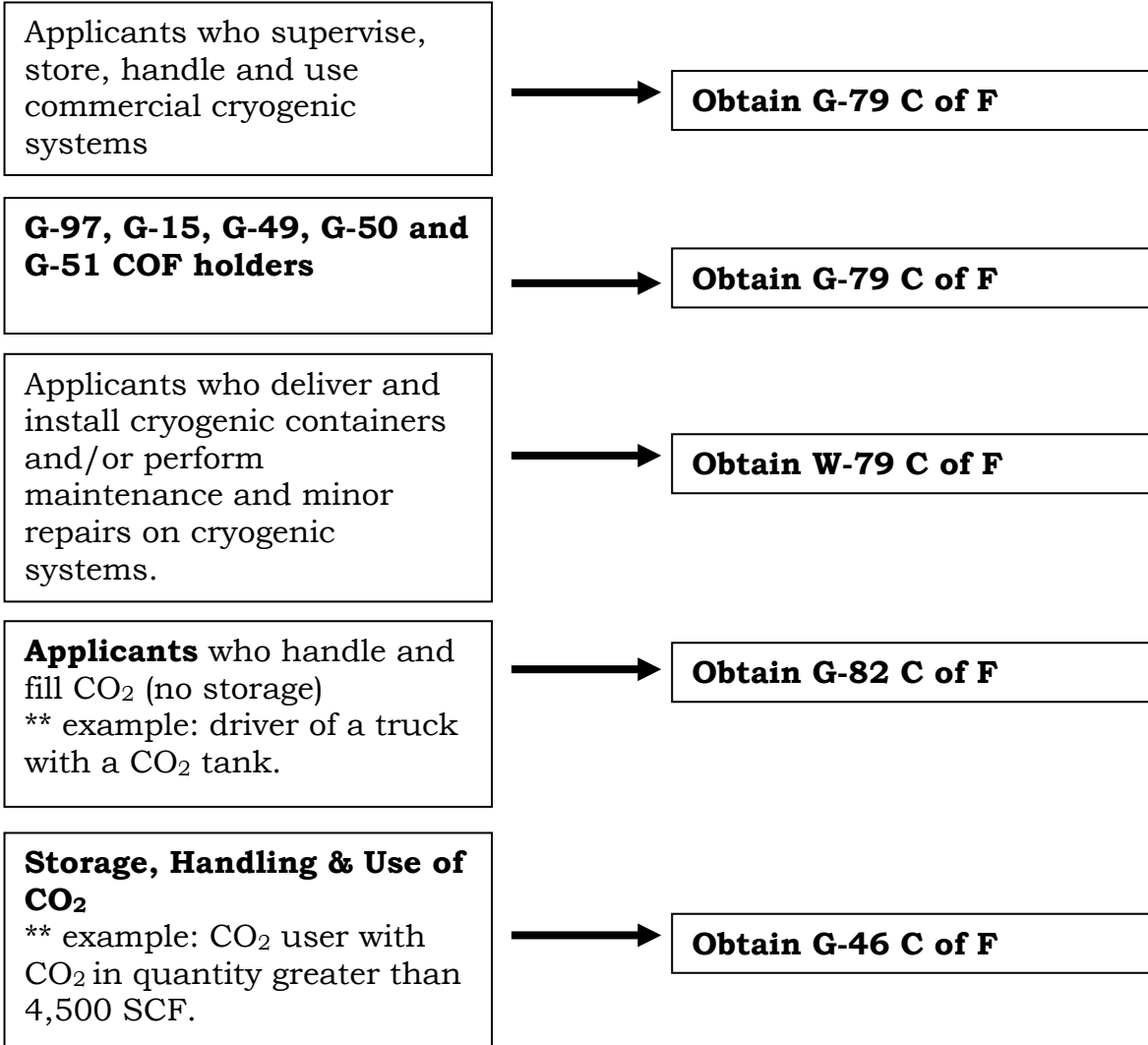


**FIRE DEPARTMENT • CITY OF NEW YORK**



**STUDY MATERIAL FOR THE  
CERTIFICATE OF FITNESS EXAMINATION  
SUPERVISION OF STORAGE, HANDLING, AND USE OF COMMERCIAL  
CRYOGENIC SYSTEMS (ex. O<sub>2</sub>, N<sub>2</sub>O, He, N<sub>2</sub>, AR) (G-79)  
DELIVERING, INSTALLING, REPAIRING CRYOGENIC CONTAINERS OR SYSTEMS  
(CITYWIDE) (W-79)**



G-15 USE OF LIQUID O<sub>2</sub> ON WORK SITE

G-49 TRANSFILLING OF CRYOGENIC LIQUID GAS CYLINDERS

G-50 SUPERVISION OF COMMERCIAL CRYOGENIC SYSTEMS (N<sub>2</sub>,AR)

G-51 USE OF CRYOGENIC INERT GASES ON WORK SITE

Note: Applicants are advised to review HANDBOOK OF CRYOGENICES 4th Ed.

***All applicants are required to apply and pay for an exam online before arriving at the FDNY. It can take about 30 minutes to complete.***

Simplified instructions for online application and payment can be found here:

<http://www1.nyc.gov/assets/fdny/downloads/pdf/business/fdny-business-cof-individuals-short.pdf>

Create an Account and Log in to:

<http://fires.fdnyccloud.org/CitizenAccess>

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## EXAM SPECIFIC INFORMATION FOR G-79/W-79 CERTIFICATE OF FITNESS

***Save time and submit application online!***

***All applicants are required to apply and pay for an exam online before arriving at the FDNY. It can take about 30 minutes to complete.***

Simplified instructions for online application and payment can be found here:

<http://www1.nyc.gov/assets/fdny/downloads/pdf/business/fdny-business-cof-individuals-short.pdf>

Create an Account and Log in to:

<http://fires.fdnyccloud.org/CitizenAccess>

### **REQUIREMENTS FOR CERTIFICATE OF FITNESS APPLICATION**

#### **General requirements:**

Review the General Notice of Exam:

<http://www1.nyc.gov/assets/fdny/downloads/pdf/business/general-notice-of-exam-cof.pdf>

#### **Special requirements for the G-79/W-79 Certificate of Fitness:**

- The W-79 is a **citywide** certificate. The recommendation letter must be a company which provide service in **delivering or installing or repairing cryogenic containers or systems**. The W-79 C of F is NOT authorized to supervise the storage of cryogenic fluid.
- G-79 can purchase W-79 without taking the W-79 exam. However, the correct recommendation letter must be provided.

#### **Application fee (Cash is NO LONGER ACCEPTED):**

Pay the **\$25** application fee online or in person by one of the following methods:

- Credit card (*American Express, Discover, MasterCard, or Visa*)
- Debit card (*MasterCard or Visa*)
- In person: Personal or company check or money order (*made payable to the New York City Fire Department*)

A convenience fee of 2% will be applied to all credit card payments.

For fee waivers submit: ***(Only government employees who will use their COF for their work- related responsibilities are eligible for fee waivers.)***

- A letter requesting fee waiver on the Agency's official letterhead stating applicant full name, exam type and address of premises; **AND**
- Copy of identification card issued by the agency

### **REQUIREMENTS FOR ALTERNATIVE ISSUANCE PROCEDURE (AIP)**

The G-79 and W-79 Certificate of Fitness can be obtained by the alternative issuance procedure. Qualified applicants should review and complete the G-79/W-79 Certificate of Fitness Alternative Issuance Procedure Application Affirmation Form:

G-79:

<http://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-g79-aip.pdf>

W-79:

<http://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-w79-aip.pdf>

The AIP applicants must submit the application, required documents and payment on **FDNY Business**:

<https://fires.fdnyccloud.org/>

### **EXAM INFORMATION**

The **G-79** exam will consist of **60** multiple-choice questions (**W-79** exam will consist of **30** multiple-choice questions), administered on a “touch screen” computer monitor. Based on the amount of the questions and reference material provided, you will have 92 minutes to complete the G-79 test and 45 minutes to complete the W-79 test.

**\*\* Implies that following material will NOT appear on the W-79 COF exam.**

A passing score of at least 70% is required in order to secure a Certificate of Fitness. Call (718) 999-1988 for additional information and forms.

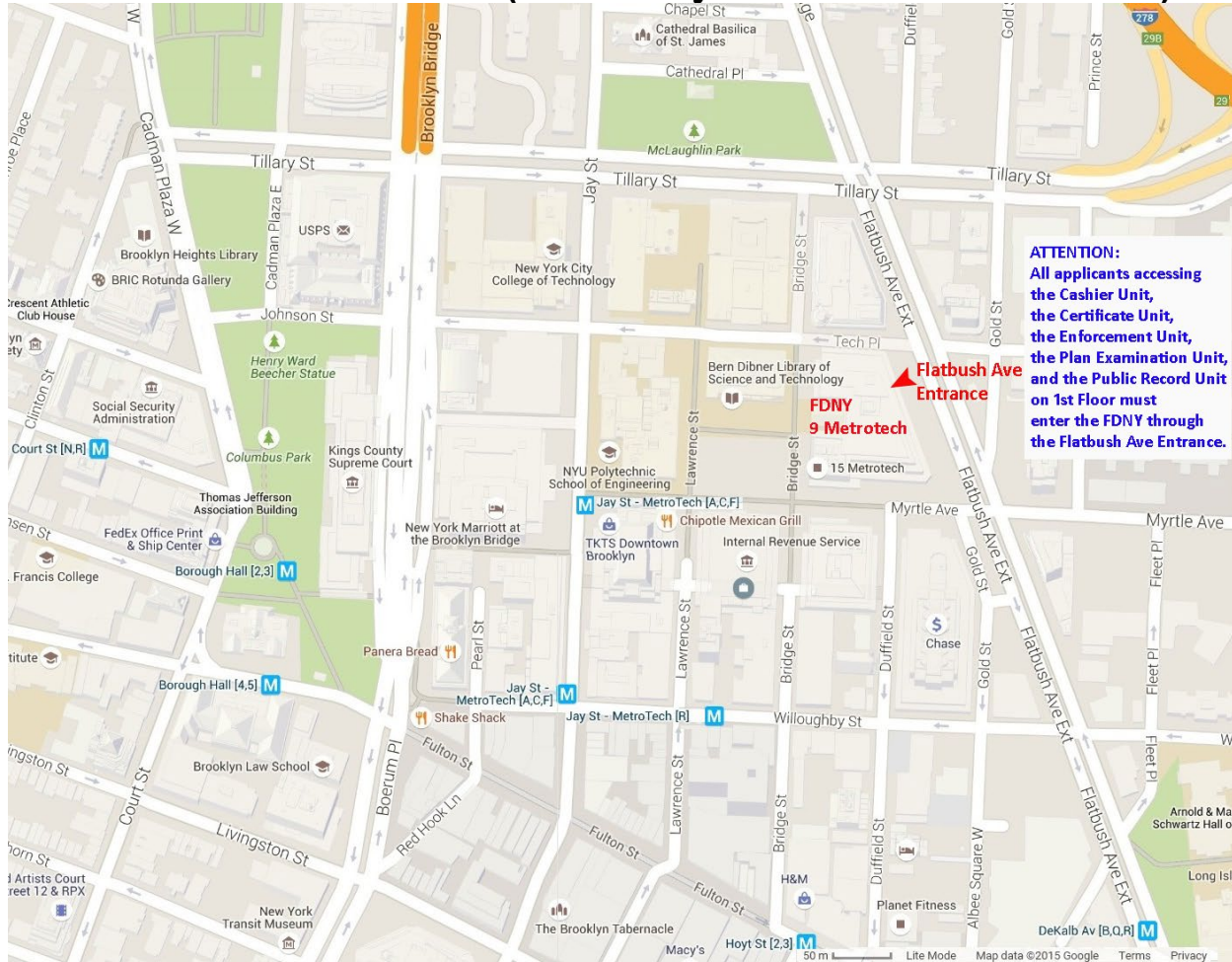
Please always check for the latest revised booklet at FDNY website before you take the exam.

<http://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-g79-noe-study-materials.pdf>

### **Special material provided during the exam (for G-79 exam applicants only):**

*The tables which appear in the booklet will be provided to you as a reference material when you take the exam at MetroTech, however, the booklet will not provide to you during the exam.* Please always check for the latest revised booklet at FDNY website before you take the exam.

**EXAM SITE: FDNY Headquarters, 9 MetroTech Center, Brooklyn, NY.** Enter through the **Flatbush Avenue entrance (between Myrtle Avenue and Tech Place)**



## **RENEWAL REQUIREMENTS**

### **General renewal requirements:**

Review the General Notice of Exam:

<https://www1.nyc.gov/assets/fdny/downloads/pdf/business/general-notice-of-exam-cof.pdf>

**Special renewal requirements.** G-79/W-79 Certificate of Fitness: None

## **QUESTIONS?**

**FDNY Business Support Team:** For questions, call 311 and ask for the FDNY Customer Service Center or send an email to [FDNY.BusinessSupport@fdny.nyc.gov](mailto:FDNY.BusinessSupport@fdny.nyc.gov).

## STUDY MATERIAL AND TEST DESCRIPTION

### **ABOUT THE STUDY MATERIAL**

This study material will help you prepare for the examination regarding the Certificate of Fitness for Supervision of *Storage, Handling, and Use of commercial cryogenic systems and fluids*. The study material includes information taken from the New York City Fire Code and New York City Fire Rules. The exam covers this entire study material and any reference tables/charts. **Keep in mind that this study material will not be provided to you during the examination.** It is important that you read and understand this booklet to help you increase your chances of passing this test.

The study material does not contain all of the information you need to know to use, store and handle cryogenic systems and fluids. It is your responsibility to become familiar with all the applicable rules and regulations of the City of New York, even if they are not covered in this study material. In order to adequately prepare for the exam, you need to be familiar with the Fire Code Chapters 27, 32, 40 and NYC Fire Rules section 3004-01. You shall also be familiar with NFPA 50 and 55 and CGA G-8.1 (Standard for Nitrous Oxide Systems at Consumer Sites) and P18 (Standard for Bulk Inert Gas Systems).

### **ABOUT THE TEST**

The G-79/W-79 Certificate of Fitness exam consists of **60** multiple-choice questions (W-79 exam will consist of **30** multiple-choice questions) with four alternative answers to each question. Only one answer is correct for each question. If you do not answer a question or if you choose more than one alternative answer, the question will be scored as incorrect. A score of 70% is required in order to qualify for the Certificate of Fitness. Read each question carefully before marking your answer. There is no penalty for guessing.

**\*\* Implies that following material  
will NOT appear on the W-79 COF  
exam.**

### **SAMPLE QUESTIONS**

**1. Which of the following are allowed to be used while taking a Certificate of Fitness examination at 9 Metro Tech Center?**

- I. cellular phone
- II. study material booklet
- III. reference material provided by the FDNY
- IV. mp3 player

- A. III only
- B. I, II, and III
- C. II and IV
- D. I only

Only reference material provided by the FDNY is allowed to be used during Certificate of Fitness examinations. Therefore, the correct answer would be A. You would touch "A" on the computer terminal screen.

**2. If the screen on your computer terminal freezes during your examination, who should you ask for help?**

- A. the person next to you
- B. the firefighters in the testing room
- C. the examiner in the testing room
- D. the computer help desk

If you have a computer related question, you must ask the examiner in the testing room. Therefore, the correct answer would be C. You would touch "C" on the computer terminal screen.

**3. If you do not know the answer to a question while taking an examination, who should you ask for help?**

- A. the person next to you
- B. the firefighters in the testing room
- C. the examiner in the testing room
- D. it is forbidden to ask anyone regarding test questions

You should not ask about examination questions or answers since FDNY staff cannot assist applicants with test questions. Therefore, the correct answer would be D. You would touch "D" on the computer terminal screen.

