Revised on March 2024 (Apply/Pay)

**FIRE DEPARTMENT • CITY OF NEW YORK**

# STUDY MATERIAL FOR THE CERTIFICATE OF FITNESS EXAMINATION

## G-71

## Supervision of Piped Non-Flammable Medical Gases

***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.fdnycloud.org/CitizenAccess

Note 1: The G-71 Certificate of Fitness was previously the **G-17 Certificate of Fitness for Supervise the Use of Medical Gases (O2/NO2) in Bulk**.

Note 2: Applicants who work in a facility where there is **NO piped medical gas system** have the option of taking this G-71 C of F exam or **the G-46 (shorter) C of F exam**.

**CONTENT**

# EXAM SPECIFIC INFORMATION FOR G-71 CERTIFICATE OF FITNESS

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## 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-71 Certificate of Fitness:** None

**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)

This Certificate of Fitness can be obtained by the alternative issuance procedure. Qualified applicants should review and complete the G-71 Certificate of Fitness Alternative Issuance Procedure Application Affirmation Form:

https://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-g71-aip.pdf.

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

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

### EXAM INFORMATION

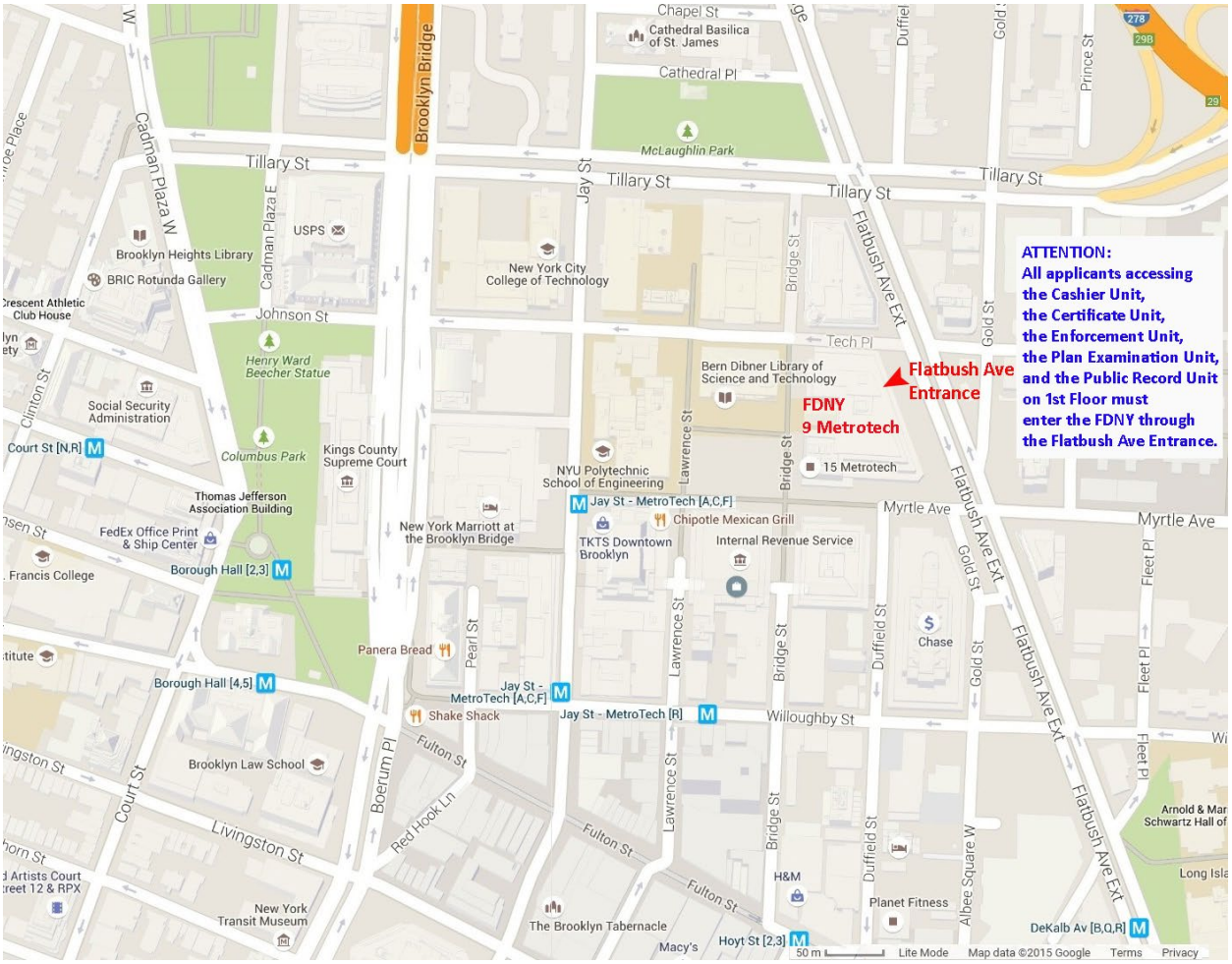
The **G-71** exam will consist of **50** multiple-choice questions, administered on a "touch screen" computer monitor. It is a time-limit exam. Based on the amount of the questions and reference material provided, you will have 75 minutes to complete the test. A passing score of at least 70% is required in order to secure a Certificate of Fitness.

***Special material provided during the exam:*** *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.

http://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-g71-noe-study-materials.pdf

**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-71 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.

## STUDY MATERIAL AND TEST DECRIPTION

About the Study Material

This study material will help you prepare for the examination for the Certificate of Fitness for ***supervising the piped non-flammable gas systems in medical facilities***. The study material includes information taken from the New York City Fire Code. The exam covers the entire booklet and any tables. **It will not be provided to you during the test. It is critical that you read and understand this booklet to help increase your chance of passing this exam.** The study material does not contain all of the information you need to know to use, store, and handle medical compressed gases. It is your responsibility to become familiar with all 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 Chapter 27, Chapter 32, FC Section 3006, the NFPA 99 Chapter 5 and 9 (2005 Ed.), the NFPA 99 (1987 Ed.), the NFPA 50 (2001 Ed.), and the CGA G-8.1(2007 Ed..)

About the Test

**50** questions on the Certificate of Fitness examination are of the multiple choice type with four alternative answers to each question. Only one answer is most correct for each question. If you do not answer a question or if you mark more than one alternative your answer will be scored as incorrect. A score of 70% is required on the examination in order to qualify for the Certificate of Fitness. Read each question carefully before marking your answer. There is no penalty for guessing.

### Sample Questions

**1. Which of the following are allowed to be used/displayed 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 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
C. the examiner in the testing room
D. you should not ask about test questions since FDNY staff can not assist applicants

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

**3. 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
C. the examiner in the testing room
D. the computer help desk

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

## 1. INTRODUCTION

This booklet outlines New York City Fire Department regulations for **the safe use, handling, storage of piped compressed non-flammable gases and cryogenic fluids in medical facilities**.

The gases that are used most commonly in healthcare facilities include air, carbon dioxide, helium, nitrogen, nitrous oxide and oxygen. The examples of common compressed medical gases including, but not limited to the following gases:

| Gases | Nonliquefied Compressed Gas | Liquefied Gas | Physical Hazards |
|---|---|---|---|
| Carbon Dioxide | | X | Nonflammable |
| Helium | X | | Nonflammable |
| Nitrogen | X | | Nonflammable |
| Air | X | | Nonflammable |
| Nitrous Oxide | | X | Oxidizer |
| Oxygen | X | | Oxidizer |

The examples of common cryogenic fluids including, but not limited to the following fluids:

**Characteristics Of Common Cryogenic Fluids**

| Cryogenic | Boiling Point | Expansion Ratio |
|---|---|---|
| Liquid Nitrous Oxide* | -127°F | 670 to 1 |
| Liquid Helium | -452°F | 700 to 1 |
| Liquid Nitrogen | -320°F | 694 to 1 |
| Liquid Oxygen | -297°F | 857 to 1 |

*For the purposes of this exam liquid nitrous oxide will be considered as a cryogenic fluid, where liquid carbon dioxide is **not** considered as a cryogenic fluid.

### 1.1 Certificate of Fitness

**(1) Handling and use:** The handling and use (including transfer) of compressed gases/cryogenic fluids used in medical gas systems in quantities requiring a permit shall be under the personal supervision of a person holding a G-71 certificate of fitness.

**(2) Storage:** The storage of compressed gases/cryogenic fluids used in medical gas system in quantities requiring a permit shall be under the general supervision of a person holding a G-71 certificate of fitness.

**(3) Installation and maintenance.** 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 **G-79** certificate of fitness. Generally, the

'end user' Certificate of Fitness individual is **NOT** allowed to make repairs on a leaking cryogenic fluid container.

The Certificate of Fitness holders are responsible for ensuring that all Fire Department regulations related to the safe storage, handling and use of non-flammable compressed gases/cryogenic fluids are obeyed on the premises.

The following materials are **NOT** covered in the G-71 Certificate of Fitness.

| Hazardous Materials | Fire Code/ Fire Rule | Related C of F/C of Q tests |
|---|---|---|
| Compressed gases used as refrigerants in refrigerating systems | FC Ch. 6 | Refrigerating system engineer(Q-99/Q-01) |
| Non-flammable compressed gases (non- medical facilities) | FC Ch.30 | Supervision of storage, handling, use, and refilling of non-flammable compressed gases (G-46) |
| Cryogenic fluid (non-medical facilities) | FC Ch.32 | Supervision of storage, handling, and use of Commercial cryogenic systems (G-79) |
| Flammable compressed gases (non-LPG/CNG) | FC Ch.35 | Supervision of storage, handling, use of flammable compressed gases (G-98) |
| LPG/CNG | FC Ch. 35<br>FC Ch. 38 | Storage and Handling of LPG/CNG (G-44) |
| Air compressor | FC Ch. 30 | To operate and maintain air compressors (A-35) |

## 1.2 Pre-existing and New Installations

In July of 2008, a new Fire Code was adopted in New York City. Unlike the former code, this new code set forth specific regulations regarding the storage, use, handling and manufacturing of compressed nonflammable gases and cryogenic fluids in medical facilities.

In this study material you will see references and requirements that are applicable to "pre-existing" installations. It is important that you understand what this means. All installations approved by the NYC Fire Department (FDNY) on or after July 1, 2008 are required to be in full compliance with the 2008 Fire Code. However, installations approved by the NYC Fire Department prior to July 1, 2008 do not have to, and in some case could not, comply with the design and installation requirements of the 2008 Fire Code, including limitations on maximum allowable quantities (MAQ). Such installations are considered to be "pre-existing" installations and as such are only required to

comply with the design and installation requirements in effect at the time the installation was established. Installations that were in existence prior to July 1, 2008 but operating without a FDNY permit may also be considered "pre-existing" installations provided they were in compliance with nationally recognized standards and the NYC Building Code at the time of installation.