## 1. DEFINITIONS

**ABSOLUTE ZERO.** Temperature at which all molecular motion, and consequently all life, ceases to exist according to Einstein and the kinetic molecular theory. Absolute zero has never been reached, but it has been approached by the temperatures of some cryogenic gases.

**BULK NITROUS OXIDE SYSTEM.** A system comprised of stationary or portable nitrous oxide storage containers, pressure regulators, safety devices, vaporizers, manifolds, interconnecting piping and/or other devices or equipment. Bulk Nitrous Oxide System has a storage capacity of more than 28,000 SCF of nitrous oxide in liquid or gaseous state, including unconnected reserves in or at the same building, structure or premises. Bulk nitrous oxide systems at industrial and institutional consumer sites shall additionally comply with the requirements of CGA G-8.1.

**BULK OXYGEN SYSTEM.** A system comprised of stationary or portable oxygen storage containers, pressure regulators, safety devices, vaporizers, manifolds, interconnecting piping and/or other devices or equipment. Bulk oxygen systems have a storage capacities of more than 20,000 SCF of oxygen in liquid or gaseous state, including unconnected reserves in or at the same building, structure or premises. Bulk oxygen systems at industrial and institutional consumer sites shall additionally comply with the requirements of NFPA 50.

**CONTROL AREA.** Spaces within a building that are enclosed and bounded by exterior walls, fire walls, fire barriers and roofs, or a combination thereof, where quantities of hazardous materials not exceeding the maximum allowable quantities per control area are stored, handled or used, including any dispensing.

**CRYOGENIC.** A fluid having a boiling point lower than -130°F at 14.7 pounds per square inch absolute (psia) (an absolute pressure of 101.3 kPa).

**\*For the purposes of this exam Liquid Nitrous Oxide will be considered a cryogenic fluid.**

**CRYOGENIC CONTAINER.** A pressure container, low-pressure container or atmospheric container of any size designed or used for the transportation, handling or storage of a cryogenic fluid, and which utilizes venting, insulation, refrigeration or a combination thereof to maintain the pressure within design parameters for such container and to keep the contents in a liquid state.





**CRYOGENIC SYSTEM.** An assembly of components, such as containers, reactors, pumps, compressors and connecting piping and tubing, designed to contain, distribute or transport cryogenics.

**DISPENSING.** The pouring or transferring by other means of any material from a container, tank or similar vessel, which would release dusts, fumes, mists, vapors or gases to the atmosphere, unless such release is prevented by a device, equipment or system designed for that purpose.

**DOTn.** United States Department of Transportation.

**EXCESS FLOW CONTROL.** A fail-safe system or other approved device, equipment or system designed to shut off flow caused by a rupture in a pressurized piping system.

**FLAMMABLE CRYOGENIC.** A cryogenic fluid that is flammable in its vapor state.

**GAS ROOM.** A separately ventilated, fully enclosed room in which only cryogenics and associated equipment and supplies are stored or used.

**GENERAL SUPERVISION.** Supervision by the holder of any FDNY certificate who is responsible for performing the duties of the certificate holder but need not be personally present on the premises at all times.

**HANDLING.** The movement of a material in its container, the removal of the material from its container, or any other action or process that may affect the material, other than its storage or use.

**HEALTH HAZARD.** A classification of a chemical for which there is statistically significant evidence that acute or chronic health effects are capable of occurring in exposed persons. The term “health hazard” includes chemicals that are toxic, highly toxic and corrosive.

### Dispensing Station



**INCOMPATIBLE MATERIALS.** Materials that, if mixed or combined, could explode, generate heat, gases or other byproducts, or react in a way hazardous to life or property.

**LIQUID.** A material having a melting point that is equal to or less than 68°F and a boiling point that is greater than 68°F at 14.7 psia. When not otherwise identified, the term “liquid” includes both flammable and combustible liquids.

**LIQUEFIED CRYOGENICS.** Gases that, in a packaging under the charged pressure, are partially liquid at a temperature of 68F.

**LOW-PRESSURE CONTAINER.** A storage container designed to withstand an internal pressure greater than 0.5 pounds per square inch gauge but not greater than 15 psig.

**MATERIAL SAFETY DATA SHEET (MSDS).** A document prepared in accordance with the regulations of the United States Department of Labor, as set forth in 29 CFR Part 1910.1200 or a federally approved state OSHA plan which sets forth information concerning a hazardous material. It contains health and physical hazards of the material used, procedures that should be followed in case of an emergency and safety work practices. MSDS does not show the cost of the cryogenic fluids. (See Appendix at the end of the study materials).

**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA.** The maximum amount of a hazardous material allowed to be stored or used within a control area inside a building or structure or an outdoor control area.

**MAXIMUM ALLOWABLE WORKING PRESSURE.** The maximum pressure permissible at the top of a container in its operating position for a designated temperature, as established by the container manufacturer.

### Nesting of Portable Containers

**NESTING.** A method of securing flat-bottomed cryogenic containers upright in a tight mass using a contiguous three-point contact system whereby all containers within a group have a minimum of 3 points of contact with other containers, walls or bracing.

**NORMAL TEMPERATURE AND PRESSURE.** A temperature of 70°F and a pressure of 1 atmosphere.

**OUTDOOR CONTROL AREA.** An outdoor area that contains hazardous materials in amounts





not exceeding the maximum allowable quantities. (as set forth in the NYC Fire Code).

**OXIDIZING GAS.** A gas that can support and accelerate combustion of other materials.

**PERSONAL SUPERVISION.** Supervision by the holder of any FDNY certificate who is required to be personally present on the premises, or other proximate location acceptable to the FDNY, while performing the duties for which the certificate is required.

**PRESSURE VESSEL.** A closed vessel designed to operate at pressures above 15 psig.

**STANDARD CUBIC FEET (SCF).** Cubic feet of gas at normal temperature and pressure.

**STATIONARY TANK.** A container having not less than 1,000-pound water capacity, designed primarily for stationary installations, and not intended to be moved in the course of normal use.

**SYSTEM.** An assembly of devices, equipment, containers, appurtenances, pumps, compressors and connecting piping that is designed to perform a complex and/or complete function.

**TANK, ATMOSPHERIC.** A storage tank designed to operate at pressures from atmospheric through 1.0 pound per square inch gauge measured at the top of the tank.

**TANK, PORTABLE.** A container of more than 60-gallon capacity, and designed to be loaded into or on or temporarily attached to a transport vehicle or marine vessel and equipped with skids, mountings or accessories to facilitate handling of the tank by mechanical means. It does not include any cargo tank or tank car.

### Portable Tank



## **2. INTRODUCTION**

This booklet outlines New York City Fire Department regulations for the safe use, handling, dispensing/transfilling and storage of cryogenic fluids and systems. The term cryogenic refers to the study of the behavior of materials that range in temperature from -130F down to absolute zero (-459.67F).

### **THIS BOOKLET COVERS THE FOLLOWING:**

G-15 USE OF LIQUID O<sub>2</sub> ON WORK SITE

G-41 SUPERVISING COMMERCIAL CRYOGENIC SYSTEMS (O<sub>2</sub>, N<sub>2</sub>O)

G-49 TRANSFILLING OF CRYOGENIC LIQUID GAS CYLINDERS

G-50 SUPERVISION OF COMMERCIAL CRYOGENIC SYSTEMS (N<sub>2</sub>, AR)

G-51 USE OF CRYOGENIC INERT GASES ON WORK SITE

**\*ALL OF THE ABOVE CERTIFICATE OF FITNESS TESTS ARE NO LONGER OFFERED.**

### **THIS BOOKLET DOES NOT COVER THE FOLLOWING:**

#### **MEDICAL GAS SYSTEMS**

Applicants who need to supervise the Piped Non-Flammable Medical Gases should obtain G-71 Certificate of Fitness.

#### **LNG**

Applicants who need to supervise LNG plants should obtain C – 10 Certificate of Fitness.

#### **LIQUID HYDROGEN**

Applicants who need to supervise the storage, handling, and use of compressed flammable gases should obtain G-98 Certificate of Fitness.

**REFRIGERATING/AIR CONDITIONING SYSTEMS**

Applicants who need to supervise the compressed gases used as refrigerants in refrigerating systems obtain Q-99/Q-01 Certificate of Qualification.

**LIQUID CARBON DIOXIDE**

Applicants who need to handle and dispense Carbon Dioxide should obtain G-82 Certificate of Fitness

**CHEMICAL LABORATORY**

Applicants who are storing less than 60 gallons of cryogenic fluid or who work within laboratories should obtain C-14 Certificate of Fitness

### 3. PERMITS

An FDNY permit is required to manufacture, store, handle or dispense cryogenic fluids in excess of the amounts listed in the table below.

TYPE OF CRYOGENIC FLUID	INDOOR (gallons)	OUTDOORS (gallons)
Nonflammable	60	100
Oxidizing (oxygen and/or nitrous oxide)	10	50
Physical or health hazard not indicated (ex. toxic, corrosive, etc.) above	Any Amount	Any Amount

**\*For citywide permits, outdoor permit amounts shall apply.**


**Exception:** Permits are not required for vehicles equipped for and using cryogenic fluids as a fuel for propelling the vehicle or for refrigerating the cargo.

Oxidizing cryogenic fluids, including oxygen, shall additionally comply with the requirements of NFPA 50 and/or NFPA 55.

Inert cryogenic fluids, including argon, helium and nitrogen, shall additionally comply with the requirements of CGA P-18.

Oxidizing cryogenic fluids such as nitrous oxide shall additionally comply with requirements of CGA G-8.1.

#### FDNY Permit

FIRE DEPARTMENT, CITY OF NEW YORK					BUREAU OF FIRE PREVENTION	
ACCOUNT NUMBER 7777777	TYPE 10	A.P. P	D.O. 12	ADM. CO. E284	ISSUANCE DATE 01/28/10	PERMIT EXPIRES 01/11
PREMISES ADDRESS 1111 YORK ST STATEN ISLAND NY 11111				ACCOUNT NAME CARI & RENO		
ITEM CODE 920	SUB CODE 00	QTY 15	DESCRIPTION COMPRESSED GASES ONLY STR/USE		FLOOR NO. 1	FEE PAID
PERMIT TYPE 1			1=REGULAR 2=SUPPLEMENTAL 3=DUPLICATE		ANNUAL FEE	PAID
			CARI & RENO 1111 YORK ST STATEN ISLAND NY 11111			
 2011012938			BY ORDER OF THE COMMISSIONER			

#### 4. CERTIFICATE OF FITNESS

STORAGE of cryogenic fluids in quantities requiring a permit shall be under the **GENERAL SUPERVISION** of a person holding a Certificate of Fitness.

HANDLING and USE of cryogenic fluids in quantities requiring a permit shall be performed under the **PERSONAL SUPERVISION** of a person holding a Certificate of Fitness.



The installation and maintenance of cryogenic containers and of systems containing cryogenic fluids, including the repair of such systems, shall be conducted under the personal supervision of a person holding a W-79 certificate of fitness. Generally, the 'end user' Certificate of Fitness individual is **NOT** allowed to make repairs on a leaking cryogenic fluid container(s).

**Business owner shall have proper** permits as required and set forth in table above.

At least one G-79 Certificate of Fitness holder shall be on the premises during the operating hours.

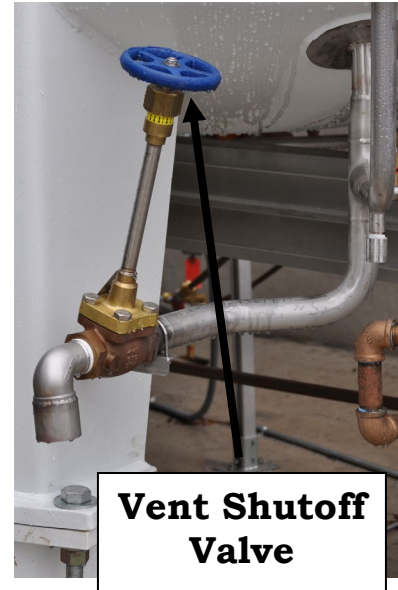
## 5. CHARACTERISTICS OF CRYOGENIC FLUIDS

All cryogenic fluids are extremely cold. Cryogenic fluids and their cold "boil-off" vapors can quickly freeze human tissue and cause many common materials such as carbon steel, plastics, and rubber to become brittle, or even fracture under stress. Liquids in poorly insulated or non-insulated containers and/or piping at temperatures at or below the boiling point of liquefied air (-318° F, -194° C) can actually condense the surrounding air to a liquid. This liquid air is oxygen-rich and should be treated as liquid oxygen. The extremely cold liquefied gases (LHe) can even solidify exposed air or other gases.

The expansion ratio of a liquefied and cryogenic substance is the volume of a given amount of that substance in liquid form compared to the volume of the same amount of substance in gaseous form, at room temperature and normal atmospheric pressure. If a sufficient amount of liquid is vaporized within a closed container, it produces pressures that can rupture the pressure vessel. Hence the use of pressure relief valves and vent valves.

Most cryogenic fluids are odorless, colorless and tasteless when vaporized to the gaseous state.

**CHARACTERISTICS OF COMMON CRYOGENIC FLUIDS IS LISTED IN THE TABLE BELOW:**



<b>Cryogenic</b>	<b>Boiling Point</b>	<b>Expansion Ratio</b>	<b>% by Volume of Gas in Atmosphere</b>
Liquid Argon	-302F	840 to 1	0.934
Liquid Helium	-452F	700 to 1	0.000524
Liquid Nitrogen	-320F	694 to 1	78.084
Liquid Nitrous Oxide	-127F	670 to 1	0
Liquid Oxygen	-297F	857 to 1	20.946

### **5.1 HAZARDS OF CRYOGENIC FLUIDS**

The hazards of cryogenic fluids fall into three main areas: the extreme coldness of the liquids and resulting vapors, the tremendous liquid-to-vapor expansion ratio, and the hazards of the particular chemical itself. Gases produced by leaking cryogenic container will sink low to the ground; therefore any working ventilation system may not be effective. These gases can cause suffocation.

In any accidental release, the greatest concern must be with what a gas or gases will do during or after evaporation. The hazards include flammability, combustibility, toxicity, corrosiveness, or any other hazard it possesses.

These hazards can be used to group the cryogenics into three classes: **flammable cryogenics, cryogenics that support combustion, and inert cryogenics.**

### **5.2 FLAMMABLE CRYOGENICS**

This group includes liquid hydrogen and liquefied natural gas. Needless to say, an accidental release of these materials will cause an extreme explosion hazard, even though the specific gravity of both gases is less than 1.0.

### **5.3 CRYOGENICS THAT SUPPORT COMBUSTION (OXIDIZING CRYOGENICS)**

This group of cryogenic liquids includes oxidizers such as liquid oxygen and liquid nitrous oxide. It must be realized that in a spill of either of these materials, a condition will exist that will produce more than 100% concentration of an oxidizing agent. You may wonder how a concentration of anything can be greater than 100%, if 100% would be pure oxygen and pure nitrous oxide with no air present; however, the expansion ratio of liquid to gas is generating such high volumes of gas that the concentration of oxidizer will not allow air to mix with the gas until the liquid is totally gone.

### **5.4 INERT CRYOGENICS**

Inert gases are, of course, those gases that will not enter into chemical reaction. This group of cryogenic liquids includes liquid helium, liquid argon, liquid krypton, liquid xenon, liquid neon, and usually liquid nitrogen. Liquid nitrogen for all intents and purposes is inert; however, if it is released near or involved in a very hot fire, it can be oxidized, and it will vigorously support the combustion of some metals, such as magnesium. Since these occasions are so rare, liquid nitrogen can be included in the class of inert cryogenics. The hazards of these gases, aside from their extreme cold, and the high expansion ratio of the change from liquid to gas, is that they will lower the concentration of oxygen in the air below life-sustaining levels and therefore are considered simple asphyxiants.

All of the gases except oxygen can cause a person to suffocate by replacing breathable air in an enclosed workplace. Employees will not be aware of the presence of such gases without a tool to help them detect the gases. Therefore, they can be suffocated before they realize that the problem exists. 21% is the average minimum percentage of oxygen concentration in air that will provide a safe working



environment. Symptoms of suffocation will begin to occur when oxygen levels are less than 19%. Cryogenic fluids can also cause frostbites. If body tissue has been in contact with cryogenic fluid or cold gas, it will most likely appear waxy with a yellow color. The first thing that must be done is it must be placed in warm water. The vapors produced from cryogenic fluids tend to be cold.

Individuals vary considerably in their reactions to an oxygen-deficient atmosphere. It is, therefore, not possible to predict exactly how people will react. A general indication of what is liable to happen is presented in a table below, but it should be understood that individual reactions may be different from those listed.

<b>OXYGEN CONTENT (% by volume)</b>	<b>EFFECTS AND SYMPTOMS (at atmospheric pressure)</b>
15-19%	Decreased ability to work strenuously. May impair coordination and may induce early symptoms in persons with coronary, pulmonary, or circulatory problems.
12-15%	Respiration increased in exertion, pulse up, impaired coordination, perception, and judgment.
10-12%	Respiration further increases in rate and depth; poor judgment; lips blue.
8-10%	Mental failure; fainting, unconsciousness, ashen face; blueness of lips; nausea, and vomiting.
6-8%	8 minutes, 100% fatal; 6 minutes, 50% fatal; 4-5 minutes, recovery with treatment.
4-6%	Coma in 40 seconds; convulsions; respiration ceases, death.

**PORTABLE AIR-PACKS MUST BE AVAILABLE FOR USE TO PREVENT SUFFOCATION WHEN ENTERING AREAS WHERE THERE IS A POTENTIAL FOR LOW OXYGEN CONCENTRATION.**

### **5.5 USES OF CRYOGENIC FLUIDS**

**Liquid oxygen** is used primarily to fill oxygen containers in construction and for welding purposes. It is also used to provide liquid oxygen to medical facilities.





Liquid oxygen is a Nonflammable gas which supports combustion.

**Liquid nitrogen** has a few uses in its liquid form, mainly as a refrigerant for food preservation, and to preserve biological specimens. Nitrogen itself is not a toxic gas, for it makes up the largest part of our breathing air (78% by volume). Whenever liquid nitrogen is being used; however, there is a chance that enough of it will be released into the air we breathe to lower the oxygen content to a level below that necessary to sustain life.

**Liquid argon** is used primarily in gaseous form in whatever operation or procedure an inert gas is needed, such as in filling incandescent lamp bulbs and in filling special bulbs and display tubes to obtain special effects. Argon is also used as an inert gas shield in arc-welding processes to prevent oxidation of the metals and being welded.

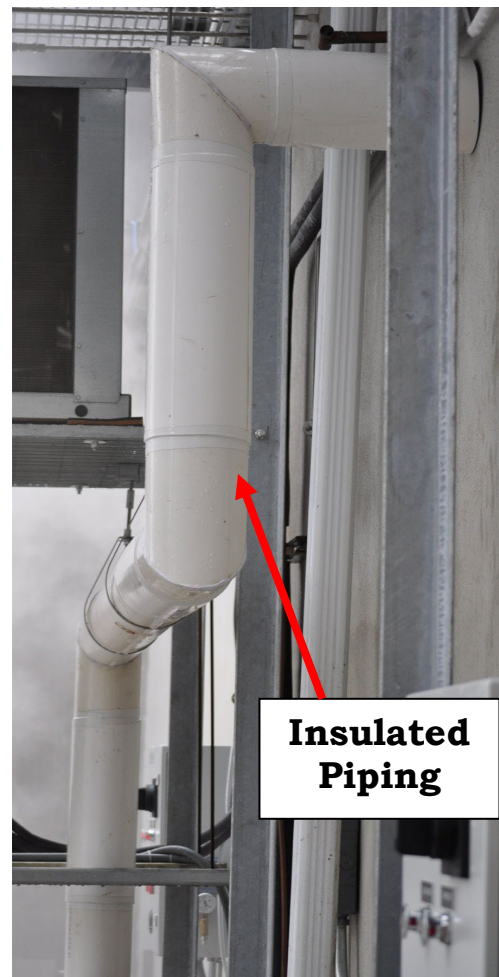
**Liquid helium** is used to produce gaseous helium for use as an inert shielding gas in welding and as an inert gas atmosphere in the production of reactive metals, such as titanium and zirconium. It is also used as the lifting gas in dirigibles, blimps, and balloons. In liquid form, helium is used in superconductivity experiments and investigations of low-temperature physics. Liquid helium is used to cool down the superconductive magnets coil in MRI scanners to a temperature below 10 Kelvin.

**Liquid nitrous oxide** is used as a gas propellant for aerosols package in pharmaceuticals. Liquid nitrous oxide is often used in the medical field. It is used as an anesthetic.

## **5.6 CRYOGENIC CONTAINER REQUIREMENTS**

Cryogenic containers do not resemble other containers for pressurized liquids or gases. It is because the vapor pressure above a cryogenic liquid is very low, often less than a few pounds per square inch. The containers are really one container within another, using air space between the container walls and insulation. Cryogenic fluids are basically self-insulating. For cryogenic gas to convert from a liquid to a gas, heat must be absorbed by the liquid so that some of the molecules may have the energy to escape from the liquid. This heat must be absorbed from somewhere, and since container is insulated, and the cryogenic liquid is very cold, there is very little heat energy to supply for the evaporation process.

With so little energy available, evaporation occurs very slowly. Even when a container of a cryogenic liquid is opened to the atmosphere, evaporation occurs so slowly that it is difficult to realize that the liquid is boiling. The Certificate of Fitness holder should be thoroughly familiar with the product and the mechanical workings of the container before using the product.

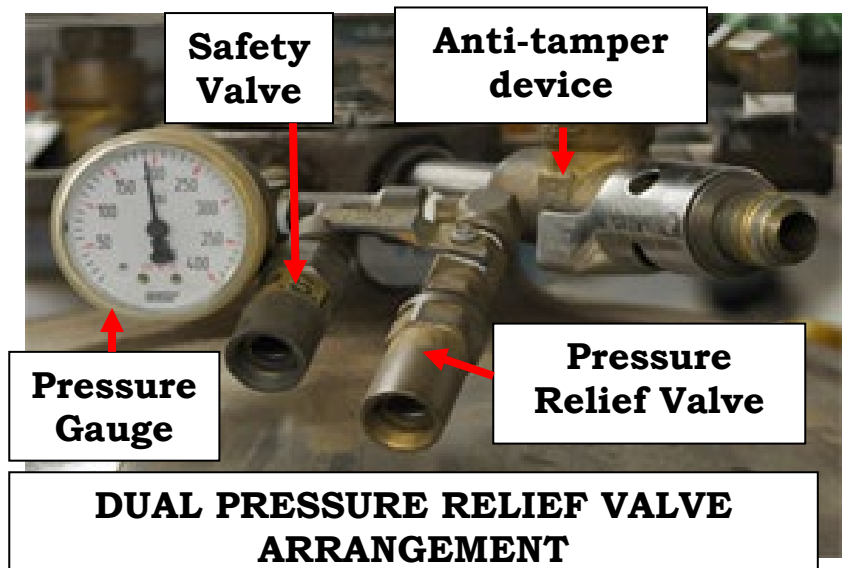


**Insulated Piping**

### **MANUFACTURE**

Cryogenic containers shall be designed, constructed, operated and maintained in accordance with the ASME Boiler and Pressure Vessel Code or United States

Department of Transportation regulations. Cryogenic fluid containers, also referred to as liquid cylinders, are double-walled, vacuum vessels with multilayer insulation in the annular space. They are designed for the reliable and economic transportation and storage of liquefied gases.



**Safety Valve**

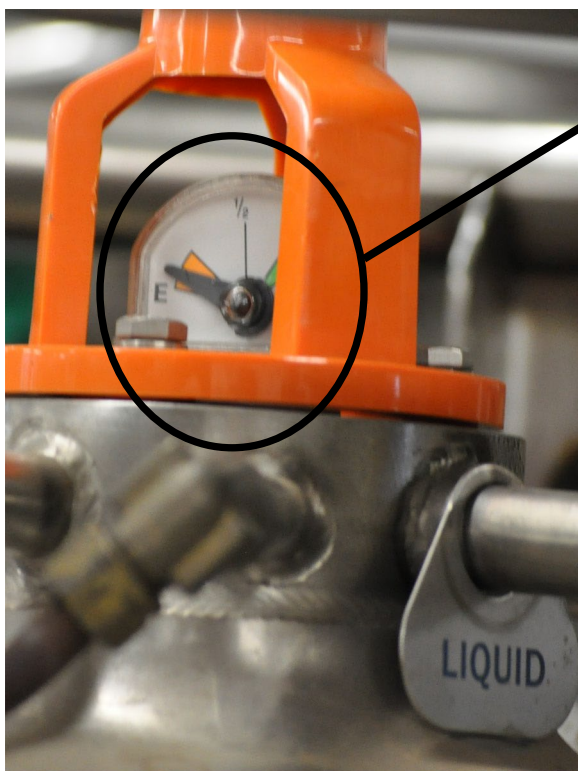
**Anti-tamper device**

**Pressure Gauge**

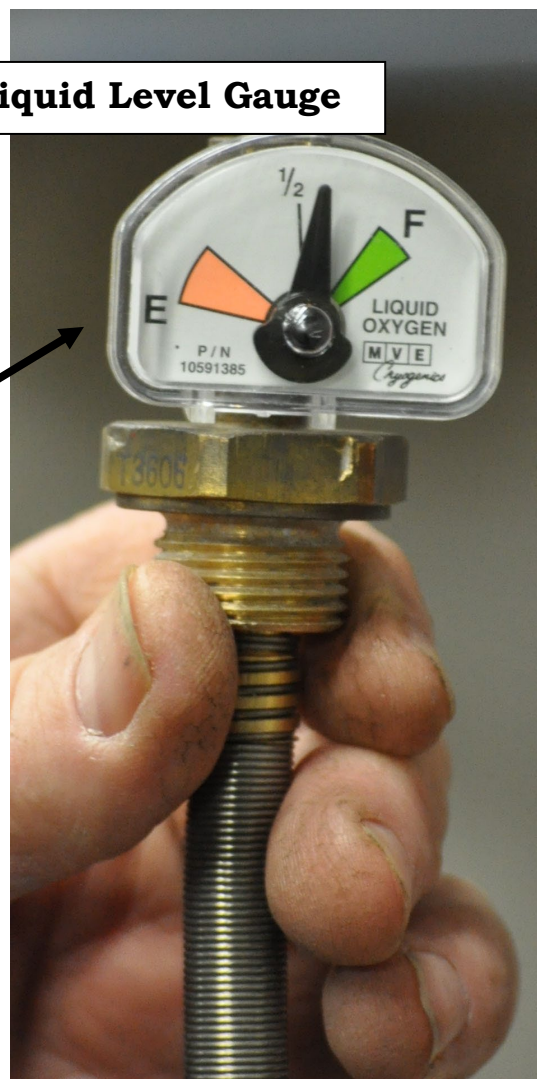
**Pressure Relief Valve**

**DUAL PRESSURE RELIEF VALVE ARRANGEMENT**

Cryogenic containers shall be provided with pressure gauges. The maximum face reading for dial-type gauges shall not be less than 133 percent nor more than 250 percent of the MAWP (maximum allowable working pressure) of the cryogenic container. Cryogenic containers shall be provided with a liquid level indicating device. It shall be unlawful to use cryogenic containers with glass liquid level gauges in direct contact with the contents of such containers. Most of the liquid gauges are spring floating gauges.



**Liquid Level Gauge**



## **VALVES**

Shutoff valves shall be provided on all cryogenic container connections except for pressure relief devices. Shutoff valves shall be readily accessible and located as close as practical to the cryogenic container. Manually-operated shutoff valves shall be designed and installed to minimize accidental opening and closing. Shutoff valves shall be installed in piping containing cryogenic fluids where needed to limit the volume of liquid discharged in the event of piping or equipment failure.

Cryogenic containers and equipment shall be protected from over-pressurization with devices such as pressure relief valves. A relief valve and frangible disc are devices that protect cryogenic fluids containers and systems from high pressure. Pressure relief valves and frangible disk are designed to protect pressurized cryogenic containers. Pressure relief valves shall be installed on all sections of piping systems

where liquid is capable of being trapped. Shutoff valves shall be installed so that piping components can be isolated for maintenance. Check valves shall be installed on discharge lines where pumps or other pressure increasing equipment operate in parallel.

Readily accessible shutoff valves shall be provided to shut off the cryogenic fluid in case of emergency. A shutoff valve shall be located at the source of supply and at the point where the system enters the building.

## **\*\*PIPING**

Aboveground piping systems shall be supported and protected from physical damage.

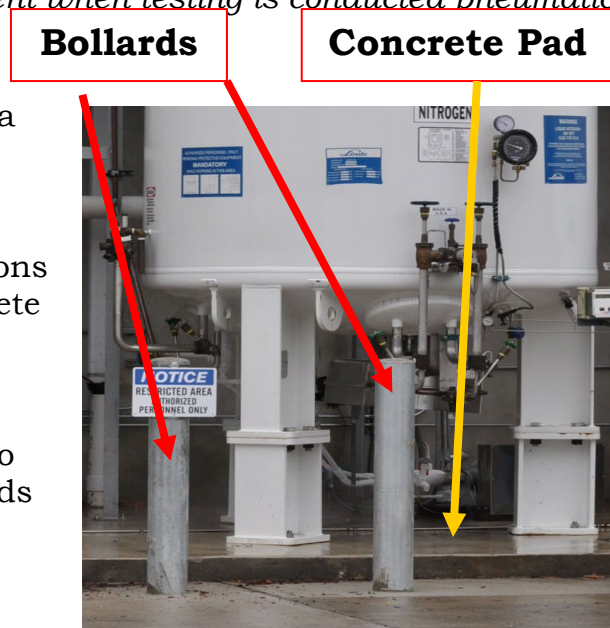
*Piping systems shall be tested and proven free of leaks after installation as required by the standards to which they were designed and constructed. Test pressures shall not be less than 150% of the MAWP (maximum allowable working pressure) when hydraulic testing is conducted or 110 percent when testing is conducted pneumatically.*

## **\*\*INSTALLATION**

Stationary containers shall be secured to a foundations in accordance with a NYC Building Code. Stationary cryogenic containers shall be installed upon substantial concrete or masonry foundations or structural steel supports on firm concrete or masonry foundations. The installations must abide by strict NYC Building Department Codes and regulations. Cryogenic containers shall be supported to prevent the concentration of excessive loads on the supporting portion of the shell. Foundations for horizontal cryogenic containers shall be constructed to accommodate expansion and contraction of the cryogenic container. Foundations shall be provided to support the weight of vaporizers and heat exchangers.

When cryogenic container foundations or supports are subject to exposure to temperatures below -130°F, the foundations or supports shall be constructed of materials to withstand the low-temperature effects of cryogenic fluid spillage.

**IT SHALL BE UNLAWFUL TO INSTALL STATIONARY CRYOGENIC CONTAINERS ON THE ROOF OF ANY BUILDING OR STRUCTURE.**





Cryogenic containers, piping, valves, pressure relief devices, regulating equipment and other appurtenances which could be exposed to physical damage and tampering shall be protected by posts or other approved means.

### **\*\*DRAINAGE**

The area surrounding portable cryogenic containers shall be provided with a means to prevent accidental discharge of fluids from endangering adjacent containers, buildings, equipment or adjoining property. Portable cryogenic containers located in areas subject to flooding shall be properly secured to prevent movement. The stationary container shall not be placed where spilled or discharged fluids will be retained around the container. The grade for a distance of not less than 50 ft from where cryogenic fluid storage or delivery systems are installed shall be higher than the grade on which flammable or combustible liquids are stored or used.