More often than not, "pre-existing" installations will be storing nonflammable compressed gases/cryogenic fluids in quantities exceeding those that are allowed by the new code. For "pre-existing" installations that have been operating with a valid FDNY permit, the maximum allowable quantity of nonflammable compressed gases/cryogenic fluids would be established by that permit. However, for "pre-existing" installations that have been operating without a FDNY permit, the burden of proof is on the owner to provide the FDNY with records establishing their need for those nonflammable compressed gases/cryogenic fluids in the quantities stored. Records acceptable to the FDNY include true copies of the annual inventory forms filed with the City of New York as required by New York State General Municipal Law Section 209-u and/or the annual facility inventory forms filed with the City of New York as required by the NYC Right to Know Law. The forms would then be reviewed and a determination made accordingly.

For the most part, **permits issued for installations established prior to July 1, 2008 are subject to compliance with the former code requirements while those issued for installations established after July 1, 2008 are subject to compliance with the new fire code.** It is, therefore, possible that there could be two different installations in the same building, covered by separate permits, both supervised by the same certificate of fitness holder. The certificate of fitness holder will have the responsibility of distinguishing and ensuring compliance with the different code requirements.

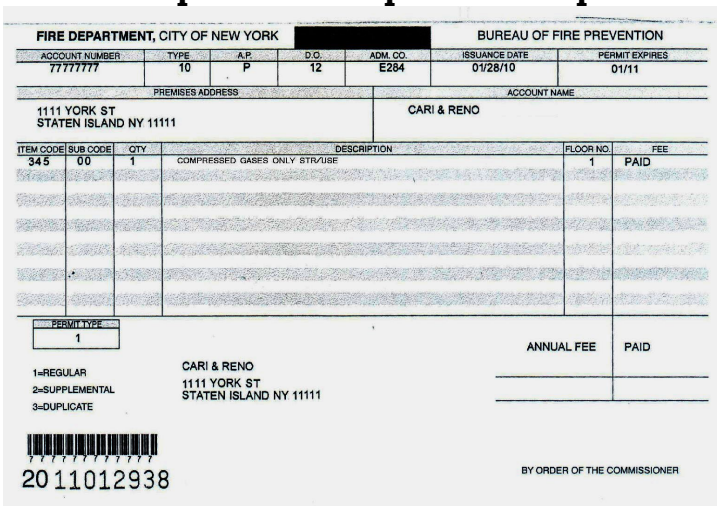
Please note that installations that were "lawfully" existing prior to July 1, 2008 but not under the purview of the FDNY (no FDNY permit established) may be considered "pre-existing" installations provided they were in compliance with nationally recognized standards and the NYC Building Code at the time of installation. More often than not most "pre-existing" installations will be storing nonflammable compressed gases/cryogenic fluids in quantities exceeding the maximum allowable quantities set forth in the new code. In these cases, the maximum allowable quantity (MAQ) of nonflammable compressed gases/cryogenic fluids would have to be established via the annual inventory form required by New York State General Municipal Law Section 209-u and/or the annual Facility Inventory Form filed with NYCDEP (Tier II).

On the other hand, **both new and pre-existing installations are required to comply with the <u>operational and maintenance requirements</u> of the 2008 Fire Code.** Operational and maintenance requirements include such things as permits, certificate of fitness, signage, housekeeping, periodic testing and portable fire extinguishers.

**FDNY Permits**

Such permit authorizes the permit holder to store, handle and use non-compressed gases/cryogenic fluids at a specific premises or location. A site-specific permit may be a permanent permit or a temporary permit. Permanent permits are valid for 12 months only. Every permit or renewal shall require an inspection and shall expire after twelve months. Temporary permits may be valid from one day to 12 months depending on the construction/operation needed. For example, a 3-month temporary permit may be issued to a hospital using a temporary oxygen trailer to supply emergency oxygen via the EOSC when the main bulk oxygen system is under repair. The truck or trailer that will be supplying oxygen via this connection, in addition to requiring a FDNY transportation (HCVIU) permit, will require a site-specific temporary permit if the amount of the oxygen exceeds 50 gallons of liquid oxygen or 504 SCF of gaseous oxygen. The temporary permit is for the additional storage and use of oxygen.

**An example of FDNY permanent permit**



FIRE DEPARTMENT, CITY OF NEW YORK — BUREAU OF FIRE PREVENTION

| ACCOUNT NUMBER | TYPE | A.P. | D.O. | ADM. CO. | ISSUANCE DATE | PERMIT EXPIRES |
|---|---|---|---|---|---|---|
| 77777777 | 10 | P | 12 | E284 | 01/28/10 | 01/11 |

PREMISES ADDRESS: 1111 YORK ST, STATEN ISLAND NY 11111

ACCOUNT NAME: CARI & RENO

| ITEM CODE | SUB CODE | QTY | DESCRIPTION | FLOOR NO. | FEE |
|---|---|---|---|---|---|
| 345 | 00 | 1 | COMPRESSED GASES ONLY STR/USE | 1 | PAID |

PERMIT TYPE: 1 (1=REGULAR, 2=SUPPLEMENTAL, 3=DUPLICATE)

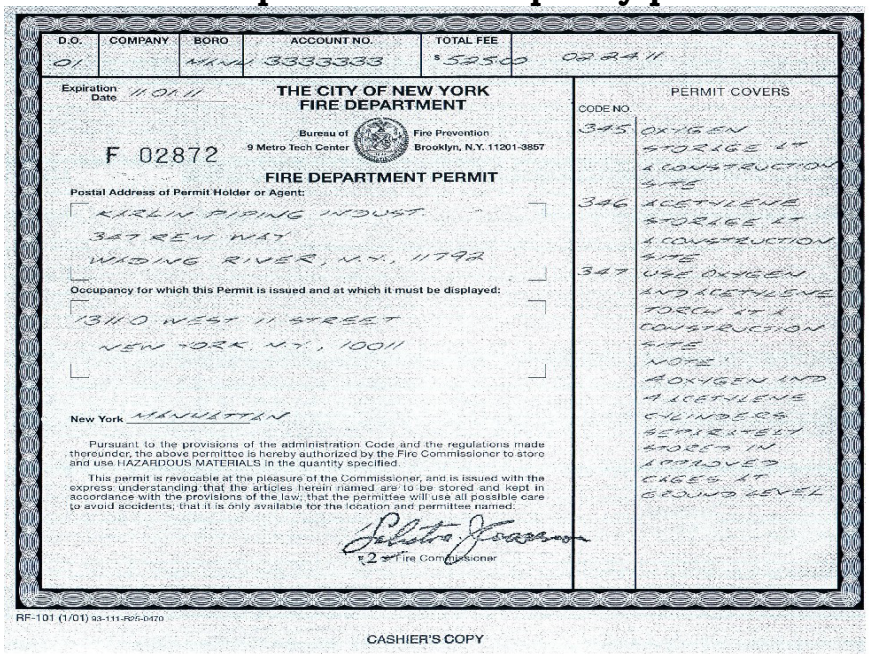
CARI & RENO
1111 YORK ST
STATEN ISLAND NY 11111

ANNUAL FEE — PAID

20 11012938

BY ORDER OF THE COMMISSIONER

**An example of FDNY temporary permit**



| D.O. | COMPANY | BORO | ACCOUNT NO. | TOTAL FEE | |
|---|---|---|---|---|---|
| 01 | | MANH | 3333333 | $525.00 | 02 24 11 |

Expiration Date: 11 04 11

THE CITY OF NEW YORK
FIRE DEPARTMENT
Bureau of Fire Prevention
9 Metro Tech Center Brooklyn, N.Y. 11201-3857

F 02872

FIRE DEPARTMENT PERMIT

Postal Address of Permit Holder or Agent:
KARLIN PIPING INDUST.
347 REN WAY
WILDING RIVER, N.Y. 11792

Occupancy for which this Permit is issued and at which it must be displayed:
1310 WEST 11 STREET
NEW YORK, N.Y., 10011

New York MANHATTEN

Pursuant to the provisions of the administration Code and the regulations made thereunder, the above permittee is hereby authorized by the Fire Commissioner to store and use HAZARDOUS MATERIALS in the quantity specified.

This permit is revocable at the pleasure of the Commissioner, and is issued with the express understanding that the articles herein named are to be stored and kept in accordance with the provisions of the law; that the permittee will use all possible care to avoid accidents; that it is only available for the location and permittee named.

Fire Commissioner

PERMIT COVERS

| CODE NO. | |
|---|---|
| 345 | OXYGEN STORAGE AT A CONSTRUCTION SITE |
| 346 | ACETYLENE STORAGE AT A CONSTRUCTION SITE |
| 347 | USE OXYGEN AND ACETYLENE TORCH AT A CONSTRUCTION SITE |

NOTE: OXYGEN AND ACETYLENE CYLINDERS SEPARATELY STORED IN APPROVED CAGES AT GROUND LEVEL

RF-101 (1/01) 93-111-R05-0420

CASHIER'S COPY

Permits are not transferable and any change in occupancy, operation, tenancy or ownership must require that a new permit be issued. The Certificate of Fitness holder is responsible for making sure that all fire safety regulations and procedures are obeyed on the premises. Permits and Certificates of Fitness shall be readily available on the premises for inspection by Fire Department representatives.

A permit is required to store, handle or use the following **compressed gases** in excess of the amount listed below:

Table 1-1. Quantities requiring permit

| **Compressed Gases** | |
|---|---|
| **Type of Gas** | **Amount (SCF)** |
| Carbon dioxide | 4,500 |
| Nonflammable and non-oxidizing | 3,000 |
| Oxidizing | 504 |

A permit is also required to manufacture, store, handle or use, including dispensing, **cryogenic fluids** in excess of the amounts listed in Table 1-2.

Table 1-2. Quantities requiring permit

| **PERMIT AMOUNTS FOR CRYOGENIC FLUIDS TYPE OF CRYOGENIC FLUID** | **INDOORS (gallons)** | **OUTDOORS (gallons)** |
|---|---|---|
| Nonflammable and non-oxidizing | 60 | 100 |
| Oxidizing | 10 | 50 |

**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.

### 1.3 Safety Data Sheets (SDS)

Safety Data Sheet (SDS) information should be readily available. The safety data sheet (SDS) contains specific information about the health and physical hazards of the material used, as well as safe work practices and required protective equipment. It may also describe the material's physical characteristics and procedures that should be followed in case of an emergency. For example, the SDS may list appropriate and inappropriate extinguishing agents. The Certificate of Fitness holder must refer to the SDS when questions arise about how to handle, use, or store hazardous chemicals or materials. The SDS may also be requested by health care personnel to facilitate proper medical care in the event of chemical exposure.

### 1.4 NFPA 704 Diamond Sign Explanation

The *transport* of hazardous materials is accompanied by the use of US DOT compliant placards and labels to assist identification of hazardous materials on

the roadway, railway, waterway and in the air. In a similar manner the *storage, handling and use* of hazardous materials is accompanied in the Fire Code by a requirement for the use of consistent signage to alert people, including first responders, to the presence of hazardous materials in a facility. The intent of the signage is to provide an indication of both the *type* of hazardous material present and the relative *degree of harm* that the material may pose. This simplistic 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.