### **\*\*FILL CONNECTION SUPPORTS**

Fill connection supports shall be designed and maintained to withstand the repeated application of force required to connect and disconnect hoses of cargo tanks.

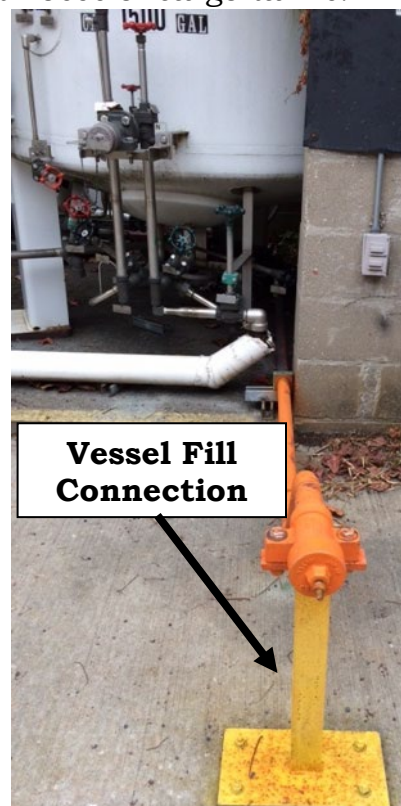
### **\*\*CONTAINER PROTECTION**

Stationary containers shall be secured to a foundation in accordance with the Building Code. Portable cryogenic containers shall be secured to prevent movement from contact, vibration or seismic activity. Nesting shall be an acceptable means of securing cryogenic containers. Cryogenic containers shall not be secured to plumbing pipes or electrical conduits.

Vaporizers, heat exchangers and similar equipment shall be anchored to a suitable foundation. Connecting piping shall be sufficiently flexible to provide for the effects of expansion and contraction due to temperature changes.

### **\*\*CORROSION PROTECTION**

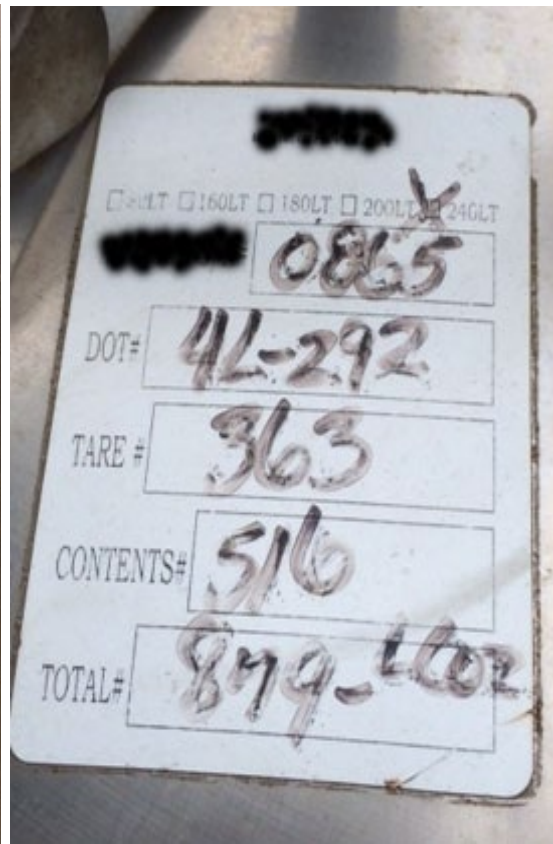
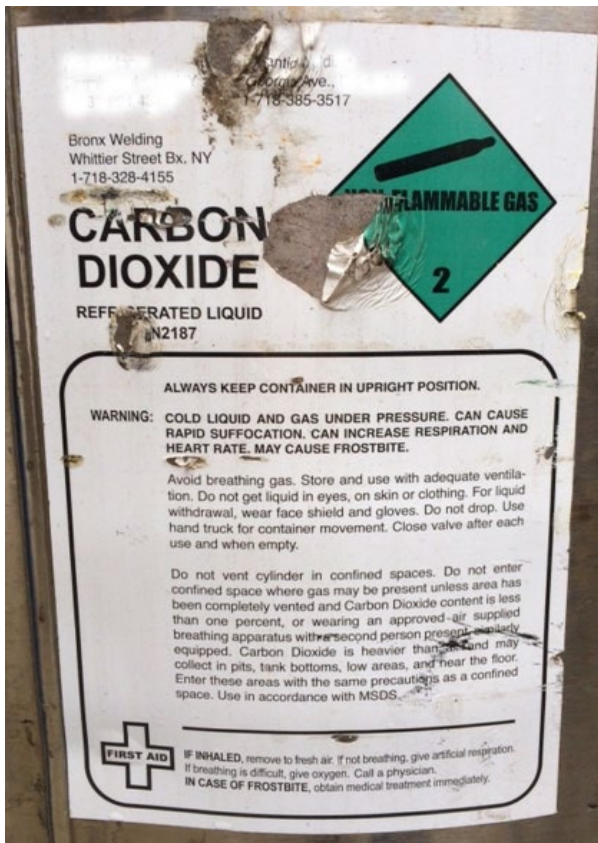
Portions of cryogenic containers in contact with foundations or saddles shall be painted to protect against corrosion. Precautions shall be taken to avoid or minimize corrosion due to galvanic action.



## 6. CONTAINER MARKINGS

### 6.1 PORTABLE CONTAINERS

Portable cryogenic containers shall be marked in accordance to CGA C-7, Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers. All DOT-4L/TC-4LM liquid cylinders shall have product identification visible from all directions with minimum 2 in. high letters.



### 6.2 STATIONARY CONTAINERS

Stationary containers shall be marked in accordance with NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response, CGA C-7: Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers and according to CGA C-9: Standard Color Marking of Compressed Gas Containers Intended for Medical Use.

Identification of Contents signs shall be at entrances to buildings or areas in which cryogenic fluids are stored, handled or used. A stationary container shall be placarded with the identity of its contents to indicate the name of the material contained. Stationary containers shall be marked with the manufacturing specification and maximum allowable working pressure on a permanent nameplate.

The nameplate shall be installed on the container in an accessible location.





## 7. OVERVIEW OF PRESSURE RELIEF DEVICES

Pressure relief devices shall be provided to protect cryogenic containers and systems containing cryogenic fluids from rupture in the event of overpressure.

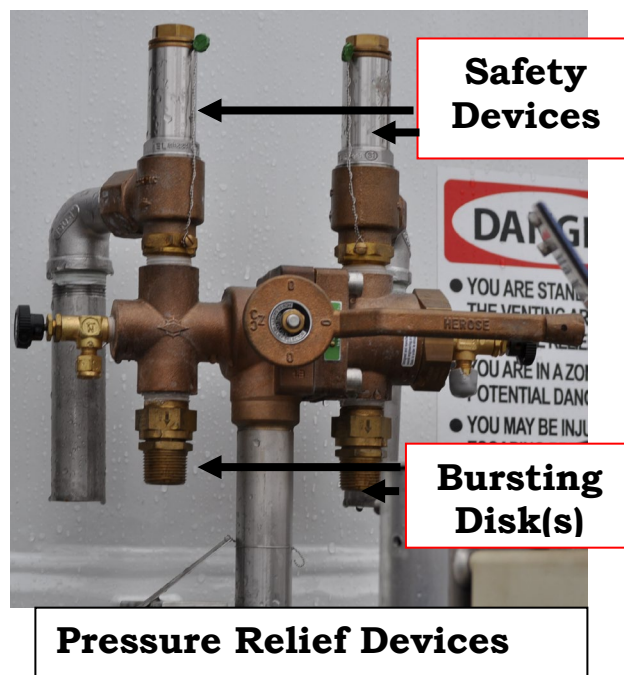
Cryogenic containers shall be provided with pressure relief devices. Precautions shall be taken to prevent over-pressurization of atmospheric tanks. Such pressure relief devices shall communicate with the vapor space of the container, not the cryogenic fluid.

Safety relief devices are used in all cryogenic liquid containers, with one in the internal container to vent to the atmosphere what little gas has evaporated, and another in the outer container to vent any gas that may have accumulated between the walls of the inner and outer containers. If this second safety relief device vents, it is usually because there is a leak in the inner container. When releasing cryogenic fluids from drain valves or blow down lines, you must open valves slowly to avoid splashing from the liquid. Safety release devices should be provided under all conditions.

Safety and relief devices should be adjusted by authorized personnel familiar with the equipment. Frost built-up can prevent safety devices from operating properly. Icing and blockage or pressure relief devices can occur if water comes into contact with the surfaces of cryogenic-refrigerated containers or piping. If that occurs, slowly pouring warm water over should remove the ice.

Heat exchangers, vaporizers, insulation casings surrounding cryogenic containers, and sections of coaxial or single wall piping systems in which liquefied cryogenic fluids could be trapped because of leakage from cryogenic containers or isolation by valves shall be provided with pressure relief

**Safety Relief Selector**



**Pressure Relief Devices**



devices. Cryogenic fluids should not be allowed to collect in piping without relief devices because as temperatures increase, expansion may cause the pipes to burst.

Pressure relief devices shall be sized in accordance with the specifications to which the cryogenic container was fabricated. The relief devices shall have sufficient capacity to prevent the MAWP (maximum allowable working pressure) of the cryogenic container or system from being exceeded. Pressure buildup because of evaporation may result from a loss of vacuum in the vacuum jacketed cryogenic gas container. It shall be unlawful to use pressure relief devices that are not clearly marked by the manufacturer with their set pressure. Pressure relief devices shall be located such that they are readily accessible for inspection and repair. They shall be arranged to discharge unobstructed, at rated capacity, to the outdoors in such a manner as to prevent escaping gas from impinging on personnel, cryogenic containers, equipment and adjacent structures or from entering enclosed spaces.

**Exception:** United States Department of Transportation has a specification for cryogenic containers with an internal volume of 2 cubic feet or less.

Nitrogen, argon, and other inert gases are non-combustible; that is, they do not present a fire hazard; however, if a system should rupture because of a fire, these gases may displace air to the point where there is not enough oxygen to support life. Excessive pressure build-up in piping and storage vessels can be prevented through proper selection of pressure-relief devices and flow control equipment.

#### **SHUTOFF VALVES SHALL NOT BE INSTALLED BETWEEN PRESSURE RELIEF DEVICES AND CRYOGENIC CONTAINERS.**

**Exception:** A shutoff valve is allowed on cryogenic containers equipped with multiple pressure-relief device installations where the design and arrangement of the valve provide sufficient relief capacity for the pressure relief devices to prevent the MAWP of the cryogenic container or system from being exceeded at all times.

## 8. STORAGE OF CRYOGENIC FLUIDS

### **8.1 INDOOR STORAGE**

Cryogenic containers stored indoors shall be located in buildings, rooms or areas constructed in accordance with the NYC Building Code. Storage areas for cryogenic containers shall be ventilated in accordance with the NYC Mechanical Code. Vented cryogenic gases should be routed to a safe outdoor location. Pressure buildup because of evaporation may result from loss of vacuum in a vacuum jacketed cryogenic gas container.

### **8.2 OUTDOOR**

Cryogenic containers shall not be located within diked areas containing other hazardous materials. Stationary cryogenic containers, vaporizers, heat exchangers and connecting piping located in areas subject to flooding shall be securely anchored or elevated to prevent separation of the cryogenic containers and related equipment from foundations or supports. The area surrounding stationary cryogenic containers shall be provided with a means to prevent accidental discharge of cryogenic fluid which would endanger personnel, and cryogenic containers, equipment and adjacent structures as well as

prevent entry into enclosed spaces. The stationary cryogenic container shall not be placed where spilled or discharged fluid will be retained around the cryogenic container.

Cryogenic containers and systems in storage or use shall be separated from materials and conditions which pose exposure hazards to or from each

other. For oxidizing cryogenic fluids, surfacing of non-combustible material shall be provided at ground level under liquid delivery connections for the storage container and mobile supply equipment.

Cryogenic containers and systems shall not be placed in areas where they are exposed to damage from falling objects.



**\*\*MAXIMUM ALLOWABLE QUANTITY OF CRYOGENIC OXIDIZING FLUIDS IN STORAGE AND USE (CLOSED SYSTEM), INDOORS**

<u>Building protected throughout by a sprinkler system</u>	<u>Floor Level</u>		<u>CRYOGENIC FLUID</u>		
			<u>Gallons</u>	<u>Max # of Control Areas per floor</u>	<u>Min Fire-Resistance rating for Fire Barriers in hours</u>
NO	Above Grade	>9	2.3	1	2
		7-9	2.3	2	2
		4-6	5.6	2	2
		3	22.5	2	1
		2	33.8	3	1
		1	45	4	1
	Below Grade	1	33.8	3	1
		2	22.5	2	1
		> 2	Not Allowed	Not Allowed	Not Allowed
			<u>Gallons</u>	<u>Max # of Control Areas per floor</u>	<u>Min Fire-Resistance rating for Fire Barriers in hours</u>
YES	Above Grade	>9	4.5	1	2
		7-9	4.5	2	2
		4-6	11.3	2	2
		3	45	2	1
		2	67.5	3	1
		1	90	4	1
	Below Grade	1	67.5	3	1
		2	45	2	1
		> 2	Not Allowed	Not Allowed	Not Allowed

**\*\*MAXIMUM ALLOWABLE QUANTITY OF CRYOGENIC OXIDIZING FLUIDS IN USE (OPEN SYSTEM), INDOORS**

<b>Building protected throughout by a sprinkler system</b>	<b>Floor Level</b>		<b>CRYOGENIC FLUID</b>		
			<b><u>Gallons</u></b>	<b><u>Max # of Control Areas per floor</u></b>	<b><u>Min Fire-Resistance rating for Fire Barriers in hours</u></b>
<b>NO</b>	Above Grade	>9	0.5	1	2
		7-9	0.5	2	2
		4-6	1.25	2	2
		3	5	2	1
		2	7.5	3	1
		1	10	4	1
	Below Grade	1	7.5	3	1
		2	5	2	1
		> 2	Not Allowed	Not Allowed	Not Allowed
			<b><u>Gallons</u></b>	<b><u>Max # of Control Areas per floor</u></b>	<b><u>Min Fire-Resistance rating for Fire Barriers in hours</u></b>
<b>YES</b>	Above Grade	>9	1	1	2
		7-9	1	2	2
		4-6	2.5	2	2
		3	10	2	1
		2	15	3	1
		1	20	4	1
	Below Grade	1	15	3	1
		2	10	2	1
		> 2	Not Allowed	Not Allowed	Not Allowed

### **8.3 STORAGE AND EXPOSURE**

#### **LEDGES, PLATFORMS AND ELEVATORS**

Cryogenic containers shall not be placed near elevators, unprotected platform ledges or other areas where the container could drop a distance exceeding one-half the height of the container.

#### **TEMPERATURE EXTREMES**

Cryogenic containers, whether full or partially full, shall not be exposed to temperatures exceeding 125F or less than mean low atmospheric temperatures unless designed for use under the exposed conditions.

#### **ELECTRICAL WIRING AND EQUIPMENT**

Electrical wiring and equipment shall comply with the requirements of the NYC Electrical Code. Cryogenic containers and systems shall not be located where they could become part of an electrical circuit. Cryogenic containers and systems shall not be used for electrical grounding. When electrical grounding and bonding is required, the grounding and bonding system shall comply with the requirements of the NYC Electrical Code. The grounding system shall be protected against corrosion, including corrosion caused by stray electric currents or galvanic action.

### **8.4 HAZARDOUS MATERIALS REPORTING**

The storage of cryogenic fluids shall be reported to the FDNY as required by the New York State General Municipal Law Section 209-u. The knowledge of the presence of cryogenic fluids is vital to meeting the contingencies of a fire or other emergency. It is the purpose of this study guide to secure the health, safety and welfare of the public, protect those called upon to respond to the emergency, encourage preparedness to meet any danger, and promote planning concerning emergency services by requiring the reporting of the presence of cryogenic fluids.

**\*\*Stationary** cryogenic containers shall be separated from exposure hazards in accordance with the provisions applicable to the type of cryogenic fluid contained and the minimum separation distances indicated in table below.

SEPARATION OF STATIONARY CRYOGENIC CONTAINERS FROM EXPOSURE HAZARDS (OUTDOOR)

	<b>any amount of inert gas or any oxidizing gases equal to or any oxidizing gas in quantities equal to or less than 20,000 SCF</b>	<b>Quantity of oxidizing gases is greater than 20,000 up to 50,000 SCF</b>	<b>Quantity of oxidizing gases is greater than 50,000 SCF</b>
Buildings of type I and II construction as defined by the building code	1	1	1
Buildings of type III, IV, or V construction as defined by the building code	1	50 <sup>a</sup>	50 <sup>a</sup>
Building exit	10 <sup>a</sup>	10 <sup>a</sup>	10 <sup>a</sup>
Group A occupancies and other public gathering places	50	50	50
Non ambulatory patients	50	50	50
Public sidewalk or public street	0 or minimum required for service access <sup>b</sup>	10 <sup>a</sup>	10 <sup>a, c</sup>
Parked vehicles	0 or minimum required for service access	10 <sup>a</sup>	10 <sup>a</sup>
Slow burning solids (ex. heavy timber, coal)	0 or minimum required for service access	25 <sup>a</sup>	25 <sup>a</sup>
Building openings other than building exits	0 or minimum required for service access	10	10
Air intakes	10	10	10
Lot lines	5	5	10 <sup>a, c</sup>
Combustible waste or vegetation	15 <sup>a</sup>	50 <sup>a</sup>	50 <sup>a</sup>
Other hazardous materials	See additional requirements table (A) below <sup>a</sup>	See additional requirements table (B) below <sup>a</sup>	

- The distances shall not apply, where a fire barrier wall having a minimum fire resistance of 2 hours interrupts the line of sight between storage system and the exposure. In such cases, the 2-hour fire barrier shall be located at least 5 ft from any exposure.
- The distance shall be increased to 5 feet if the quantity of oxidizing gases is greater than 3,000 SCF up to 20,000 SCF.
- The distance shall be increased to 15 feet if there is no fire barrier and the quantity of oxidizing gases is greater than 100,000 SCF.

**Portable** cryogenic containers shall be separated from exposure hazards in accordance with the table below.

**\*\*SEPARATION OF PORTABLE CRYOGENIC CONTAINERS FROM EXPOSURE HAZARDS (OUTDOOR)**

	<b>any amount of inert gas or any oxidizing gases equal to or any oxidizing gas in quantities equal to or less than 20,000 SCF</b>	<b>Quantity of oxidizing gases is greater than 20,000 up to 50,000 SCF</b>	<b>Quantity of oxidizing gases is greater than 50,000 SCF</b>
Buildings of type I and II construction as defined by the building code	0 or minimum required for service access	1 or minimum required for service access	1 or minimum required for service access
Buildings of type III, IV, or V construction as defined by the building code	0 or minimum required for service access	50 <sup>a</sup>	50 <sup>a</sup>
Building exit	10 <sup>a</sup>	10 <sup>a</sup>	10 <sup>a</sup>
Group A occupancies and other public gathering places	50	50	50
Non ambulatory patients	50	50	50
Public sidewalk or public street	0 or minimum required for service access <sup>b</sup>	10 <sup>a</sup>	10 <sup>a, c</sup>
Parked vehicles	0 or minimum required for service access	10	10
Slow burning solids (ex. heavy timber, coal)	0 or minimum required for service access	25 <sup>a</sup>	25 <sup>a</sup>
Building openings other than building exits	0 or minimum required for service access	10	10
Air intakes	10	10	10
Lot lines	5	5	10 <sup>a, c</sup>
Combustible waste or vegetation	15 <sup>a</sup>	50 <sup>a</sup>	50 <sup>a</sup>
Other hazardous materials	See additional requirements table (A) below <sup>a</sup>	See additional requirements table (B) below <sup>a</sup>	

- The distances shall not apply, where a fire barrier wall having a minimum fire resistance of 2 hours interrupts the line of sight between storage system and the exposure. In such cases, the 2-hour fire barrier shall be located at least 5 ft from any exposure.
- The distance shall be increased to 5 feet if the quantity of oxidizing gases is greater than 3,000 SCF up to 20,000 SCF.
- The distance shall be increased to 15 feet if there is no fire barrier and the quantity of oxidizing gases is greater than 100,000 SCF.

### **Additional Distance Requirements Table**

#### **(A) DISTANCE REQUIREMENTS FROM INCOMPATIBLE MATERIALS**

Incompatible materials shall be separated while in storage or use except for stored materials in containers having a capacity of not more than 5 pounds or 0.5 gallon. Separation shall be accomplished by:

1. Segregating incompatible materials in storage by a distance of not less than 20 feet.
2. Isolating incompatible materials in storage by a noncombustible partition extending not less than 18 inches above and to the sides of the stored material.

#### **(B) DISTANCE REQUIREMENTS FROM HAZARDOUS MATERIALS WHERE STORAGE EXCEEDS 20,000 SCF OF OXIDIZING FLUIDS**

1-*All classes of flammable and combustible liquids above ground.*

- |                        |       |
|------------------------|-------|
| (a) 0 gal to 1,000 gal | 25 ft |
| (b) Over 1,000 gal     | 50 ft |

2-*All classes of flammable and combustible liquids in belowground tanks or vaults*

- |  |       |
|--|-------|
| (a) Horizontal distance from oxygen storage container to tank or vault   | 15 ft |
| (b) Horizontal distance from oxygen storage container to filling and vent connections or other openings to tank or vault | 25 ft |

3-*Flammable gases aboveground*

- |  |       |
|--|-------|
| (a) Liquefied hydrogen (any quantity)                    | 75 ft |
| (b) Other liquefied gas, 0 gal to 1,000 gal              | 25 ft |
| (c) Other liquefied gas, over 1,000 gal                  | 50 ft |
| (d) Nonliquefied or dissolved gases, 0 SCF to 25,000 SCF | 25 ft |
| (e) Nonliquefied or dissolved gases, over 25,000 SCF     | 50 ft |

**The distances mentioned in (B) shall not apply, where a fire barrier wall having a minimum fire resistance of 2 hours interrupts the line of sight between storage system and the exposure. In such cases, the 2-hour fire barrier shall be located at least 5 ft from any exposure.**

The surface of the area on which stationary cryogenic containers are placed, and the surface of the area located below the point where connections are made for the purpose of filling such cryogenic containers, shall be compatible with the cryogenic fluid in the cryogenic container. The surface shall be capable of withstanding the temperatures of the cryogenic fluid that may be released during normal filling operations, without cracking, shifting or other impact upon the stability of the installation. Cryogenic containers shall be positioned such that the pressure relief valve discharge is directed away from any building exit.



Control areas shall be separated from each other by not less than a 1-hour fire barrier constructed in accordance with the construction codes, including the NYC Building Code.

### **8.5 SECURITY**

Cryogenic containers and systems shall be secured against accidental dislodgement and against access by unauthorized personnel. Areas used for the storage of containers and systems shall be secured against unauthorized entry. Containers, piping, valves, pressure relief devices, regulating equipment, and other appurtenances shall be protected against physical damage and tampering.

### **8.6 SOURCES OF IGNITION**

Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition.

### **8.7 SMOKING**

It shall be unlawful to smoke in the following locations:

- In rooms or areas where oxidizing cryogenic containers are stored or used in open systems in amounts requiring a permit.
- Within 25 feet of oxidizing cryogenic outdoor storage, handling and use areas, including dispensing areas.
- Facilities or areas within facilities in which smoking has been entirely prohibited shall have “No Smoking” signs conspicuously placed at all entrances to the facility or area. Facilities or areas within facilities in which smoking is permitted in designated areas shall have signs indicating that smoking is permitted in designated areas only.
- In rooms or areas where oxidizing cryogenic containers are stored, handled or used.



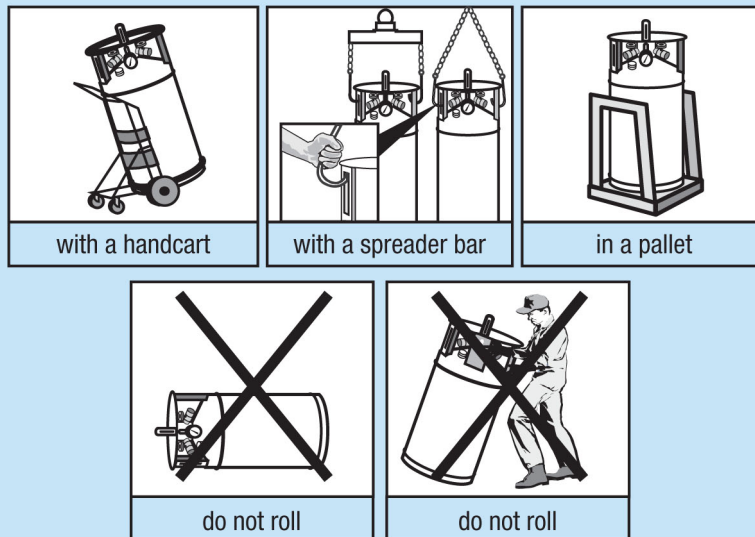
### **8.8 VENTILATION**

Indoor storage and use areas for cryogenic fluids shall be provided with mechanical exhaust ventilation or natural ventilation. Where mechanical ventilation is provided, the system shall be operational during the time the building or space is occupied. Mechanical ventilation shall be at a rate of not less than 1 ft<sup>3</sup> / min / ft<sup>2</sup> of floor area over the area of storage or use. A ventilation system should operate continuously. Cryogenic fluids should be stored and used in well-ventilated areas to prevent a reduction in oxygen concentration.

**EXHAUST SYSTEMS IN STORAGE ROOMS OR ANY PLACES WHERE GASES FROM CRYOGENIC FLUIDS CAN COLLECT MUST BE OPERATING AT ALL TIMES.**

## 9. HANDLING AND USE OF CRYOGENIC FLUID CONTAINERS

### How to Handle Liquid Containers



Liquid containers must only be unloaded from or loaded onto a delivery vehicle by means of a crane, fork truck, or a power-assisted tailgate. Liquid containers may be moved using a forklift if they are secured on a pallet, in a cradle, or some other device designed for this purpose. When the container is removed from a pallet, it should only be moved using a specially designed four-wheel handcart. Liquid containers must only be transported in an upright position and must never be laid on their side.

### **9.1 PARTIALLY FULL CONTAINERS**

Partially full cryogenic containers containing residual gases shall be treated as full.

### **9.2 PORTABLE CONTAINERS**

Pressurized portable cryogenic containers shall be moved with all operable valves in a closed position. Cryogenic containers designed for use at atmospheric conditions shall be moved with appropriate loose fitting covers in place to prevent spillage.

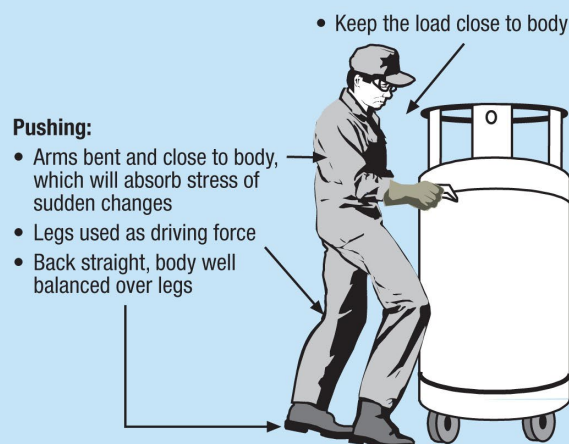
Portable containers for the storage of cryogenic fluids are designed and manufactured to operate in the vertical position only. Since the pressure inside the cylinder will increase, possibly causing an explosion it is not safe to store a liquefied gas container near a furnace, radiator or any other source of heat.

Liquid containers equipped with wheels should always be moved by pushing the container, never pulling it. This reduces the possibility of the container failing in the event it becomes unstable.

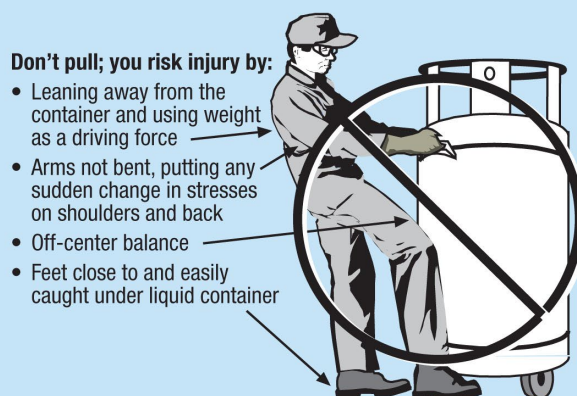
### **9.3 STATIONARY CONTAINERS**

Stationary cryogenic containers shall not be moved while containing cryogenic fluid. Handling of cryogenic containers shall be in accordance with the manufacturer's instructions.

#### **Moving Liquid Containers: Push, Don't Pull**



If the container tips over . . . **let it go!**



#### **9.4 CARTS AND TRUCKS**

Cryogenic containers shall be moved using an approved method. Where cryogenic containers are moved by hand cart, hand truck or other mobile device, such carts, trucks or devices shall be designed for the secure movement of containers, including a means of restraining the containers. Carts and trucks utilized for moving cryogenic containers outdoors shall be designed so that the containers will be secured against dropping or otherwise striking against each other or other surfaces.



**Liquid Cylinder Hand Cart**



## 10. SERVICE AND REPAIR OF CRYOGENIC CONTAINERS AND RELATED EQUIPMENT

Certificate of Fitness holders assigned to operate and maintain cryogenic containers and related equipment shall be adequately trained and thoroughly familiar with the operation instructions and with the hazards and safety precautions involved with the handling of a cryogenic system.

Service, repair, modification or removal of valves, pressure relief devices or other cryogenic container appurtenances, shall comply with the requirements of FC 3203.7.1 and 3203.7.2 and the ASME Boiler and Pressure Vessel Code, Section VIII or the regulations of the United States Department of Transportation, as set forth in 49 CFR Parts 100-180, as applicable and shall be performed by persons holding a W-79 certificate of fitness.

Bulk cryogenic fluid systems installed on consumer premises shall be inspected and maintained by a qualified representative such as a W-79 Certificate of Fitness holder or a manufacturer of the equipment. **A G-79 Certificate of Fitness holder is not permitted to perform this inspection and maintenance.**

**Out-of-service** cryogenic containers shall be marked to indicate that they are no longer available for service.

Service, repair, modification or removal of valves, pressure relief devices or other cryogenic container appurtenances, shall comply with the ASME Boiler and Pressure Vessel Code, Section VIII or United States Department of Transportation regulations as set forth in 49 CFR Part 178. In addition CGA (Compressed Gas Association) rules and regulations shall also be enforced. Cryogenic containers that have been removed from service shall be repaired by a person holding a W-79 certificate of fitness or disposed of lawfully. Cryogenic containers and systems shall be inspected by competent personnel at least once a month. Containers out-of-service in excess of 1 year shall be inspected and



tested, the pressure relief devices shall be tested for operability and to determine if they are set at the relief pressure required by the tank design.

Small leaks from liquefied gas piping or fittings are most easily detected by conducting a soap and water test on the joints. The container component with the greatest potential for leakage is on the valve. Leaking, damaged or corroded cryogenic containers shall be immediately removed from service, and the supplier must be contacted for container pick up. Leaking, damaged or corroded systems shall be replaced, repaired or disposed of lawfully.