**NFPA Rating Explanation Guide**

| RATING NUMBER | HEALTH HAZARD | FLAMMABILITY HAZARD | INSTABILITY HAZARD |
|---|---|---|---|
| 4 | Can be lethal | Will vaporize and readily burn at normal temperatures | May explode at normal temperatures and pressures |
| 3 | Can cause serious or permanent injury | Can be ignited under almost all ambient temperatures | May explode at high temperature or shock |
| 2 | Can cause temporary incapacitiation or residual injury | Must be heated or high ambient temperature to burn | Violent chemical change at high temperatures or pressures |
| 1 | Can cause significant irritation | Must be preheated before ignition can occur | Normally stable. High temperatures make unstable |
| 0 | No hazard | Will not burn | Stable |

| RATING SYMBOL | SPECIAL HAZARD |
|---|---|
| ALK | Alkaline |
| ACID | Acidic |
| COR | Corrosive |
| OX | Oxidizing |
| | Radioactive |
| 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*

The basis of the system is a diamond-shaped sign that is divided into four color-coded quadrants (see left figure below). The left-most quadrant is colored blue and represents the *health* hazard posed by the material. 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 hazardous materials are stored, handled and used, and on stationary containers and aboveground tanks containing hazardous materials. Note that the sign requirement also applies to locations at which a hazardous material is 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, fire and reactivity). A number is placed in each box, specific to the material at hand. In

each quadrant, a “0” represents the least concern 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 above). Intermediate numbers represent increasing levels of hazard in all categories, such as the “3” that is present in the “health” quadrant of the right figure above. This is indicative of a material that can cause permanent or serious injury upon exposure.

## 2. DEFINITION

**ABSOLUTE ZERO.** Temperature at which all molecular motion, and consequently all life, ceases 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.

**ATMOSPHERIC TANK.** 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.

**AREA ALARM SYSTEM.** A warning system within an area of use that provides continuous visible and audible surveillance of Level 1 and Level 2 medical gas systems.

**BULK NITROUS OXIDE SYSTEM.** An assembly of equipment as described in the definition of bulk oxygen system that has a storage capacity of more than 3200 lb [approximately 28,000 $ft^3$ (at normal temperature and pressure)] of nitrous oxide.

**BULK OXYGEN SYSTEM.** An assembly of equipment such as oxygen storage containers, pressure regulators, pressure relief devices, vaporizers, manifolds, and interconnecting piping that has a storage capacity of more than 20,000 $ft^3$ of oxygen (at normal temperature and pressure) including unconnected reserves on hand at the site.

**COMPRESSED GAS.** A material, or mixture of materials that is a gas at 68°F or less at 14.7 psia of pressure; and has a boiling point of 68°F or less at 14.7 psia that is either liquefied, nonliquefied or in solution at that temperature and pressure, except that gases which have no other health- or physical-hazard properties are not considered to be compressed until the pressure in the packaging exceeds 41 psia at 68°F. Compressed gases shall be classified as follows:

**Nonliquefied compressed gases.** Gases, other than those in solution, that are in a packaging under the charged pressure and are entirely gaseous at a temperature of 68°F.

**Liquefied compressed gases.** Gases that, in a packaging under the charged pressure, are partially liquid at a temperature of 68°F.

**Compressed gases in solution**. Nonliquefied gases that are dissolved in a solvent.

**Compressed gas mixtures**. A mixture of two or more compressed gases contained in a single packaging, the hazard properties of which are represented by the properties of the mixture as a whole.

**COMPRESSED GAS CONTAINER.** A pressure container designed to hold compressed gases at pressures greater than one atmosphere at 68°F.

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

**CONTAINER.** For solid and liquid hazardous materials, a vessel of 60 gallons or less in capacity used for storage or transportation. For compressed gases, a cylinder, pressure vessel or tank designed for pressures greater than one atmosphere at 68°F. Pipes, piping systems, engines and engine fuel tanks associated with solid or liquid hazardous materials or compressed gases, shall not be deemed to be containers if in active use.

**CONTAINMENT SYSTEM.** A gas-tight recovery system comprised of devices or equipment which, when placed over or around the portion of the compressed gas container that is leaking, stops or controls the escape of gas from the container.

**CONTAINMENT VESSEL.** A gas-tight vessel which, when installed or placed over or around a leaking compressed gas container, confines the container and the gas leaking therefrom.

**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 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 FLUID.** 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 cryogenic fluid.**

**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.

**EMERGENCY OXYGEN SUPPLY CONNECTION.** An assembly of equipment which permits a gas supplier to make a temporary connection to supply oxygen to a building which has had its normal source of oxygen disconnected.

**EXCESS FLOW VALVE.** A valve inserted into a compressed gas container that is designed to shut off the flow of gas in the event that its predetermined flow is exceeded.

**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.

**EXHAUSTED ENCLOSURE.** A device, typically consisting of a hood equipped with a fan that serves to capture and exhaust fumes, mist, vapors and gases generated at a workstation or other local environment. An exhausted enclosure does not include a room provided with general ventilation.

**FLAMMABLE GAS.** A material which is a gas at 68°F or less at 14.7 pounds per square inch absolute (psia) of pressure which:

1. Is ignitable at 14.7 psia when in a mixture of 13 percent or less by volume with air, in accordance with testing procedures set forth in ASTM E 681; or
2. Has a flammable range at 14.7 psia with air of at least 12 percent, regardless of the lower limit, in accordance with testing procedures set forth in ASTM E 681.

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

**GAS ROOM.** A separately ventilated, fully enclosed room in which only compressed gases 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.

**GAS CABINET.** A fully enclosed, noncombustible enclosure used to provide an isolated environment for compressed gas containers in storage or use, including any doors and access ports for exchanging containers and accessing pressure-regulating controls.

**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.

**LEVEL 1 MEDICAL PIPED GAS AND VACUUM SYSTEMS (NFPA 99 of 2005).** Systems serving occupancies where interruption of the piped medical gas and vacuum system would place patients in imminent danger of morbidity or mortality.

**LEVEL 2 MEDICAL PIPED GAS AND VACUUM SYSTEMS (NFPA 99 of 2005).** Systems serving occupancies where interruption of the piped medical gas and vacuum system would place patients at manageable risk of morbidity or mortality.

**LEVEL 3 COMPRESSED AIR SYSTEM (NFPA 99 of 2005).** A system of component parts, including, but not limited to, air compressor, motor, receiver, controls, filters, dryers, valves, and piping, that delivers compressed air <1100 kPa (<160 psi gauge) to power devices (hand pieces, syringe, cleaning devices, etc.) as a power source.

**LEVEL 3 PIPED GAS SYSTEMS (NFPA 99 of 2005).** Systems serving occupancies where interruption of the piped medical gas would terminate procedures but would not place patients at risk of morbidity or mortality.

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

**LOCAL ALARM SYSTEM.** A warning system that provides continuous visible and audible surveillance of medical gas and vacuum system source equipment at the equipment site.

**LOW-PRESSURE CONTAINER.** A storage container designed to withstand an internal pressure greater than 0.5 pounds per square inch gauge (psig) (3.4 kPag) but not greater than 15 psig (103.4 kPag).

**MANIFOLD.** A device for connecting the outlets of one or more gas cylinders to the central piping system for that specific gas.

**MASTER ALARM SYSTEM.** A warning system that monitors the operation and condition of the source of supply, the reserve source (if any), and the pressure in the main lines of each medical gas and vacuum piping system.

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

**MEDICAL GAS SYSTEM.** An assembly of equipment and piping for the distribution of nonflammable medical gases such as oxygen, nitrous oxide, compressed air, carbon dioxide, and helium.

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

**NONFLAMMABLE GAS.** A gas that does not meet the definition of a flammable gas.

**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.

**PIPE AND TUBE.** Pipes are used to transport something, and tubes to construct something; hence, tubes are defined by the od (outside diameter) and wt (wall thickness) for construction stability, and pipes by id (inside diameter) to allow a calculation for transportation, eg, speed, volumes, etc. (od = id + 2(wt))

**PORTABLE TANK.** 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.

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

**REDUCED FLOW VALVE.** A valve equipped with a restricted flow orifice and inserted into a compressed gas container that is designed to reduce the maximum flow from the valve under full-flow conditions. The maximum flow rate from the valve is determined with the valve allowed to flow to atmosphere with no other piping or fittings attached.

**SITE OF INTENTIONAL EXPULSION**. All points within 1 ft of a point at which an oxygen-enriched atmosphere is intentionally vented to the atmosphere. This definition addresses the site of intended expulsion. Actual expulsion can occur at other sites remote from the intended site due to disconnections, leaks, or

rupture of gas conduits and connections. Vigilance on the part of the patient care team is essential to ensure system integrity.

For example, for a patient receiving oxygen via a nasal cannula or face mask, the site of expulsion normally surrounds the mask or cannula; for a patient receiving oxygen while enclosed in a canopy or incubator, the site of intentional expulsion normally surrounds the openings to the canopy or incubator; for a patient receiving oxygen while on a ventilator, the site of intentional expulsion normally surrounds the venting port on the ventilator.

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

**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.

## 3. GENERAL REQUIREMENTS

A medical gas system is an assembly of equipment and piping for the distribution of medical gases. The G-71 Certificate of Fitness holder must be familiar with the safety regulations for piped medical gas systems.

### 3.1 Identification and Labeling

3.1.1 Labels on compressed gas containers

The contents of any compressed gas container must be clearly identified. Portable compressed gas containers shall be marked in accordance with CGA C-7 and DOTn regulations. Gas identification should be stenciled or stamped on the container or a label, and is typically applied near the neck of the container.

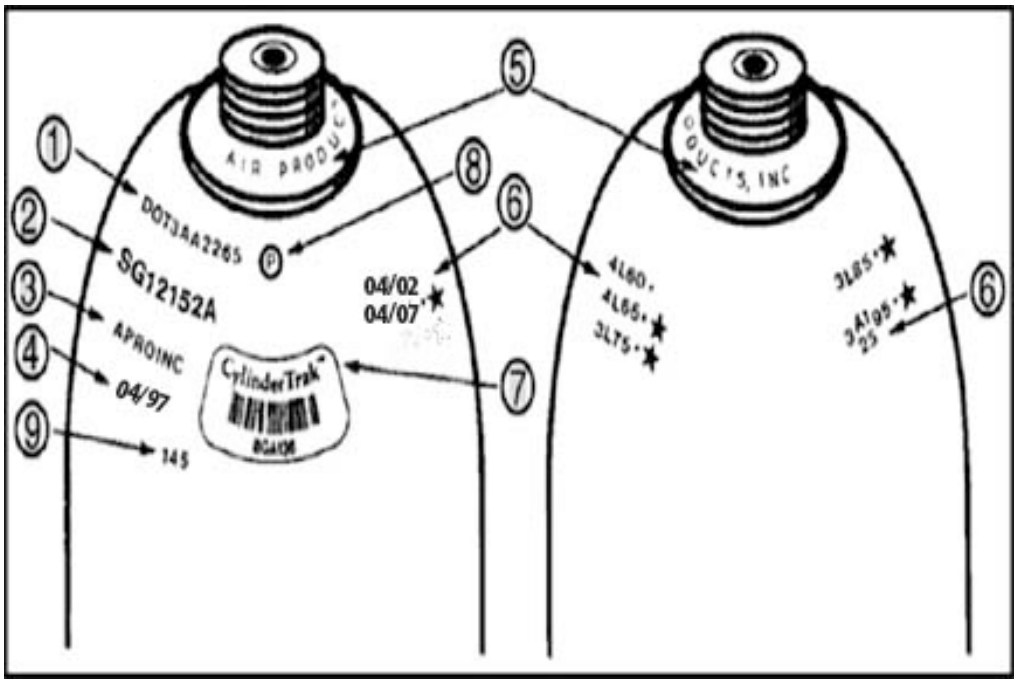
Although there is common color coding for medical gas containers, you **should NOT rely solely on the color of the container to identify the contents.** However, if you receive a gas container where **the label of the content is not consistent with the common color coding, you should always consult with the supplier before using the container.**

| Gas | Color |
|---|---|
| Oxygen | Green |
| Carbon Dioxide | Grey |
| Medical Air | Yellow |
| Nitrogen | Black |
| Nitrous Oxide | Blue |
| Helium | Brown |
| He-$O_2$ | Brown and Green |

All labels shall not be defaced, altered, or removed, and connecting fittings shall not be modified. Contents of compressed gas container and cryogenic liquid containers must be verified prior to use**. Do not use any container that is unmarked or has conflicting marking or labels.**

Stationary compressed gas containers must be marked with the name of the gas. Markings shall be visible from any direction of approach. All uninsulated stationary outdoor compressed gas containers shall be of light-reflective design or painted with a light-reflecting color.

Any out-of-service compressed gas container shall be marked to indicate that they are no longer available for service.




1. DOT or ICC (prior to 1968) identification number - ex. DOT3AA2265. This identifies the cylinder material and the service pressure in psi.
2. Cylinder serial number - ex. SG12152A. The letters "SG" may precede the serial number to indicate a specialty gas cylinder.
3. Original owner of the cylinder - ex. APROINC
4. Date of maintenance to indicate the original hydrostatic test (month/year).
5. Current owner of the cylinder will appear on the neck ring.
6. Retest markings (month, facility, year, rating, stamp). A "+" indicates the cylinder qualified for a 10 percent overfill. A star stamp on the end of the marking indicates the cylinder meets the requirements for a 10-year retest.
7. CylinderTrak bar code provides a unique identifier and is used by computer systems to track cylinders through the filling process.
8. Cylinder manufacturer's inspection marking, which is unique to the inspector.
9. Cylinder tare weight, i.e. the weight of the cylinder plus the valve without product, preceded by the letters "TW".

***USP-NF tag***

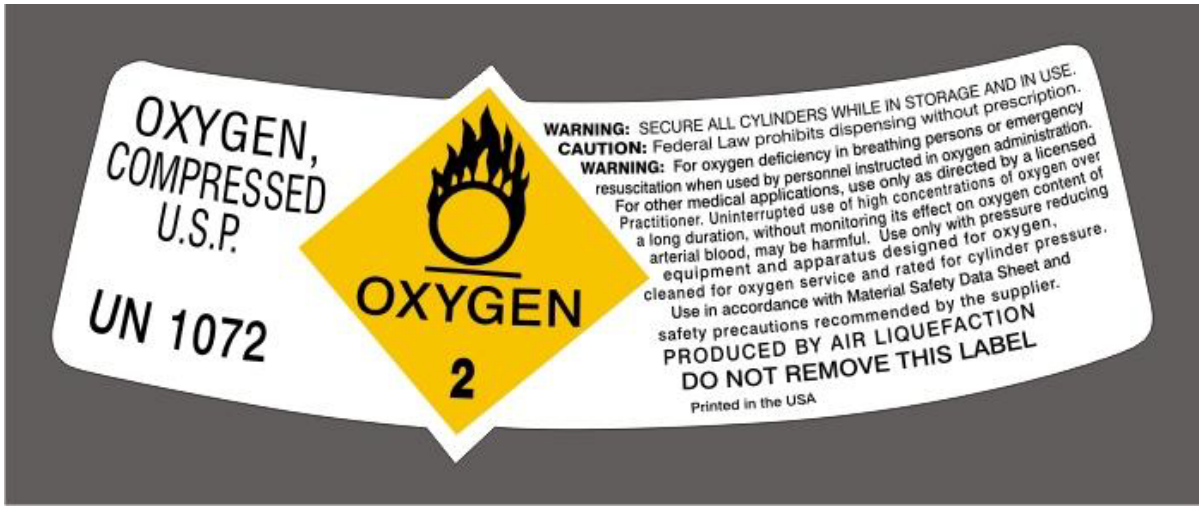
The U.S. Federal Food, Drug, and Cosmetics Act designates the USP–NF (Unitied States Pharmacopoeia- National Formulary) as official compendia for drugs marketed in the United States. A drug product in the U.S. market must conform to the standards in USP–NF to avoid possible charges of adulteration and misbrand. To be labeled Oxygen, USP, the gas cylinder must contain a documented minimum of 99.0 percent oxygen by volume and be odor free. The label must also specify whether the oxygen gas was produced by the fractional distillation of air (also called air-liquefaction process) or other means. If

produced from liquid air, then the cylinder contents may be labeled USP without an analysis for either carbon dioxide ($CO_2$) or carbon monoxide (CO).

In general, medical gases that must meet the USP-NF standards include:
- Oxygen- USP
- Nitrogen-NF
- Helium- USP
- Air – USP
- Carbon Dioxide – USP
- Nitrous Oxide – USP

Example of Nitrogen-NF tag


Gas supply vendors typically maintained two separate storage facilities for oxygen: " welding or industrial or technical" (a non-USP, or illegal to sell for human consumption label) variety and gas intended for human use in respirators or medical procedures (a USP label). Since most gas supply vendors have decided that it is simply not cost-effective to store separate grades of medical gases, almost all oxygen sold in the US is a USP grade (meets USP requirements for human consumption). However, there are distinct differences in how the cylinders are filled. (see below). So, the debate as to whether to use a non-USP welding gas or a USP medical grade oxygen for diving is mostly irrelevant since most vendors are now filling all cylinders with USP gas.



The label designates the following:

**Oxygen, Compressed USP**

This cylinder contains compressed oxygen gas that meets the purity standards for human use as defined by the United States Pharmacopoeia (USP).

**UN 1072**

The DOT chemical compound identification number is 1072. This is a reference to the Safety Data Sheet (SDS) which lists physical properties, special handling precautions, chemical reactivity, health hazards, waste disposal and transportation requirements for the cylinder contents. (US OSHA regulations mandate that all chemicals sold in the US be accompanied by an SDS to facilitate safety when handling purchased chemical materials.)

**Yellow Diamond**

This is a reference symbol established by the National Fire Protection Agency (NFPA) to quickly identify the nature of potential hazards associated with the chemical contents of a container. The yellow color implies the contents may contribute to substantial releases of energy. This symbol contains the name of the chemical, Oxygen, and identifies it as a combustion hazard (the fire symbol) with a relative danger of 2 (of 4 possible). The relative danger of 2 suggests a potential of violent combustion, an increased fire threat typically without immediate detonation.

**Contents**

This blank allows the vendor to specify volume of contents contained within the cylinder at the time of filling.

**Warning**

This is this the legal consumer product safety warning. Notice that this label allows filling of emergency-only cylinders without prescription,

**Produced by Air Liquefaction**

Identifies the method of manufacturer that exempts contents from required-for-USP-label carbon dioxide or carbon monoxide analysis.

**Warning**

Specific hazards associated with the chemical nature of oxygen. The Chemical Abstracts Service (CAS, a chemical organization that abstracts all published chemical journals, as well as assigning unique numbers to all chemicals known as they are discovered) identification number for oxygen (CAS 778244-7) is also provided as a reference to the chemical and physical properties of the cylinder contents. The caution to use in accordance to the SDS refers to a reference document (the Oxygen SDS furnished by the manufacturer) that lists known concerns about the safety issues associated with handling the contents of the cylinder.

**Do Not Remove**

FDA requires that drugs always be properly labeled such that the contents are readily identifiable.

3.1.2 Markings on cryogenic containers and systems

Stationary and portable cryogenic containers shall be clearly marked with the name of the cryogenic fluid contained therein. Stationary aboveground cryogenic containers shall be placarded as set forth in NFPA 704. Portable cryogenic containers shall be identified in accordance with CGA C-7.

Stationary cryogenic containers shall be identified with a permanent nameplate indicating the manufacturing specification and maximum allowable working pressure (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 DOTn regulations as set forth in 49 CFR Part 178.

Stationary cryogenic containers shall be identified with a nameplate indicating the MAWP.


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. Where a schematic drawing is provided, it shall be permanently attached to the cryogenic container and maintained in a legible condition. **Emergency shutoff valves shall be identified by posting a durable sign at a conspicuous location at or near the valve.**

3.1.3 Markings on medical piping systems

**Medical gas piping shall be color coded using the NFPA 99 standard and shall not be painted for matching the wall painting.** 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 **direction of flow**. Markings shall be provided at **each valve**; at **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**.


Where positive pressure gas piping systems operate at pressures other than the standard gauge pressure, the pipe labeling shall include the operating pressure in addition to the name of the gas.

When vented outside, relief valve vent lines shall be labeled in any manner that will distinguish them from the medical gas pipeline.

3.1.4 Labels on valves.

All valves except valves in zone valve box assemblies shall be located in secured areas such as locked piped chases, or be locked or latched in their operating position, and be labeled as to gas supplied and the area(s) controlled.

Shutoff valves shall be identified as follows:

(1) The name or chemical symbol for the specific medical gas or vacuum system

(2) The room or areas served

(3) A caution to not close or open the valve except in emergency

Where positive pressure gas piping systems operate at pressures other than the standard gauge pressure of 50 psi to 55 psi or a gauge pressure of 160 psi to 185 psi for nitrogen or instrument air, the valve identification shall also include the nonstandard operating pressure.

*A. Source valves*


Source Valve is a shutoff valve shall be placed at the immediate connection of each source system to the piped distribution system to permit the entire source, including all accessory devices (e.g., air dryers, final line regulators, etc.), to be isolated from the facility. The source valve shall be located in the immediate vicinity of the source equipment.

Source valves should be labeled in substance as follows:

**SOURCE VALVE**
**FOR THE (SOURCE NAME).**

*B. Main line valves*


Main Line Valve is a shutoff valve shall be provided in the main supply line inside of the building, except where one or more of the following conditions exist:

(1) The source and source valve are located inside the building served.

(2) The source system is physically mounted to the wall of the building served and the pipeline enters the building in the immediate vicinity of the source valve.

The main line valve shall be located to permit access by authorized personnel only (i.e., by locating above a ceiling or behind a locked access door). It shall be located on the facility side of the source valve and outside of the source room, enclosure, or where the main line first enters the building.