**NOTE:** The container component with the greatest potential for leakage is the container valve.





## 11. FILLING AND DISPENSING OF CRYOGENIC FLUIDS

Dispensing of cryogenic fluids shall be conducted in approved locations. Dispensing usually takes place outdoors, unless approved to do so indoors. Dispensing indoors shall be conducted in areas constructed in accordance with the construction codes, including the NYC Building Code. If dispensing is taking place inside it MUST be in a well-ventilated area.

Indoor areas where cryogenic fluids are dispensed shall be ventilated in accordance with the NYC Mechanical Code in a manner that captures any vapor at the point of generation. Oxygen sensors equipped with an audible alarm shall be provided in dispensing areas involving asphyxiant gases to continuously monitor the level of oxygen in the area. The alarm shall actuate when oxygen concentration drops below 19.5 percent.

Loading and unloading areas shall be capable of withstanding the weight of the fully loaded cargo tank. Limit procedures shall be established to prevent overfilling of stationary cryogenic containers during filling operations.

Never attempt to transfer liquefied inert gas into a container or vessel that was not specifically designed for cryogenic liquid service. Containers used in shipment, storage, and transfer of cryogenic liquids are fabricated from materials that are able to withstand impact shock at low temperatures as well as to sustain the thermal stresses created by extreme temperature changes during the cool-down period. During the handling as well as the transfer of cryogenic fluids, the Certificate of Fitness holder must always wear protective gloves, long



**Liquid Manifold with Scales**

cuffless pants, long-sleeved shirt, safety glasses, and full face shield also known as personal protective equipment. The best way to transfer cryogenic fluids into warm lines or containers is slowly in order to prevent thermal shock. If you notice that the relief valve of the container is being discharged into the atmosphere while filling you should immediately discontinue filling the container until the cause of the discharge is determined (unless this is a normal part of a filling procedure at your work site).

**IT SHALL BE UNLAWFUL TO FILL A CRYOGENIC CONTAINER INTENDED FOR A NON-FLAMMABLE CRYOGENIC FLUID WITH A FLAMMABLE CRYOGENIC FLUID.**

## **12. HEALTH HAZARDS AND EMERGENCY MEASURES**

Oxygen-Deficient Atmosphere hazards were discussed earlier in the guide; however; the **CERTIFICATE OF FITNESS HOLDER SHOULD KNOW THE HAZARDS ASSOCIATED WITH THE PHYSICAL CONTACT OF CRYOGENIC FLUIDS.**

### **SKIN OR EYE FROSTBITE**

Always handle cryogenic liquids carefully. At their extremely low temperatures, they can produce frostbite on skin and exposed eye tissue. When spilled, they tend to cover a surface completely, cooling a large area. The vapor from these liquids is also extremely cold. Delicate tissues, such as those of the eyes, can be damaged by exposure to these cold gases, even when the contact is too brief to affect the skin of the hands or face.

### **BOILING AND SPLASHING**

Stand clear of boiling or splashing cryogenic liquid and its vapors. Boiling and splashing always occurs when filling a warm container, or when inserting warm objects into a cryogenic fluid. Use tongs to introduce or withdraw objects immersed in a cryogenic fluid. Always perform these operations slowly to minimize boiling and splashing. If liquid or cold vapor contacts the skin or eyes, follow the first aid recommendations.

### **FLESH TEARING**

Never allow any unprotected part of the body to touch uninsulated pipes or vessels which contain cryogenic fluids. The extremely cold metal will cause the flesh to stick fast and tear when one attempts to withdraw from it. Even nonmetallic materials are dangerous to touch at low temperatures.

### **FIRST AID FOR COLD-CONTACT BURNS**

In the event of contact with a liquid or cold gas, a cold-contact “burn” may occur. Actually, the skin or eye tissue freezes. Recommended emergency treatment for cold-contact burn is as follows:

- Remove any clothing that may restrict circulation to the frozen area. Do not rub frozen parts, as tissue damage may result. Obtain medical assistance as soon as possible.
- As soon as practical, immerse the affected part of the body in a warm water bath which has a temperature not exceeding 105F. Never use dry heat. The victim should also be in a warm room.
- If there has been massive exposure so that the general body temperature is depressed, prompt medical attention is imperative. If immediate medical assistance is unavailable, the patient may be re-warmed by immersion in 105F water. It is likely the patient will lapse into shock and standard treatment for this condition should be administered.

- Frozen tissues are painless and appear waxy with a possible yellow color. They become swollen, painful, and prone to infection when thawed. Do not re-warm rapidly under any circumstances. Thawing may require from 15 to 60 minutes and should be continued until the pale tint of the skin turns pink or red. Medication may be required to control the pain during thawing and should be administered under professional medical supervision.
- If the frozen area has thawed by the time medical attention has been obtained, cover the area with a dry sterile dressing and with a large bulky protective covering.
- Alcoholic beverages and smoking decrease blood flow to the frozen tissues and must not be used. Warm drinks and food may be given to a conscious victim.

## 13. FIRE PREVENTION AND FIRE FIGHTING

### 13.1 ASPHYXIANT WARNING SIGNS

Areas where exposure to non-life supporting gases may occur, such as indoor storage rooms or confined spaces, should have signs warning of a possible asphyxiation hazard.

### 13.2 WARNING SIGN(S) AND CAUTIONS

Wording for such signs shall include, as a minimum, the following:

#### HAZARD IDENTIFICATION SIGNS:



**WARNING – (Name of Gas)  
HIGH CONCENTRATION OF GAS MAY OCCUR  
IN THIS AREA  
AND MAY CAUSE ASPHYXIATION.  
VERIFY THAT OXYGEN CONCENTRATION IS  
ABOVE 19.5% BEFORE ENTERING  
AND DURING ACTIVITY IN THIS AREA.**



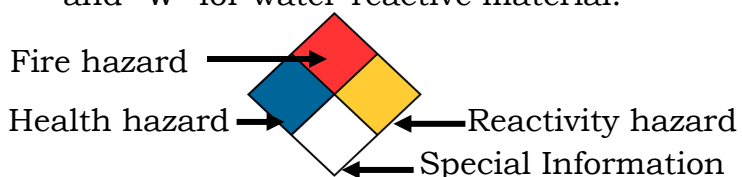
### 13.3 NFPA 704 DIAMOND SIGN

Storage, handling and use of cryogenic fluids is accompanied in the NYC Fire Code by a requirement for the use of consistent signage to alert people, including first responders, to the presence of flammable materials in a facility. The intent of the signage is to provide an indication of the relative degree of harm that the material may pose. In general, the NFPA 704 sign system is used for storage of the flammable materials on the premises. This simple system uses symbols, colors and numbers to readily communicate these concerns in a visual manner, and recognizes the fact that a material may pose more than one type of hazard. Unless otherwise exempted by the Fire Commissioner, hazard identification signs as set forth in NFPA 704 for the specific material contained shall be conspicuously affixed on stationary containers and aboveground tanks and at entrances to locations where flammable gases are stored, handled or used, including dispensing, in quantities requiring a permit, as well as at such other locations as may be designated by the Fire Commissioner.

NFPA Rating Explanation Guide					
RATING NUMBER	HEALTH HAZARD	FLAMMABILITY HAZARD	INSTABILITY HAZARD	RATING SYMBOL	SPECIAL HAZARD
4	Can be lethal	Will vaporize and readily burn at normal temperatures	May explode at normal temperatures and pressures	ALK	Alkaline
3	Can cause serious or permanent injury	Can be ignited under almost all ambient temperatures	May explode at high temperature or shock	ACID	Acidic
2	Can cause temporary incapacitation or residual injury	Must be heated or high ambient temperature to burn	Violent chemical change at high temperatures or pressures	COR	Corrosive
1	Can cause significant irritation	Must be preheated before ignition can occur	Normally stable. High temperatures make unstable	OX	Oxidizing
0	No hazard	Will not burn	Stable	W	Reacts violently or explosively with water
				W OX	Reacts violently or explosively with water and oxidizing

This chart for reference only - For complete specifications consult the NFPA 704 Standard  
NFPA-Chart\_1 www.ComplianceSigns.com

The basis of the system is a diamond-shaped sign that is divided into four color-coded quadrants (see left figure on the following page). The left-most quadrant is colored blue and represents the *health* hazard posed by the material, it is often referred to as the nine o'clock quadrant. The upper quadrant is red in color and indicates the relative *fire* hazard. The right-most quadrant is yellow and conveys the relative potential for *reactivity* of the material. The last quadrant, at the bottom, is white in color and serves to convey “special” information such as “OX” for oxidizer and “W” for water-reactive material.



**Blank NFPA Diamond Sign**



**Sign with Hazards Indicated**



The diamond-shaped sign is required by the Fire Code to be conspicuously displayed at the entrance to locations where cryogenic fluids are stored, handled and used, and on stationary containers and aboveground tanks containing cryogenic materials. Note that the sign requirement also applies to locations at which cryogenic fluids are dispensed. The triggering amount for the sign requirement is the amount required for a permit.

The numbering system that is used to convey the hazards of a material uses a scale of 0 through 4 for each of the three hazard types (health, flammability and instability). A number is placed in each box, specific to the material at hand. In each quadrant, a “0” represents the least degree of hazard and “4” represents the highest degree of hazard posed by a material. For instance, a “0” in the upper quadrant indicates a material that will not burn, while a “4” in the same quadrant indicates a gaseous material that will burn very readily (see right figure on the previous page). Intermediate numbers represent increasing levels of hazard in all categories, such as the “3” that is present in the “health” quadrant at nine o’clock in the figure above. This is indicative of a material that can cause permanent or serious injury upon exposure.

## 14. CONTAINER MARKING

Stationary and portable cryogenic containers shall be clearly marked with the name of the cryogenic fluid contained therein. Portable cryogenic gas containers shall be marked in accordance with DOT as well as CGA C-7 regulations. Markings shall be visible from any direction of approach. All stationary outdoor cryogenic containers shall be of light-reflective design or painted with a light-reflecting color.

Stationary cryogenic containers shall be identified with a permanent nameplate indicating the manufacturing specification and MAWP. The nameplate shall be installed on the cryogenic container in an accessible location. The nameplate shall be marked in accordance with the ASME Boiler and Pressure Vessel Code or DOT regulations as set forth in 49 CFR Part 178.



Cryogenic container inlet and outlet connections, liquid level indicating devices, liquid level limit controls, valves, pressure gauges, regulators, and safety devices shall be marked with a permanent tag or label identifying their function or identified by a schematic drawing designating their function and whether they are connected to the vapor or liquid space of the cryogenic container. Valves and controls should be properly and permanently labeled so the system or parts of it can be shut down properly and safely in an emergency. Where a schematic drawing is provided, it shall be permanently attached to the cryogenic container and maintained in a legible condition.

Piping systems shall be marked in accordance with ANSI A13.1. Markings used for piping systems shall consist of the name of the contents and include an arrow indicating the direction of flow. Markings shall be provided at each valve; at the wall, floor or ceiling penetrations; at each change of direction; and at a minimum of every 20 feet or fraction thereof throughout the piping run.

Emergency shutoff valves shall be identified by posting a durable sign at a conspicuous location at or near the valve. Shutoff valves are provided to shut off the cryogenic fluid supply in case of emergency. A shutoff valve shall be located at the

source of supply and at the point where the system enters the building, at the final use point.

Lighting shall be provided for equipment such as control valves, gauges, regulators, vaporizers and heat exchangers and operating facilities such as walkways and gates ancillary to stationary cryogenic container installations.

## 15. FIRE SAFETY AND FIRE FIGHTING EQUIPMENT

**A Certificate of Fitness holder shall not attempt to extinguish a fire, unless it is a small and manageable and poses no immediate danger. Otherwise, immediately call 911.**

The location and maintenance of fire safety and fire fighting equipment is extremely important. All valves and controls should be properly and permanently labeled so as to permit a safe shut down in the event of an emergency. All personnel must be informed of all necessary safeguards before entering a potentially hazardous area. Several reasons for that include:

1. so that the system or its components can be shut down safely in an emergency;
2. so devices can be properly identified as to their function;
3. so that less than fully trained employees can safely operate the system.

Some of the problems that are encountered by first responders when attempting to extinguish a fire involving a cryogenic fluids include the following:

- Cryogenic fluids have a potential to rapidly freeze water. On one hand, the use of water on surfaces of cryogenic containers or piping can lead to heavy icing and possible blockage of pressure relief devices. On the other hand, relatively warm water will cause the liquefied gas to vaporize more rapidly.
- There are no general safety objections to using carbon dioxide (CO<sub>2</sub>) extinguishers to fight smaller cryogenic fluid fires; however, the operation of CO<sub>2</sub> extinguishers may create electrostatic discharges that may ignite some hydrogen/air mixtures. CO<sub>2</sub> extinguishers are ineffective with oxygen-rich fires.
- After large volumes of cryogenic substances are released into the atmosphere, a fog will form from water vapor condensing in the surrounding air. This fog may severely reduce visibility. Escape routes in potentially vulnerable areas should include blind reference points such as handrails (about 4 feet high), and simple solid object such as curbs to permit location and identification by hand alone.

It is not possible to outline specific fire fighting techniques that will cover all types of fires involving cryogenic fluids. Nevertheless below is a BRIEF OUTLINE OF SEVERAL IMPORTANT STEPS THAT SHOULD BE TAKEN BY FIRST RESPONDERS:

- **Everyone not actively engaged in fighting the fire should leave the area. Occupants should be evacuated well outside the fire area.**
- **If electrical equipment is involved in the fire, be sure that the power supply is disconnected before using water for fire fighting or else use carbon dioxide or dry chemical fire extinguishers.**
- **When using water, use large quantities in spray form, to cool equipment in the areas surrounding the fire.**
- **Use the spray to cool any burning material below its ignition temperature. If possible, do not spray cold areas of equipment, or direct water onto the cryogenic fluid.**

- **If an inert cryogenic liquid is involved judgment should be used in deciding whether to allow the gas to escape- with possible risk of suffocation of firefighters- or to cut off the gas flow.**
- **Where suffocation is not a factor, it is wise to reduce the pressure at the source of the inert cryogenic fluid.**

### **15.1 FIRE NOTIFICATION**

Certificate of Fitness holders becoming aware of any fire are required to immediately notify the emergency operator (911). The Fire Department will respond. No supervisor or other person shall issue any directive or take any action to prevent or delay the reporting of a fire or other emergency to the Fire Department.

The Certificate of Fitness holder must know the locations of manual fire alarm system pull stations and portable fire extinguishers and how to operate them in an event of a small manageable fire. In addition to calling 911, the G-79/W-79 holder must activate the fire alarm system manual pull station. Activation of the manual pull station will sound the alarm in the facility.

The Certificate of Fitness holder may need to initiate an orderly evacuation when required by the hazard presented by any release of cryogenic fluid and take reasonable steps to isolate the hazard until the Fire Department arrives. The Certificate of Fitness holder must answer any questions asked by firefighters when they arrive. For example, he or she must indicate the location of the fire, describe the type of fire protection devices available, and describe the materials stored on the fire floor, the floor above and below as well as surrounding areas. The Bureau of Fire Prevention must be notified as soon as possible after an explosion or fire has occurred. The Bureau of Fire Prevention may require a detailed report on the causes and the consequences of the explosion or fire. Generally, this report must be filed within ten days after the incident.