Main line valves should be labeled in substance as follows:

**MAIN LINE VALVE FOR THE**
**(GAS/VACUUM NAME) SERVING THE**
**(NAME OF THE BUILDING).**

*C. Riser valve(s)*

Each riser supplied from the main line shall be provided with a shutoff valve in the riser adjacent to the main line.Riser valves shall be permitted to be located above ceilings, but shall remain accessible and not be obstructed.

Riser valve(s) should be labeled in substance as follows:

**RISER FOR THE (GAS/VACUUM NAME)**
**SERVING (NAME OF THE AREA/BUILDING**
**SERVED BY THE PARTICULAR RISER).**

*D. Service valve(s)*

Service valves shall be installed to allow servicing or modification of lateral branch piping from a main or riser without shutting down the entire main, riser, or facility. Only one service valve shall be required for each branch off of a riser regardless of how many zone valve boxes are installed on that lateral. These valves shall be placed in the branch piping prior to any zone valve box assembly on that branch.

Service valves shall be located according to any one of the following:

(1) Behind a locked access door
(2) Locked open above a ceiling
(3) Locked open in a secure area

Service valve(s) should be labeled in substance as follows:

**SERVICE VALVE FOR THE**
**(GAS/VACUUM NAME) SERVING**
**(NAME OF THE AREA/BUILDING**
**SERVED BY THE PARTICULAR VALVE).**

*E. Zone valve(s)*

All station outlets/inlets shall be supplied through a zone valve as follows:

(1) The zone valve shall be placed such that a wall intervenes between the valve and outlets/inlets that it controls.
(2) The zone valve shall serve only outlets/inlets located on that same story.

Zone valves shall be readily operable from a standing position in the corridor on the same floor they serve. These valves shall be so arranged that shutting off the supply of medical gas or vacuum to one zone will not affect the supply of medical gas or vacuum to another zone or the rest of the system. A pressure/vacuum indicator shall be provided on the station outlet/inlet side of each zone valve.

Zone valve boxes shall be installed where they are visible and accessible at all times. A zone valve shall be located immediately outside each vital life-support, critical care, and anesthetizing location in each medical gas and/or vacuum line, and located so as to be readily accessible in an emergency.

All gas-delivery columns, hose reels, ceiling tracks, control panels, pendants, booms, or other special installations shall be located downstream of the zone valve. Zone valves shall be so arranged that shutting off the supply of gas to any one operating room or anesthetizing location will not affect the others.

Zone valve(s) should be labeled in substance as follows:

**ZONE VALVE FOR THE**
**(GAS/VACUUM NAME) SERVING**
**(NAME OF THE AREA/BUILDING**
**SERVED BY THE PARTICULAR VALVE).**

*F. In-line Valve(s)*

Optional in-line valves shall be permitted to be installed to isolate or shut off piping for servicing of individual rooms or areas. In-line shutoff valves intended for use to isolate piping for maintenance or modification should meet the following requirements:

(1) Be located in a restricted area
(2) Be locked or latched open
(3) Be labeled in substance as follows:

**In-line VALVE FOR THE**
**(GAS/VACUUM NAME) SERVING**
**(NAME OF THE AREA/BUILDING**
**SERVED BY THE PARTICULAR VALVE).**

## 3.2 Compressed Gas Containers

Compressed gas containers shall be designed and fabricated in accordance with the FDNY requirements. Compressed gas containers that are not designed for refillable use shall not be refilled after use of the original contents. **Partially full compressed gas containers containing residual gases shall be considered as full for the purposes of the controls required.**

Areas used for the storage, handling and use of compressed gas containers and systems shall be **provided with approved lighting by natural or artificial means**. Compressed gas containers and systems shall not be used for any purpose other than as a vessel for the materials that they are designed to contain.

3.2.1 Container Protection

Compressed gas containers and systems shall be secured and protected against physical damage and tampering. Compressed gas containers and systems that could be exposed to physical damage shall be protected. Posts or other approved means shall be provided to protect compressed gas containers and systems indoors and outdoors from vehicular damage. Never use the containers as rollers, supports, or for any purpose other than to contain the content as received.

Compressed gas containers are allowed to be stored or used in direct sun except in locations where extreme temperatures prevail. Containers shall be protected from direct contact with soil or unimproved surfaces to prevent bottom corrosion. The surface of the area upon which the containers are placed shall be graded to prevent accumulation of water. When extreme temperatures prevail, overhead covers shall be provided. Overhead covers shall also be provided to prevent accumulations of ice and snow on the valves of containers connected for use.

(1) Securing containers

Compressed gas containers shall be secured to prevent movement from contact, vibration or seismic activity, utilizing one or more of the following methods:

1. Securing containers to a fixed object with one or more noncombustible restraints. Containers shall not be secured to plumbing systems or electrical conduits.
2. Securing containers on a cart or other mobile device designed for the movement of compressed gas containers.
3. Securing of compressed gas containers to or within a rack, framework, cabinet or similar assembly designed for such use, except when the containers are in the process of examination, filling, transport or servicing.
4. Securing stationary compressed gas containers to a foundation designed for such use in accordance with the construction codes, including the Building Code.
5. Nesting of compressed gas containers is NOT allowed in medical facilities.

Securing containers on a cart designed for the movement of the type of the containers.

(2) Valve protection

Compressed gas containers designed to be fitted with protective caps, collars or other protective devices shall have such caps or devices in place except when the containers are in use or are being serviced. Valves of compressed gas containers

designed to accept protection caps or other protective devices shall have such caps or devices attached. Outlet caps or plugs shall be in place except when the compressed gas containers are in use or are being serviced. Keep container valve closed at all times, except when the container is in active use.

(3) Regular Inspection

The Certificate of Fitness holder must regularly inspect the compressed gas containers, connections, and appliances for leaks. The damaged containers must be removed from service.

Items for quick visual check:

- No extreme denting, gouging, or corrosion on the compressed gas container.
- The container protective cap/collar and the foot ring are intact and are firmly attached where applicable.
- The container is painted or coated to minimize corrosion.
- No damage is visible in the pressure relief valve or obstruction to discharge.
- There is no leakage from the compressed gas container.
- The container is installed on a firm foundation and is not in contact with the soil.

Notify permit holder if any condition has occurred which might allow any foreign substance to enter the gas container or valve. No service, repair, modification or removal of valves, pressure-relief devices or other compressed gas container appurtenances are allowed to be performed by unauthorized personnel. Leaking, damaged or corroded compressed gas containers shall be removed from service under the personal supervision of a G-71 certificate of fitness holder.

3.2.2 Related Equipment of Compress Gas Containers and Piped Gas Systems

Piping, hose, fittings and other equipment that comes in contact with the compressed gases shall be metallic, certified by the manufacturer as suitable for the compressed gas use and for the operating temperature and maximum operating pressure of the gas system.

Valves, pressure regulators and pressure relief devices shall be suitable for the compressed gas use and rated for the operating temperature and maximum operating pressure of the compressed gas system.

(1) Control valve

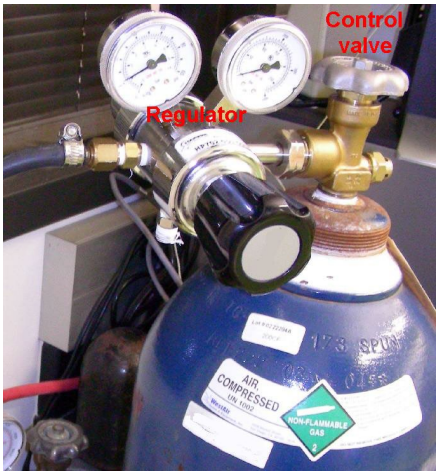
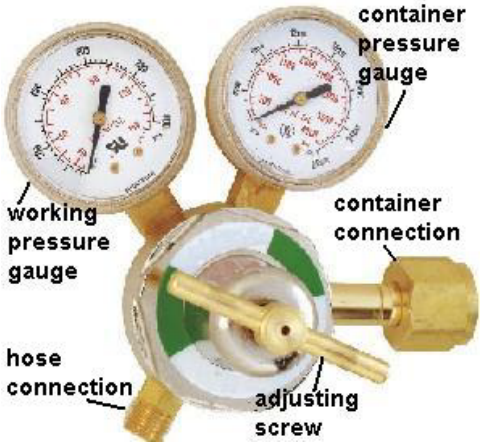
A control valve is on the top of each gas container. This valve can be opened or closed to control the discharge of the contents of the gas container. A handle is simply turned to open most gas control valve. **The control valve must be opened by hand.** Container valves shall be closed before moving a gas container.

(2) Regulator

**Before the gas containers can be used, a regulator must be attached to each of the control valves.** A regulator is one of the most important parts of a compressed gas system. The purpose of the regulator is to control the flow of gas and lower the pressure from the container to the appliance. The regulator

not only acts as a control regarding the flow and distribution of gas, but also as a safety barrier between the high pressure of the gas container and the end use appliance.

Always select the regulators recommended by the manufacturer. Do not interchange regulators between different sizes/types of container without consulting the manufacture. **Do not open the gas container valve or regulator tap until the regulator is securely attached**. Regulator connections to gas container valves must be completely free of dirt, dust, oil, and grease. The regulator controls the discharge rate of gas from the container. Examples of typical regulators are shown below.

| Control Valve and Regulator | A Typical Regulator of Oxygen Container |
|---|---|
|   |   |

(3) Pressure-Relief Devices

Pressure-relief devices shall be provided to protect containers and systems containing compressed gases from rupture in the event of overpressure from thermal exposure. Pressure relief valves and vent lines from pressure relief valves shall not be provided with shut off valves or other obstructions which could render such valves inoperable. The pressure-relief device shall have the capacity to prevent the maximum design pressure of the container or system from being exceeded. Vent lines from pressure relief valves shall be of such a size, length and arrangement so as not to interfere with the proper operation of the valves. The size of the vents of pressure relief devices shall be equal or larger in size than the pressure relief device outlet size.

Pressure-relief devices shall be arranged to discharge upward and unobstructed to the open air in such a manner as to prevent any impingement of escaping gas upon the container, adjacent structures, or personnel. Pressure relief devices shall discharge in a manner designed to prevent harm to the public or delivery person. This requirement shall not apply to DOTn specification containers having an internal volume of 2.0 SCF or less. Pressure-relief devices or vent piping shall be designed or located so that moisture cannot collect and freeze in a manner that would interfere with operation of the device.

(4) Hose, Piping and Valves

The regulator is also connected to a hose that supplies the gas to the appliance. This hose must be securely connected to the appliance. **Hoses must be as short as practical to protect hoses from damage**. When the gas containers are used inside buildings, the hose must not pass through any partitions, walls, ceilings, or floors.

Piping, tubing, pressure regulators, valves and other apparatus shall be kept gas tight to prevent leakage. Valves utilized on compressed gas systems shall be suitable for the material and temperature intended and shall be accessible. **Valve handles shall not be removed or otherwise altered to hinder operation**. In the United States, valve connections are referred to as "CGA connections," since the Compressed Gas Association (CGA) publishes guidelines on what connections to use for what products. It can make the user aware of the correct gas cylinder connections. The careless gas connection could easily be life-threatening mistakes in medical facilities (refer to appendix A)

Valves and piping components shall be suitable for the intended use at the temperatures of the application and shall be designed and constructed to withstand the maximum pressure at the minimum temperature to which they will be subjected. Valves shall be oriented so that the stem is above the horizontal plane and discharge is directed away from supporting elements.