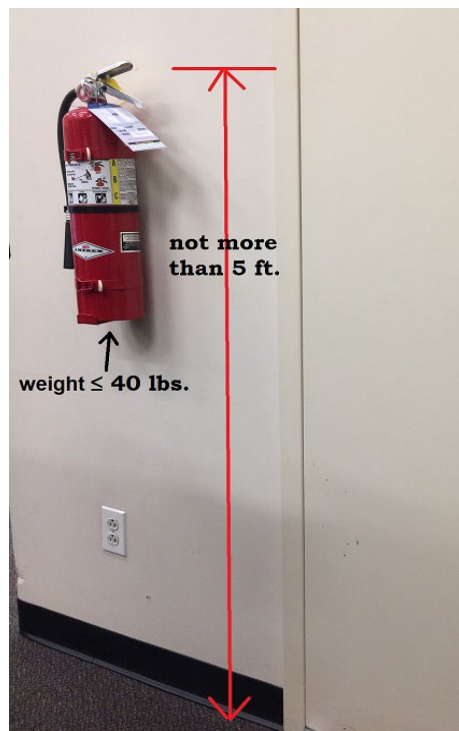
## **16. FIRE EXTINGUISHERS**

### **16.1 INSTALLATION AND PLACEMENT**

Fire extinguishers must be located in conspicuous locations where they will be readily accessible and immediately available for use. These locations must be along normal paths of travel. Fire extinguishers having a gross weight 40 pounds or less must be installed so that the top of the extinguisher is not more than 5 ft above the floor. Hand-held fire extinguishers having a gross weight exceeding 40 pounds shall be installed so that their tops are not more than 3.5 feet above the floor. The clearance between the floor and the bottom of installed hand-held extinguishers shall not be less than 4 inches.

**IN OTHER WORDS, NO FIRE EXTINGUISHER IS ALLOWED TO BE ON THE FLOOR.**





- (1) For a fire extinguisher weighing 40 pounds or less, its top must not be more than 5 ft above the floor
- (2) The fire extinguisher must be accessible and unobstructed.

- (1) The bottom of the fire extinguisher must be at least 4 inches above the floor.
- (2) The fire extinguisher must be properly mounted.

Minimum sizes of fire extinguishers for a Class B hazard shall be provided in accordance with the chart below:

Type of Hazard	Basic Minimum Extinguisher Rating	Maximum Travel Distance to Extinguishers (ft)
LIGHT	5-B	30
(LOW)	10-B	50
ORDINARY	10-B	30
(MODERATE)	20-B	50
EXTRA	40-B	30
(HIGH)	80-B	50

In the event that a fire extinguisher has been discharged, a

fully charged replacement is required before work can resume.

Portable fire extinguishers are important in preventing a incipient fire from growing into a catastrophic fire; however, they are not intended to fight large or spreading fires. By the time the fire has spread, fire extinguishers, even if used properly, will not be adequate to extinguish the fire. Such fires should be extinguished only by the building fire extinguishing systems or trained firefighters.

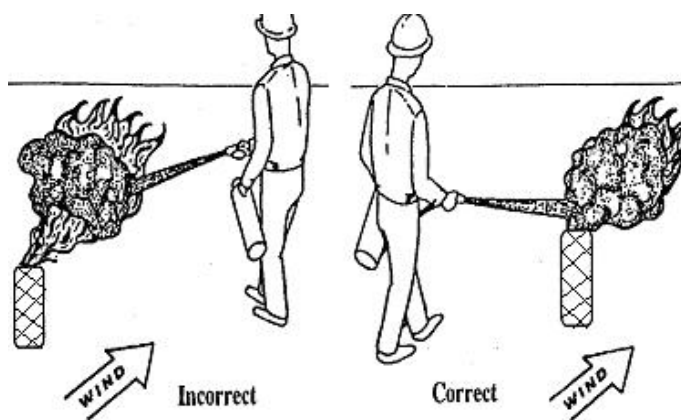


In case of any fire, **911 MUST** be called. Fire extinguishers must be used in accordance with the instructions painted on the side of the extinguisher. They clearly describe how to use the extinguisher in case of an emergency. The Certificate of Fitness holder should be familiar with the use of portable fire extinguishers. When it comes to using a fire-extinguisher just remember the acronym **P.A.S.S.** to help ensure you use it properly. **P.A.S.S.** stands for Pull, Aim, Squeeze, Sweep. An example of these instructions is depicted in the image on the left.

### **16.2 OPERATING INSTRUCTIONS FOR A FIRE EXTINGUISHER**

Special care must be taken when extinguishing a fire caused by a gas leak. The easiest way to extinguish the fire is to shut off the source by using the emergency-shut-off valve until the flame is extinguished. The flame must be approached from an upwind direction. This will prevent the Certificate of Fitness holder from being burned by the flames. Never approach a fire from a downwind direction.

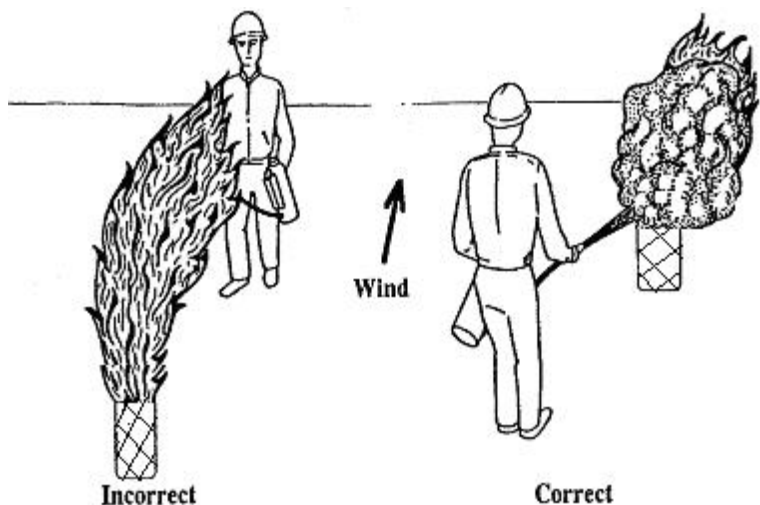
The dry chemical stream must be directed toward the point where the flame begins. Do not direct the chemical stream at the center of the flame. This will not extinguish the fire.



In relation to a fire connected piped gas, the gas supply must be shut off first and 911 must then be called. This is safer than allowing the flammable gas to leak out. A flammable gas leak could result in a serious explosion if it were ignited.

Never attempt to extinguish the flame unless the gas supply is shut. When it is not possible to shut off the gas supply (e.g. the fire is near the control valve or the shut-off valve), allow the flame to burn itself out while

calling 911. In the mean time, the COF holder should try to control the scene and prevent the fire from spreading to the surrounding materials. The Certificate of Fitness holders should only consider extinguishing fires when they are limited in size such that they can readily be extinguished using a portable fire extinguisher. Fire extinguishers, even if used properly, will not be adequate to extinguish the fire by the



time the fire has spread. Such fires should only be extinguished by the building fire extinguishing systems or trained firefighters only.

### **16.3 TYPES OF FIRE EXTINGUISHERS**

The Certificate of Fitness holder must be familiar with the different types of fire extinguishers that are present. They must know how to operate the extinguishers in a safe and efficient manner. They must know the difference between the various types of extinguishers and when they should be used. A description of the four classes of fires and the appropriate extinguishers are described below.

Class A fires are caused by ordinary combustible materials (such as wood, paper, and cloth). To extinguish a Class A fire, extinguishers must utilize either the heat-absorbing effects of water or the coating effects of certain dry chemicals.

Class B fires are caused by flammable or combustible liquids and gases such as oil, gasoline, etc. To extinguish a Class B fire, the blanketing-smothering effect of oxygen-excluding media such as CO<sub>2</sub>, dry chemical or foam is most effective.

Class C fires involve live electrical equipment. These fires must be fought with fire extinguishers that do not conduct electricity. Foam and water type extinguishers must not be used to extinguish electrical fires. After the power has been isolated from the electrical equipment, extinguishers for Class A or B fires may be used.

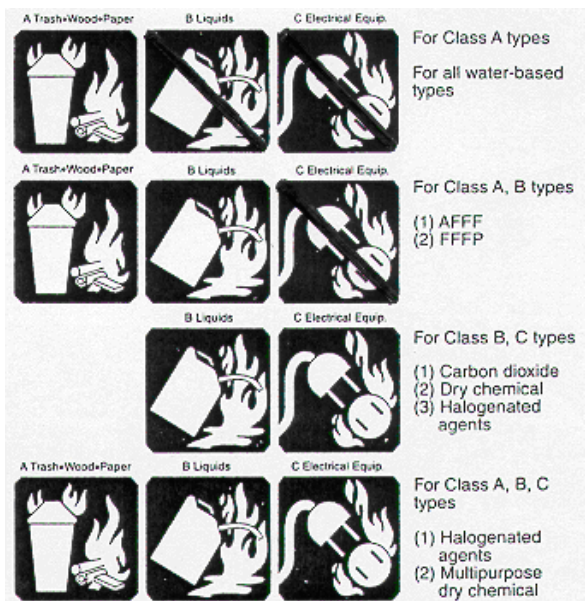
Class D fires are caused by ignitable metals, such as magnesium, titanium, and metallic sodium, or metals that are combustible under certain conditions, such as calcium, zinc, and aluminum. Generally, water should not be used to extinguish these fires.





A multi-purpose dry chemical fire extinguisher may be used to extinguish more than 2 Classes fires. Examples of some fire extinguishers are shown below.

### EXAMPLES OF FIRE EXTINGUISHERS



Symbols may also be painted on the extinguisher. The symbols indicate what kind of fires the extinguisher may be used upon. Examples of these symbols are shown below.



CLASSES OF FIRES	TYPES OF FIRES	PICTURE SYMBOL
<b>A</b>	Wood, paper, cloth, trash & other ordinary materials.	
<b>B</b>	Gasoline, oil, paint and other flammable liquids.	
<b>C</b>	May be used on fires involving live electrical equipment without danger to the operator.	
<b>D</b>	Combustible metals and combustible metal alloys.	

### FIRE EXTINGUISHER IDENTIFICATION SYMBOLS

The symbol with the shaded background and the slash indicates when the extinguisher must not be used. The Certificate of Fitness holder must understand these symbols. All fire extinguishers should be kept in good working order at all times.



#### **16.4 PORTABLE FIRE EXTINGUISHER TAGS**

Installed portable fire extinguishers must have an FDNY standard PFE tag affixed. This tag will have important information about the extinguisher. By November 15, 2019, all portable fire extinguishers must have the new PFE tags. The FDNY will only recognize new PFE tags and will be issuing violations to business that have PFE installed without a proper tag.

The color of the fire extinguishers may be changed by the FDNY every few years. The FDNY recommends two ways to verify the tag's legitimacy:

1. Hologram:

A real hologram strip shown on the tag is 3 inches long by ¼ inch wide. Counterfeit tags will NOT have a high quality silver hologram. The hologram on a counterfeit tag will NOT change color as it is moved against the light.

2. QR code

If you scan the QR code, it should direct you to the updated FDNY approved fire extinguisher company list. You can use the company list to verify if the company printed on the list is currently approved by the FDNY.

If your PFE tags cannot be verified via these two methods, contact your supervisor. If you suspect your PFE is a counterfeit, contact FDNY immediately by e-mail:

[Tags.Decal@fdny.nyc.gov](mailto:Tags.Decal@fdny.nyc.gov)



FRONT

DO NOT REMOVE  
BY ORDER OF THE FDNY

• ABC (Dry Chem)	HALOTRON	•
• AFFF/FFFP	WATER	•
• BC (Dry Chem)	LOADED STREAM	•
• PURPLE K (PK)	WET CHEM	•
• CARBON DIOXIDE	CLEAN AGENT	•
• CLASS D (Dry Powder)	INTERGEN	•
• CLASS K	WATER MIST	•
• FE-36	FE-13	•
• FM 200		•
• HALON 1211		•
• HALON 1301		•

THIS PORTABLE FIRE EXTINGUISHER HAS BEEN SERVICED  
AS REQUIRED BY NYC FIRE CODE 906.2.1.2

2021  
2022  
2023

PROOF OF COMPLIANCE FOR USE BY CERTIFIED  
PORTABLE FIRE EXTINGUISHER SERVICING COMPANY

VOID 1 YR. FROM MONTH PUNCHED

SERVICED	NEW	RECHARGED
JAN	JUNE	DEC
FEB	JULY	NOV
MAR	AUG	OCT
APR	SEPT	
MAY		

BACK

DO NOT REMOVE  
BY ORDER OF THE FDNY

Name \_\_\_\_\_

C of F \_\_\_\_\_

Company \_\_\_\_\_

DEA \_\_\_\_\_

NYC LIC# \_\_\_\_\_

Address \_\_\_\_\_

Phone Number \_\_\_\_\_

**MONTHLY INSPECTION RECORD**

DATE	BY	DATE	BY

Barcode: DON253W220004746

QR code

SERIAL # \_\_\_\_\_

PREMISES ADDRESS \_\_\_\_\_

UNAUTHORIZED POSTING IS A CRIME PUNISHABLE BY FINE AND/OR IMPRISONMENT

PFE tag (This tag is released for 2021-2023)

## 16.5 FIRE EXTINGUISHER INSPECTIONS

### MONTHLY

The portable fire extinguishers are required to be checked monthly. The owner of the business is responsible to select a person to do a monthly inspection. This monthly inspection is called a "quick check".

The **QUICK CHECK** should check if:

- (1) the fire extinguisher is fully charged;
- (2) it is in its designated place;

- (3) it has not been actuated or tampered with;
- (4) there is no obvious or physical damage or condition to prevent its operation.

The information of the monthly inspection record must include the date of the inspection, the name/initials of the person who did the inspection. This monthly quick check is documented on the back of the PFE tag.

### **ANNUALLY**

At least annually all Portable Fire Extinguishers must be checked by a W-96 Certificate of Fitness holder from FDNY approved company. After each annual inspection W-96 COF holder will replace the PFE tag. This monthly quick check record must be kept on the back of the PFE tag or by an approved electronic method that provides a permanent record.

### **MONTHLY INSPECTION RECORD KEEPING**

During the inspection the designated employee should date and initial the tag. Where manual inspections are conducted, records for manual inspections shall be kept on a tag or label attached to the fire extinguisher, on an inspection checklist maintained on file, or by an electronic method. Records shall be kept to demonstrate inspections have been performed in each of the last 12 months.

## 17. LITHIUM-ION BATTERY SAFETY

### **Lithium-ion safety**

Lithium-ion batteries are rechargeable batteries found in electric bikes, scooters, cars, laptops, tablets, phones, and many other common household devices.

Lithium-ion battery fires have caused deaths, serious injuries, and devastating damage to property around the city. It's important to follow rules for safe storage, charging, and disposal for these types of batteries.

If you own a lithium-ion powered device or plan to buy one, the FDNY has important safety tips that you should follow. These tips apply to all devices powered by lithium-ion batteries, including phones, tablets, laptops, e-cigarettes, toys, high-tech luggage, and even robotic vacuum cleaners.

**Immediately stop** using or charging battery and call 911 if you notice:

- **Fire or Smoke**
- **Overheating**
- **Change in color or shape**
- **Odd noises**
- **Leaking**
- **Strange smell**

### **ALWAYS:**

- purchase and use devices certified by a Nationally Recognized Testing

Laboratory (NRTL). 

- follow the manufacturer's instructions for:
  - charging and storage.
  - correct battery, cord, and power adapter
- **keep exit path clear at all times.**
- plug directly into a wall electrical outlet for charging.
- keep batteries and devices at room temperature.
- store and/or charge batteries away from anything flammable.
- keep away from heat sources.
- bring batteries to a **NYC Battery Recycling Center**. Visit [nyc.gov/batteries](https://nyc.gov/batteries) for more information.

### **NEVER:**

- use aftermarket batteries or chargers.
- use damaged or altered batteries
- plug into a power strip or overload an outlet.
- overcharge or leave battery charging overnight.
- charge a battery or device under your pillow, on your bed, or near a couch.
- leave e-bikes or e-scooters unattended while charging.
- block your primary way in or out of a room/space with e-bikes, e-scooters, wheelchairs, etc.
- place batteries in Trash or Recycling bin. **It is ILLEGAL.** Visit [nyc.gov/batteries](https://nyc.gov/batteries) for disposal locations and information.