## 3.3 Separation from Hazardous Conditions

Compressed gas containers and systems in storage or use shall be separated from materials and conditions that present potential hazards, or to which they present potential hazards.

(1) Combustible waste and vegetation.

Do not store compressed gas containers near flammable or combustible substances such as oil, gasoline or waste. A noncombustible partition, without openings or penetrations extending not less than 18 inches above the height of the tallest container or system piping and not less than 18 inches to the sides of the storage area is allowed in lieu of such distance. The wall shall either be an independent structure, or the exterior wall of the building adjacent to the storage area.

(2) Ledges, platforms and elevators.

Compressed gas 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**.

(3) Heating and temperature extremes

Compressed gas containers shall not be heated by devices that could raise the surface temperature of the container to above 125°F. Heating devices shall comply with the requirements of the Mechanical Code and the Electrical Code. Approved heating methods not capable of producing surface temperatures above 125°F are allowed to be used by trained personnel. Devices designed to maintain

individual compressed gas containers at constant temperature shall be approved and shall be designed to be fail-safe.

Compressed gas containers, whether full or partially full, shall not be exposed to temperatures exceeding 125°F, or below the mean low atmospheric temperatures unless designed for use under the exposed conditions. Many steels undergo decreased ductility at low temperatures.

(4) Falling objects.

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

(5) Exposure to chemicals.

Compressed gas containers and systems shall not be exposed to salt or corrosive chemicals or fumes that could damage containers, valves or protective caps.

(6) Wiring and equipment.

Compressed gas containers and systems shall not be located where they could become part of an electrical circuit. Compressed gas containers and systems shall not be used for electrical grounding.

(7) Incompatible materials.

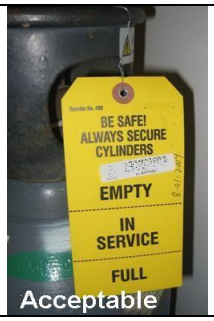
Compressed gas containers must be separated from the incompatible materials. Incompatible materials shall be separated while in storage or use except for stored materials in containers having a capacity of not more than 5 pounds or 0.5 gallon. Separation shall be accomplished by:

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.

## 3.4 Empty Containers and Return

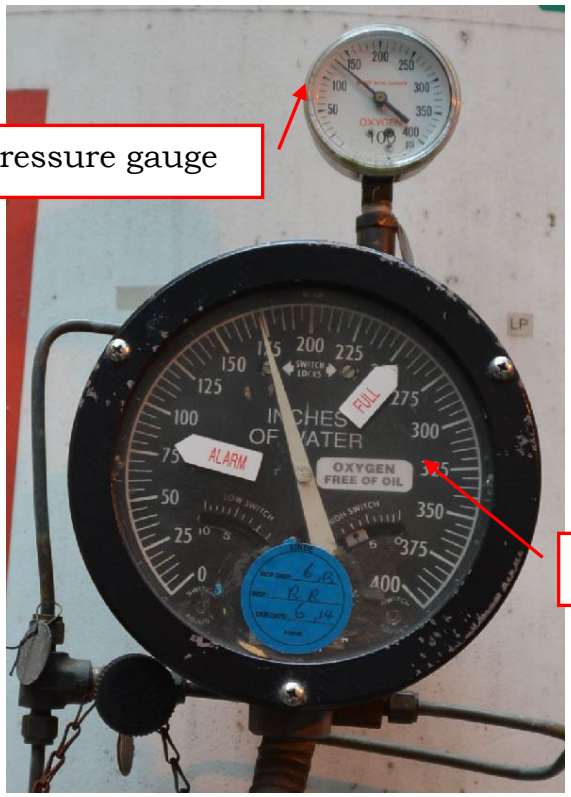
Before removing empty compressed gas containers from service, close the valve and ensure that the plugs and the protective caps, if used, are replaced. The empty containers should be labeled with the word “empty” or the abbreviation “MT” and the date. Always handle empty containers as carefully as full ones; residual pressure can be dangerous.

Examples of the gas container tag

| Container before use | Container in service | Empty container |
|---|---|---|
|  |  |  |

## 3.5 Cryogenic Container

Cryogenic containers shall not be used for any purpose other than as a container for the product that it is designed to contain. 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.




3.5.1 Devices

**(1) Pressure gauges.**

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 of the cryogenic container.

**(2) Liquid level indicating devices.**

Stationary 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.

**(3) Shutoff valves**

**Shutoff valves on cryogenic containers.** Shutoff valves shall be provided on all cryogenic container connections except for pressure relief devices. Shutoff valves shall not be installed between pressure relief devices and cryogenic containers. 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.

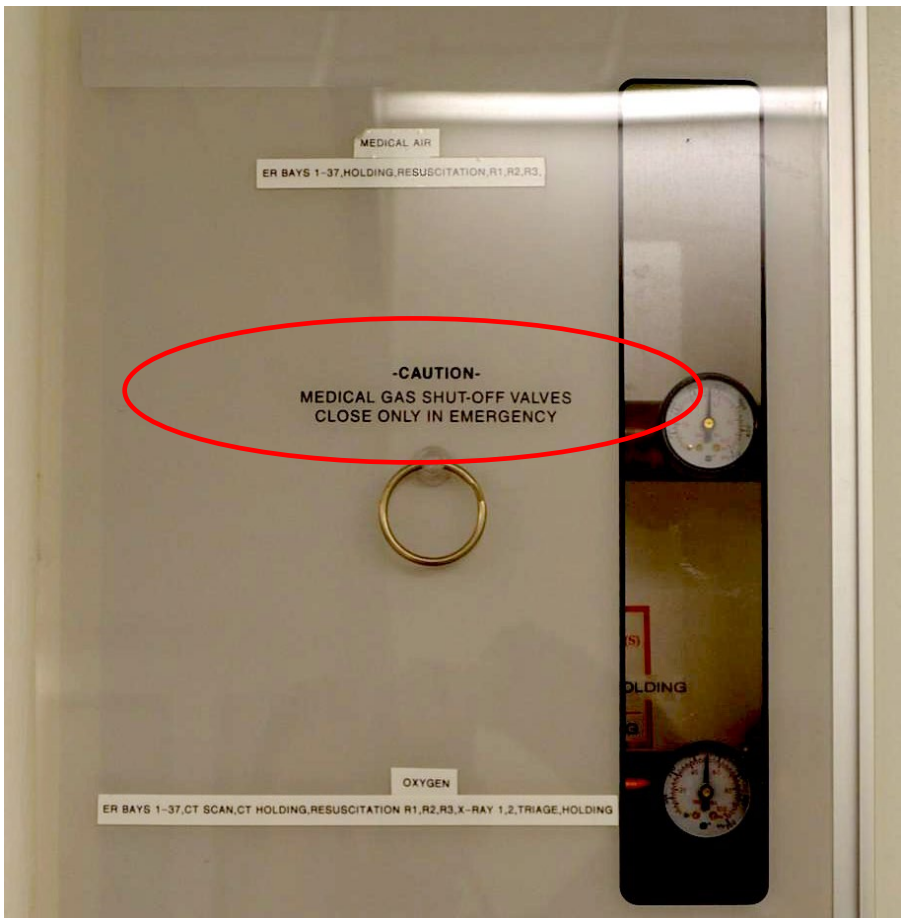
> **Exception:** A shutoff valve is allowed on cryogenic containers equipped with multiple pressure-relief devices where the design and arrangement of the valves provide sufficient relief capacity for the pressure relief devices to prevent the MAWP of the cryogenic container or system from being exceeded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

**Shutoff valves on piping.** 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. 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.

**(4) Emergency shutoff valves.**

Where the central supply is remote from the medical gas system use points, the main supply line shall be provided with a shutoff valve so located in the single treatment facility as to be accessible from use-point locations in an emergency. Where the supply is remote from a single treatment facility, the main supply line shall be provided with a shutoff valve so located in the single treatment facility as to be accessible from use-point locations in an emergency. Such valves shall be labeled to indicate the gas controlled and shall shut off only the gas to that single treatment facility.




Each riser supplied from the main line shall be provided with a shutoff valve adjacent to the riser connection. Riser valves shall remain accessible and shall not be obstructed.

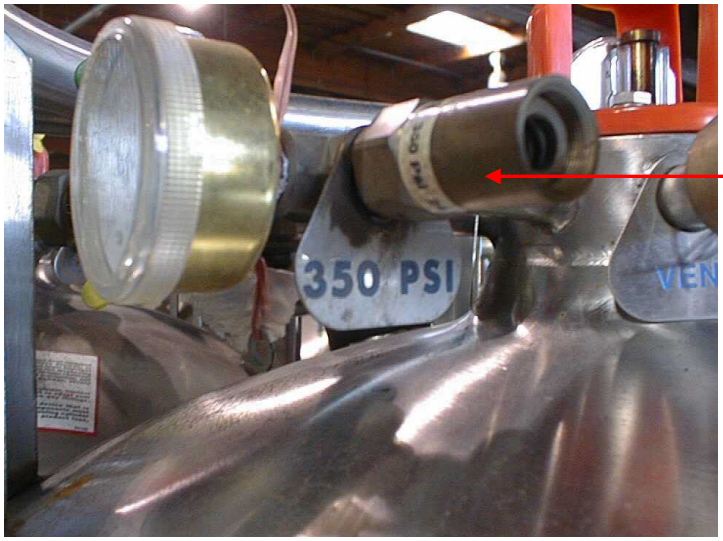
**All the emergency shutoff valves shall be clearly visible and readily accessible. A durable sign shall be conspicuously posted immediately adjacent to such valves to identify their location.**

### (5) Pressure relief devices

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 devices. Pressure relief devices are to designed to protect cryogenic containers and systems containing cryogenic fluids from rupture in the event of overpressure.

Cryogenic liquid is converted to gas at about 2.3% per day even under ideal container conditions. If the liquid is not used regularly, the vessel will be empty in a certain amount of time.

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 of the cryogenic container or system from being exceeded. It shall be unlawful to use pressure relief devices that are not clearly marked by the manufacturer with their set pressure.




This is the pressure relief device with the gauge marked for 350 psig.

Pressure relief devices 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 specification cryogenic containers with an internal volume of 2 cubic feet or less.

Precautions shall be taken to prevent overpressurization of atmospheric tanks. Such pressure relief devices shall communicate with the vapor space of the container, not the cryogenic fluid. Such devices shall be located such that they are readily accessible for inspection and repair.

**(6) Pressure-relief vent piping.**

Pressure-relief vent-piping systems shall be constructed and arranged so as to remain functional and direct the flow of gas to a safe location. Pressure-relief-device vent piping shall have a cross-sectional area not less than that of the pressure-relief-device vent opening and shall be arranged so as not to restrict the flow of escaping gas.

Pressure-relief-device vent piping and drains in vent lines shall be arranged so that escaping gas will discharge unobstructed to the outdoors and not impinge on personnel, containers, equipment, foundations and adjacent structures or enter enclosed spaces. Pressure-relief-device vent lines shall be installed in such a manner to exclude or remove moisture and condensation and prevent malfunction of the pressure relief device because of freezing or ice accumulation or other types of obstruction.

When vented outside, relief valve vent lines shall be labeled in a manner that will distinguish them from the medical gas piping.

**(7) Emergency Oxygen Supply Connection.**

EOSCs shall be installed when the source is remote to permit connection of a temporary auxiliary source of supply for emergency or maintenance situations. EOSCs shall be located as follows:

(1) **On the exterior of the building** being served in a location accessible by emergency supply vehicles at all times in all weather conditions
(2) Connected to the main supply line immediately downstream of the main shutoff valve

EOSCs shall consist of the following:

(1) Physical protection to prevent unauthorized tampering
(2) A female DN (NPS) inlet for connection of the emergency oxygen source that is sized for 100 percent of the system demand at the emergency source gas pressure
(3) A manual shutoff valve to isolate the EOSC when not in use
(4) Two check valves, one downstream of the EOSC and one downstream of the main line shutoff valve, with both upstream from the tee connection for the two pipelines
(5) A relief valve sized to protect the downstream piping system and related equipment from exposure to pressures in excess of 50 percent higher than normal line pressure
(8) Any valves necessary to allow connection of an emergency supply of oxygen and isolation of the piping to the normal source of supply

**(9) In-building emergency reserves.**

If in-building emergency reserves are provided inside the building as a substitute for the EOSC, it shall be located in accordance with NFPA 99 regulations. In-building emergency reserves shall include a check valve in the main line placed on the distribution system side of the ordinary source's main line valve to prevent flow of gas from the emergency reserve to the ordinary source.

In-building emergency reserves shall actuate a local signal and an alarm at all master alarms when or just before it begins to serve the system.

3.5.2 Container protection

Cryogenic containers and systems shall be secured and protected against physical damage and tampering. Stationary containers shall be secured to foundations in accordance with the Building Code. Portable cryogenic containers shall be secured to prevent movement from contact, vibration or seismic activity. Cryogenic containers shall not be secured to plumbing pipes or electrical conduits.

**Note: Unlike compressed gas container storage, nesting is an acceptable means of securing cryogenic containers.**

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.

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.

3.5.3 Separation from hazardous conditions.
Cryogenic containers and systems in storage or use shall be separated from materials and conditions which pose exposure hazards to or from each other. Cryogenic containers must be separated from the incompatible material. 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.

**(1) Stationary cryogenic containers.**

**Point-of-fill connections.** Fill connections for stationary cryogenic containers shall not be positioned closer to exposures than the minimum distances required for stationary cryogenic containers. Fill connections for stationary cryogenic containers shall be located and maintained to afford cargo tank operator access to valves and indicators on the cryogenic containers and cargo tank.

**Surfaces beneath cryogenic containers.** The surface of the area on which stationary cryogenic containers are placed, including 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 temperatures of cryogenic fluid that may be released during normal filling operations, without cracking, shifting or other impact upon the stability of the installation.

For oxidizing gas systems, where the oxidizing gas is stored as a liquid, surfacing of noncombustible material shall be provided at ground level under liquid delivery connections for the storage container and mobile supply equipment. This area of noncombustible surfacing shall be at least 3 ft in diameter from points at ground level where leakage of liquid oxygen might fall during unloading and normal operation of the system. The area under the mobile supply equipment shall be at least the full width of the vehicle and at least 8 ft in the direction of the vehicle axis. For purposes of this standard, asphaltic or bitumastic paving is considered to be combustible. The slope, if any, of such areas shall take into consideration the possible flow of spilled liquid oxygen to adjacent combustible material. If expansion joints are used, fillers shall also be of noncombustible materials.

**Prohibited locations.** It shall be unlawful to install stationary cryogenic containers on the roof of any building or structure.

**(2) Portable cryogenic containers.**

Cryogenic containers shall be placed on surfaces that are compatible with the cryogenic fluid in the cryogenic container. Cryogenic containers shall be positioned such that the pressure relief valve discharge is directed away from any building exit. A shutoff valve shall be located in liquid product withdrawal lines as close to the container as practical.

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 3-1.

Table 3-1
**Separation of stationary cryogenic containers from exposure hazards (outdoor)**

| | **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** | **Quantity of oxidizing gases is greater than 20,000 up to 50,000 SCF** | **Quantity of oxidizing gases is greater than 50,000 SCF** |
|---|---|---|---|
| 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[a] | 50[a] |
| Building exit | 10[a] | 10[a] | 10[a] |
| 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*[b] | 10[a] | 10[a, d] |
| Parked vehicles | 0 *or minimum required for service access* | 10[a] | 10[a] |
| Slow burning solids (ex. heavy timber, coal) | 0 *or minimum required for service access* | 25[a] | 25[a] |
| 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[a, d] |
| Combustible waste or vegetation | 15[a,c] | 50[a] | 50[a] |
| Other hazardous materials | See additional requirements [a] in table 3-3 (A) | See additional requirements [a] in table 3-3 (B) | |

a. 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.
b. 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.
c. The distance shall be increased to 20 feet if there is no fire barrier and the gas is an oxidizing gas using in medical facilities.
d. 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 Table 3-2.

Table 3-2
**Separation of portable cryogenic containers from exposure hazards (outdoor)**

| | **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** | **Quantity of oxidizing gases is greater than 20,000 up to 50,000 SCF** | **Quantity of oxidizing gases is greater than 50,000 SCF** |
|---|---|---|---|
| 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[a] | 50[a] |
| Building exit | 10[a] | 10[a] | 10[a] |
| 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*[b] | 10[a] | 10[a, d] |
| 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[a] | 25[a] |
| 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[a, d] |
| Combustible waste or vegetation | 15[a,c] | 50[a] | 50[a] |
| Other hazardous materials | See additional requirements [a] in table 3-3 (A) | See additional requirements [a] in table 3-3 (B) | |

a. 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.
b. 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.
c. The distance shall be increased to 20 feet if there is no fire barrier and the gas is an oxidizing gas using in medical facilities.
d. 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.

## Table 3-3 Additional Distance Requirements

**(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 |

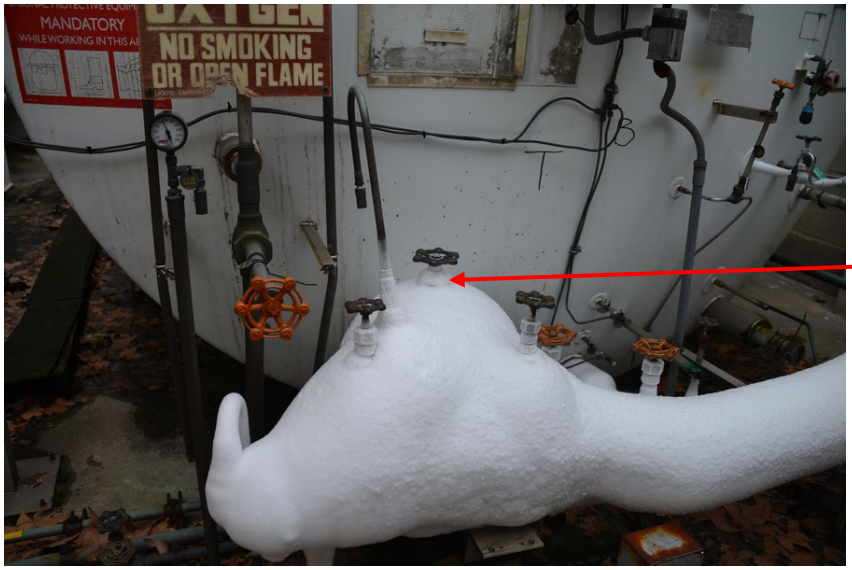
**The distances mentioned in (B) shall not apply, where a fire barrier wall having a minimum fire resistance of 2 hours interrupts the line of sight between storage system and the exposure. In such cases, the 2-hour fire barrier shall be located at least 5 ft from any exposure.**

3.5.4 Electrical wiring and equipment.

Cryogenic containers and systems shall not be located where they could become part of an electrical circuit or 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 Electrical Code. The grounding system shall be protected against corrosion, including corrosion caused by stray electric currents or galvanic action.

3.5.5 Service and repair.

Frost built-up prevents safety devices or valves from operating properly. Icing and blockage on pressure relief devices or valves can occur if water comes into contact with the surfaces of cryogenic-refrigerated containers or piping. If that occurs, notify the supplier/vendor of the ice build-up.




Ice built-up preventing proper operation of the valves should be regularly removed by the supplier.

Hearing from a portable cryogenic liquid cylinder is usually the normal operation of its pressure relief device. If the gas vents intermittently through the safety relief valve, then that is probably normal operation. Ensure that the inactive containers are stored in well-ventilated area. However, there are some issues may need further attention:

(1) gas vent continuously through the safety relief valve
It might be relief valve failure or excessive heat leak. It is recommended to remove container or vent the exhaust to a well ventilated area. Contact the supplier for assistance.

(2) Gas vents during use through safety relief valve
The set point on regulators might exceed safety relief valve setting. Contact the supplier for assistance.

(3) Pressure in the container is low
It might be leak from container; pressure building valve is not fully opened; or pressure building regulator not set high enough. Contact supplier.

(4) Pressure in the container is too high
It might be leaking, vacuum integrity failing or improper setting of pressure building regulator. Contact the supplier especially if the container walls are covered with frost.

(5) Frost issues
(a) Container top covered with frost: It might because of high product use.

(b) Container has isolated spots of frost: The container may have been damaged, compromising integrity of insulation. You should contact the supplier.
(c) Container surface is uniformly covered with frost: The vacuum integrity might be compromised. If it is accompanied by a high rate of product venting through the safety relief valve, or high rate of pressure increase, call supplier.

Any Leaking, damaged or corroded cryogenic containers shall be immediately removed from service. Leaking, damaged or corroded systems shall be replaced, repaired or disposed of lawfully. Cryogenic containers that have been removed from service shall be repaired or disposed of lawfully. Cryogenic containers and systems shall be inspected by competent personnel (e.g. supplier) **at least once a month**.

# 4. STORAGE, HANDLING, AND USE OF COMPRESSED GAS AND CRYOGENIC FLUIDS

## 4.1 Maximum Allowance Per Control Area

This section addresses the 2008 New York City Fire Code applicable to **new or modified installations/facilities approved by the Fire Department on or after July 1st, 2008.** It also applies to any pre-existing installations that are requesting an increase of their previously **permitted storage quantities when the aggregate quantity will be in excess of the maximum allowable quantity (MAQ) listed below. If the quantity of nonflammable gases is in excess of a previously permitted quantity in any pre-existing installations, a revised FDNY permit must be obtained.**

Nonflammable compressed gases shall not exceed the maximum allowable quantity (MAQ) per control area indicated in Table below. Quantities exceeding the MAQ shall be in gas cabinets specifically designed for medical gas storage or the one-hour rooms in accordance with the storage regulations.