**In the event of a Fire,  
Leave and CLOSE the door.  
Call 911 once you are in  
a safe location.**



## Charging Lithium Ion

Lithium-ion batteries do not have to be fully charged; partial charge is the most suitable.

When **charging more than five (5)** personal mobility devices or their removable batteries, it must be in a **dedicated room with ventilation** and a self-closing door.

For a total battery capacity of 20 kilowatt-hours (kWh), a 2-foot separation between charging batteries is required. For a total battery capacity up to 50 kWh, a 3-foot separation is needed.

Chargers must only be used with a compatible battery pack. The original equipment manufacturer (OEM) charger interplays with the battery pack using the battery management system (BMS). The wrong battery/charger combination may not work safely. For example, the 100% cutoff to prevent overcharging, which damages batteries, may not work which can easily create hazardous conditions such as fires, explosions and/or injuries.

Always check with the manufacturer or retailer of the personal mobility device, an authorized repair shop or a testing laboratory such as Underwrites Laboratories (UL) to see if replacement is recommended or listed and safe for use with that device. Using unauthorized parts, including batteries and/or chargers, may cause damage, fire and possibly void your warranty.

## Extinguishing Lithium-ion

Water may not prevent a battery from burning and spreading. Battery cells are known to explode and quickly spread to another battery. It can spread to another devices.



**Fire Extinguishers**  
**do not work**  
on lithium-ion batteries  
fires.

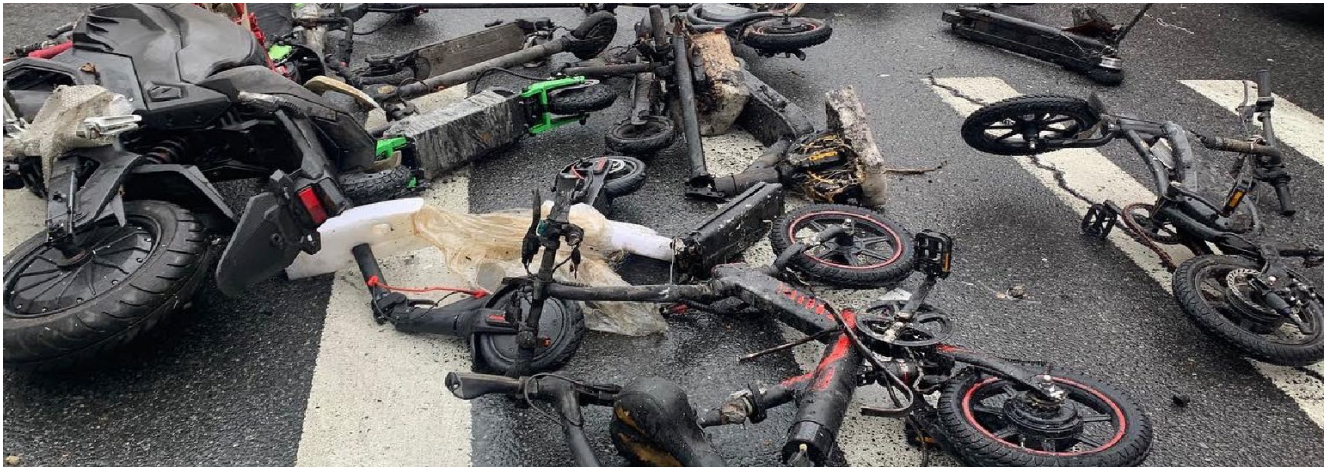


### **Unexpected Re-ignition.**

Reignition is common. Lithium-Ion Batteries are known to unexpectedly re-ignite (without warning) minutes, hours and even days after all visible fire has been put out.

Lithium-ion batteries can enter an uncontrollable, self-heating state. This can result in the release of gas, cause fire and possible explosion.

These batteries may continue to generate heat even when there is no visible sign of fire. Once heat reaches a certain level fire may reignite on the battery and surrounding area.



# Material Safety Data Sheet

Oxygen

## Section 1. Chemical product and company identification

<b>Product name</b>	: Oxygen
<b>Supplier</b>	: AIRGAS INC., on behalf of its subsidiaries 259 North Radnor-Chester Road Suite 100 Radnor, PA 19087-5283 1-610-687-5253
<b>Product use</b>	: Synthetic/Analytical chemistry.
<b>Synonym</b>	: Molecular oxygen; Oxygen molecule; Pure oxygen; O <sub>2</sub> ; UN 1072; Dioxygen; Oxygen USP, Aviator's Breathing Oxygen (ABO)
<b>MSDS #</b>	: 001043
<b>Date of Preparation/ Revision</b>	: 9/24/2013.
<b>In case of emergency</b>	: 1-866-734-3438

## Section 2. Hazards identification

<b>Physical state</b>	: Gas. [Compressed gas.]
<b>Emergency overview</b>	: DANGER! GAS: OXIDIZER. CONTACT WITH COMBUSTIBLE MATERIAL MAY CAUSE FIRE. CONTENTS UNDER PRESURE. Do not puncture or incinerate container. May cause severe frostbite. LIQUID: OXIDIZER. CONTACT WITH COMBUSTIBLE MATERIAL MAY CAUSE FIRE. Extremely cold liquid and gas under pressure. May cause severe frostbite.  Do not puncture or incinerate container. Store in tightly-closed container. Avoid contact with combustible materials. Contact with rapidly expanding gases or liquids can cause frostbite.
<b>Routes of entry</b>	: Inhalation
<b>Potential acute health effects</b>	
<b>Eyes</b>	: May cause eye irritation. Contact with rapidly expanding gas may cause burns or frostbite. Contact with cryogenic liquid can cause frostbite and cryogenic burns.
<b>Skin</b>	: May cause skin irritation. Contact with rapidly expanding gas may cause burns or frostbite. Contact with cryogenic liquid can cause frostbite and cryogenic burns.
<b>Inhalation</b>	: Respiratory system irritation after overexposure to high oxygen concentrations.
<b>Ingestion</b>	: Ingestion is not a normal route of exposure for gases. Contact with cryogenic liquid can cause frostbite and cryogenic burns.
<b>Medical conditions aggravated by over-exposure</b>	: Acute or chronic respiratory conditions may be aggravated by overexposure to this gas.
<b>See toxicological information (Section 11)</b>	



### Section 3. Composition, Information on Ingredients

<u>Name</u>	<u>CAS number</u>	<u>% Volume</u>	<u>Exposure limits</u>
Oxygen	7782-44-7	100	

### Section 4. First aid measures

No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

- Eye contact** : Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately.
- Skin contact** : None expected.
- Frostbite** : Try to warm up the frozen tissues and seek medical attention.
- Inhalation** : Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.
- Ingestion** : As this product is a gas, refer to the inhalation section.

### Section 5. Fire-fighting measures

- Flammability of the product** : Non-flammable.
- Products of combustion** : No specific data.
- Fire hazards in the presence of various substances** : Extremely flammable in the presence of the following materials or conditions: reducing materials, combustible materials and organic materials.
- Fire-fighting media and instructions** : Use an extinguishing agent suitable for the surrounding fire.
- Apply water from a safe distance to cool container and protect surrounding area. If involved in fire, shut off flow immediately if it can be done without risk.
- Contains gas under pressure. Contact with combustible material may cause fire. This material increases the risk of fire and may aid combustion. In a fire or if heated, a pressure increase will occur and the container may burst or explode.
- Special protective equipment for fire-fighters** : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

### Section 6. Accidental release measures

- Personal precautions** : Immediately contact emergency personnel. Keep unnecessary personnel away. Use suitable protective equipment (section 8). Eliminate all ignition sources if safe to do so. Do not touch or walk through spilled material. Shut off gas supply if this can be done safely. Isolate area until gas has dispersed.
- Environmental precautions** : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.
- Methods for cleaning up** : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

### Section 7. Handling and storage

- Handling** : High pressure gas. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Store in tightly-closed container. Avoid contact with combustible materials. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.
- Never allow any unprotected part of the body to touch uninsulated pipes or vessels that contain cryogenic liquids. Prevent entrapment of liquid in closed systems or piping without pressure relief devices. Some materials may become brittle at low temperatures

## Oxygen

and will easily fracture.

### Storage

- : Keep container tightly closed. Keep container in a cool, well-ventilated area. Separate from acids, alkalies, reducing agents and combustibles. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

## Section 8. Exposure controls/personal protection

### Engineering controls

- : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

### Personal protection

#### Eyes

- : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or dusts.  
When working with cryogenic liquids, wear a full face shield.

#### Skin

- : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

#### Respiratory

- : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

The applicable standards are (US) 29 CFR 1910.134 and (Canada) Z94.4-93

#### Hands

- : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.  
Insulated gloves suitable for low temperatures

### Personal protection in case of a large spill

- : Self-contained breathing apparatus (SCBA) should be used to avoid inhalation of the product.

### Product name

Oxygen

Consult local authorities for acceptable exposure limits.

## Section 9. Physical and chemical properties

<b>Molecular weight</b>	: 32 g/mole
<b>Molecular formula</b>	: O <sub>2</sub>
<b>Boiling/condensation point</b>	: -183°C (-297.4°F)
<b>Melting/freezing point</b>	: -218.4°C (-361.1°F)
<b>Critical temperature</b>	: -118.15°C (-180.7°F)
<b>Vapor density</b>	: 1.1 (Air = 1)
<b>Specific Volume (ft<sup>3</sup>/lb)</b>	: 12.0482
<b>Gas Density (lb/ft<sup>3</sup>)</b>	: 0.083

## Section 10. Stability and reactivity

### Stability and reactivity

- : The product is stable.

### Incompatibility with various substances

- : Extremely reactive or incompatible with the following materials: oxidizing materials, reducing materials and combustible materials.

### Hazardous decomposition products

- : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

### Hazardous polymerization

- : Under normal conditions of storage and use, hazardous polymerization will not occur.

# Material Safety Data Sheet

Nitrogen

## Section 1. Chemical product and company identification

<b>Product name</b>	: Nitrogen
<b>Supplier</b>	: AIRGAS INC., on behalf of its subsidiaries 259 North Radnor-Chester Road Suite 100 Radnor, PA 19087-5283 1-610-687-5253
<b>Product use</b>	: Synthetic/Analytical chemistry. Liquid – cryogenic coolant.
<b>Synonym</b>	: nitrogen (dot); nitrogen gas; Nitrogen NF, LIN, Cryogenic Liquid Nitrogen, Liquid Nitrogen
<b>MSDS #</b>	: 001040
<b>Date of Preparation/ Revision</b>	: 11/22/2013.
<b>In case of emergency</b>	: 1-866-734-3438

## Section 2. Hazards identification

<b>Physical state</b>	: Gas. [NORMALLY A COLORLESS GAS: MAY BE A CLEAR COLORLESS LIQUID AT LOW TEMPERATURES. SOLD AS A COMPRESSED GAS OR LIQUID IN STEEL CYLINDERS.]
<b>Emergency overview</b>	: WARNING! GAS: CONTENTS UNDER PRESURE. Do not puncture or incinerate container. Can cause rapid suffocation. May cause severe frostbite. LIQUID: Extremely cold liquid and gas under pressure. Can cause rapid suffocation. May cause severe frostbite.  Do not puncture or incinerate container. May cause target organ damage, based on animal data. Contact with rapidly expanding gases or liquids can cause frostbite.
<b>Target organs</b>	: May cause damage to the following organs: lungs.
<b>Routes of entry</b>	: Inhalation
<b>Potential acute health effects</b>	
<b>Eyes</b>	: Contact with rapidly expanding gas may cause burns or frostbite. Contact with cryogenic liquid can cause frostbite and cryogenic burns.
<b>Skin</b>	: Contact with rapidly expanding gas may cause burns or frostbite. Contact with cryogenic liquid can cause frostbite and cryogenic burns.
<b>Inhalation</b>	: Acts as a simple asphyxiant.
<b>Ingestion</b>	: Ingestion is not a normal route of exposure for gases. Contact with cryogenic liquid can cause frostbite and cryogenic burns.
<b>Potential chronic health effects</b>	
<b>Chronic effects</b>	: May cause target organ damage, based on animal data.
<b>Target organs</b>	: May cause damage to the following organs: lungs.
<b>Medical conditions aggravated by over-exposure</b>	: Pre-existing disorders involving any target organs mentioned in this MSDS as being at risk may be aggravated by over-exposure to this product.

Build 1.1

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## Nitrogen

See toxicological information (Section 11)

### Section 3. Composition, Information on Ingredients

<u>Name</u>	<u>CAS number</u>	<u>% Volume</u>	<u>Exposure limits</u>
Nitrogen	7727-37-9	100	Oxygen Depletion [Asphyxiant]

### Section 4. First aid measures

No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

- Eye contact** : Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately.
- Skin contact** : None expected.
- Frostbite** : Try to warm up the frozen tissues and seek medical attention.
- Inhalation** : Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.
- Ingestion** : As this product is a gas, refer to the inhalation section.

### Section 5. Fire-fighting measures

- Flammability of the product** : Non-flammable.
- Products of combustion** : Decomposition products may include the following materials: nitrogen oxides
- Fire-fighting media and instructions** : Use an extinguishing agent suitable for the surrounding fire.
- Apply water from a safe distance to cool container and protect surrounding area. If involved in fire, shut off flow immediately if it can be done without risk.
- Contains gas under pressure. In a fire or if heated, a pressure increase will occur and the container may burst or explode.
- Special protective equipment for fire-fighters** : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

### Section 6. Accidental release measures

- Personal precautions** : Immediately contact emergency personnel. Keep unnecessary personnel away. Use suitable protective equipment (section 8). Shut off gas supply if this can be done safely. Isolate area until gas has dispersed.
- Environmental precautions** : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.
- Methods for cleaning up** : Immediately contact emergency personnel. Stop leak if without risk. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

### Section 7. Handling and storage

- Handling** : High pressure gas. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.
- Never allow any unprotected part of the body to touch uninsulated pipes or vessels that contain cryogenic liquids. Prevent entrapment of liquid in closed systems or piping without pressure relief devices. Some materials may become brittle at low temperatures and will easily fracture.



## Nitrogen

- Storage** : Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).  
For additional information concerning storage and handling refer to Compressed Gas Association pamphlets P-1 Safe Handling of Compressed Gases in Containers and P-12 Safe Handling of Cryogenic Liquids available from the Compressed Gas Association, Inc.

## Section 8. Exposure controls/personal protection

- Engineering controls** : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

### Personal protection

- Eyes** : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or dusts.  
When working with cryogenic liquids, wear a full face shield.
- Skin** : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- Respiratory** : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.  
The applicable standards are (US) 29 CFR 1910.134 and (Canada) Z94.4-93
- Hands** : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.  
Insulated gloves suitable for low temperatures
- Personal protection in case of a large spill** : Self-contained breathing apparatus (SCBA) should be used to avoid inhalation of the product.

### Product name

Nitrogen

Oxygen Depletion [Asphyxiant]

Consult local authorities for acceptable exposure limits.

## Section 9. Physical and chemical properties

- Molecular weight** : 28.02 g/mole
- Molecular formula** : N<sub>2</sub>
- Boiling/condensation point** : -195.79°C (-320.4°F)
- Melting/freezing point** : -210.01°C (-346°F)
- Critical temperature** : -146.9°C (-232.4°F)
- Vapor density** : 0.967 (Air = 1) Liquid Density@BP: 50.46 lb/ft<sup>3</sup> (808.3 kg/m<sup>3</sup>)
- Specific Volume (ft<sup>3</sup>/lb)** : 13.8889
- Gas Density (lb/ft<sup>3</sup>)** : 0.072

## Section 10. Stability and reactivity

- Stability and reactivity** : The product is stable.
- Hazardous decomposition products** : Under normal conditions of storage and use, hazardous decomposition products should not be produced.
- Hazardous polymerization** : Under normal conditions of storage and use, hazardous polymerization will not occur.