Table 4- 1. MAQ of compressed oxidizing gases and cryogenic oxidizing fluid, **storage and used in closed systems**, per **indoor** control area

| **Building protected throughout by a sprinkler system?**[a] | **Floor Level** | | **# of Control Areas per Floor** | **NOT in Gas cabinets/ Exhausted enclosures** | | **in Gas cabinets/ Exhausted enclosures**[b] | |
|---|---|---|---|---|---|---|---|
| | | | | Oxidizing gas (SCF) | Cryogenic Oxidizing (gallons) | Oxidizing gas (SCF) | Cryogenic Oxidizing[c] (gallons) |
| **NO** | Above Grade | >9 | 1 | 75 | 2.25 | 150 | 2.25 |
| | | 7-9 | 2 | 75 | 2.25 | 150 | 2.25 |
| | | 4-6 | 2 | 187.5 | 5.625 | 375 | 5.625 |
| | | 3 | 2 | 750 | 22.5 | 1,500 | 22.5 |
| | | 2 | 3 | 1,125 | 33.75 | 2,250 | 33.75 |
| | | 1 | 4 | 1,500 | 45 | 3,000 | 45 |
| | Below Grade | 1 | 3 | 1,125 | 33.75 | 2,250 | 33.75 |
| | | 2 | 2 | 750 | 750 | 1,500 | 750 |
| | | > 2 | | Not Allowed | | Not Allowed | |
| | | | | Oxidizing gas (SCF) | Cryogenic Oxidizing (gallons) | Oxidizing gas (SCF) | Cryogenic Oxidizing[c] (gallons) |
| **YES** | Above Grade | >9 | 1 | 150 | 5.5 | 300 | 5.5 |
| | | 7-9 | 2 | 150 | 5.5 | 300 | 5.5 |
| | | 4-6 | 2 | 375 | 11.25 | 750 | 11.25 |
| | | 3 | 2 | 1,500 | 45 | 3,000 | 45 |
| | | 2 | 3 | 2,250 | 67.5 | 4,500 | 67.5 |
| | | 1 | 4 | 3,000 | 90 | 6,000 | 90 |
| | Below Grade | 1 | 3 | 2,250 | 67.5 | 4,500 | 67.5 |
| | | 2 | 2 | 1,500 | 45 | 3,000 | 45 |
| | | > 2 | | Not Allowed | | Not Allowed | |

a. MAQ may be increased 100% in buildings protected throughout by a sprinkler system.
b. MAQ for non-cryogenic gases may be increased 100% when stored in approved storage cabinets, exhausted enclosures.
c. Gas cabinet does not help to increase MAQ for storing cryogenic oxidizing fluids

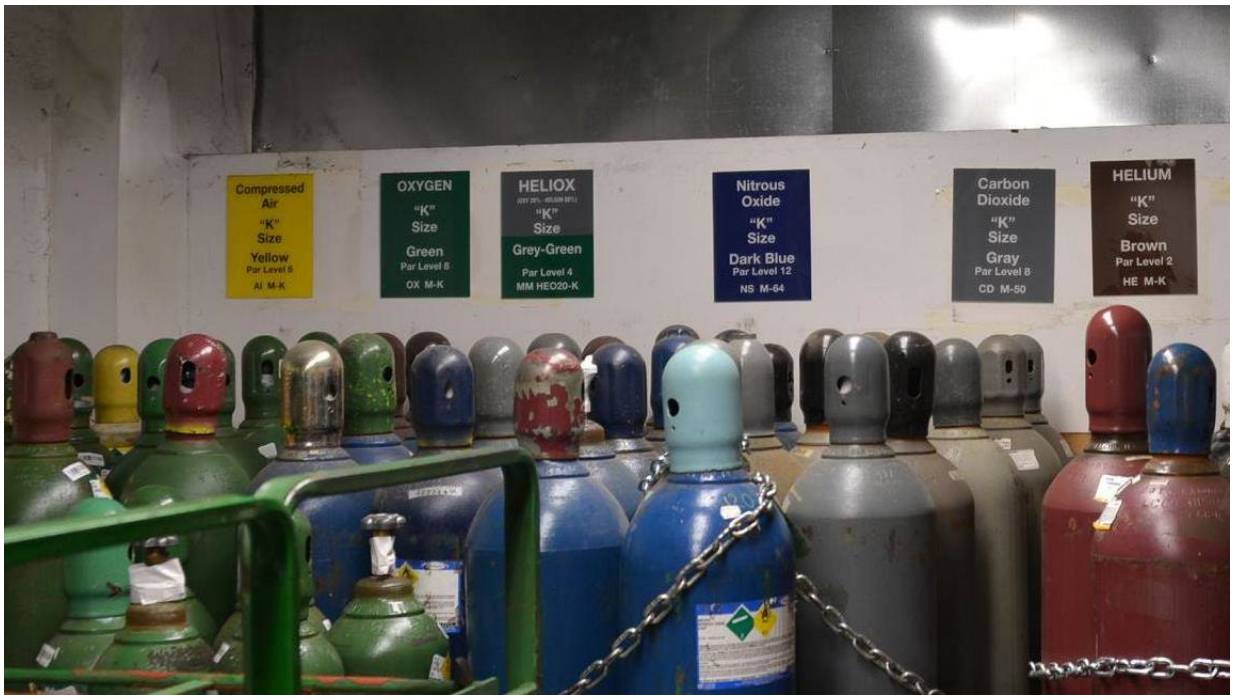
Table 4-2.Maximum allowable quantity of oxidizing gases per **outdoor** control area

| Gases | Storage | Use |
|---|---|---|
| Oxidizing gases | 1,500 SCF | 1,500 SCF |

## 4.2 General Requirement for Gas Storage

4.2.1 Required signs

Compressed gas containers storage areas should be **prominently posted with the names of the gases to be stored**. Where gases of different types are stored at the same location, compressed gas containers should be **grouped by types of gas**, and the groups arranged to take into account the gases contained, e.g. flammable gases must not be stored near oxidizing gases.




Where gases of different types are stored at the same location, compressed gas containers should be **grouped by types of gas.**

Unless otherwise exempted by the Fire Department, hazard identification signs as set forth in NFPA 704 for the compressed gas/cryogenic fluid shall be conspicuously affixed **at entrances** to locations where the containers in quantities requiring a permit are stored, handled or used, including dispensing, and at such other locations as may be designated by the Fire Department.

Individual containers, cartons or packages shall be conspicuously marked or labeled in an approved manner.

Signs reading "**COMPRESSED GAS**" shall be conspicuously posted at the entrance to rooms or on cabinets containing compressed gases.


In health care facilities, precautionary signs readable from a distance of 5 feet shall be conspicuously displayed prominently (strategically) placed at all major entrances or gate of the storage room or enclosure.

Precautionary signs should be at least 8 in. × 11 in. in size. Any material that can burn in air will burn more rapidly in the presence of oxygen.
Special signs and additional precautionary measures should be employed whenever foreign languages present a communication problem.


Smoking is prohibited in all health care facilities. Durable "No Smoking" signs shall be conspicuously posted at approved locations throughout the facility or other location in accordance with Fire Code. The content, lettering, size and color of required "No Smoking" signs shall be in accordance with the rules, or as otherwise approved by the commissioner.

Smoking, open flames, electric heating elements, and other sources of ignition shall be prohibited within storage locations and within 20 ft of outside storage locations. No sources of open flame, including candles, shall be permitted in the area of administration. Nonmedical appliances that have hot surfaces or sparking mechanisms shall not be permitted within oxygen-delivery equipment or within the site of intentional expulsion (see definition).

Sparking toys shall not be permitted in any patient care area. Such toys have been associated with fire incidents in health care facilities. A suggested text for precautionary signs for oxygen tent canopies and oxygen hoods used in pediatric nursing units is the following:

**CAUTION: OXYGEN IN USE**
**ONLY TOYS APPROVED BY NURSES**
**MAY BE GIVEN TO CHILD**


**Examples of Acceptable Signs**

Locations containing central supply systems or cylinders containing only oxygen or medical air shall have their door(s) labeled as follows:

**CAUTION**
**Medical Gases**
**NO Smoking or Open Flame**

Locations containing positive pressure gases other than oxygen and medical air shall have their door(s) labeled substantially as follows:

**CAUTION**
**Positive Pressure Gases**
**NO Smoking or Open Flame**
**Room May Have Insufficient Oxygen**
**Open Door and Allow Room to Ventilate Before Entering**

All signs and markings required by the Fire Department must not be obscured or removed, must be in English as a primary language or in symbols allowed by the Fire Department, shall be durable, and the size, color and lettering must be acceptable to the Fire Department. Do not repaint gas containers.

4.2.2 Empty containers

**Charged and empty containers should be stored separately** with the storage layout so planned that containers comprising old stock can be removed first with a minimum handling of other containers.


Empty containers should be stored separately from the full containers.

4.2.3 Upright position

Compressed gas containers, except those designed for use in a horizontal position, and all compressed gas containers containing nonliquefied gases, shall be stored in an **upright position** with the valve end up.

*Exception*: Compressed gas containers with an internal volume less than 0.174 SCF may be stored in a horizontal position.

## 4.3 Medical Gas Storage

The storage of compressed gases intended for inhalation or sedation including, but not limited to, analgesics for dentistry, podiatry, veterinary and similar uses at hospitals and other medical facilities shall comply with the requirements of this section in addition to other requirements of Fire Code.

4.3.1 Flammable gases.

**It shall be unlawful to store, handle or use flammable gas as an anesthetizing agent**.

4.3.2 Storage locations within buildings.

Medical gases shall be stored in areas dedicated to the storage of such gases without other storage or uses. Where containers of medical gases in quantities requiring a permit but NOT greater than the maximum allowable quantity (MAQ) per control area (refer to page 43-44 of this study material) are located inside buildings or structures, they shall be stored in approved control areas. Where a gas cabinet or an exhausted enclosure is used to increase the MAQ per control area, gas cabinets or exhaust enclosures shall be in accordance with the following.

**(A) Exhausted enclosures**

When the location of hazardous materials in exhausted enclosures is provided to comply with the FDNY requirements, the exhausted enclosure shall be in accordance with the following regulations:

(1). Exhausted enclosures shall be of noncombustible construction.

(2). The ventilation system for exhausted enclosures shall be designed to operate at a negative pressure relative to the surrounding area. The ventilation system shall be installed in accordance with the construction codes, including the Mechanical Code.

(3). Exhausted enclosures where flammable materials are used shall be protected by a fire extinguishing system.

**(B) Gas cabinet**

When the location of compressed gases in gas cabinets is provided to comply with the FDNY requirements, the gas cabinet shall be in accordance with the following regulations:

(1). The number of containers stored in a single gas cabinet shall not exceed **three**.

(2). Gas cabinets shall be constructed of not less than 0.097-inch (No. 12 gauge) steel; provided with self-closing limited access ports or noncombustible windows to give access to equipment controls; and have all interior surfaces treated, coated or constructed of materials that are compatible with the hazardous materials stored.

(3). The ventilation system for gas cabinets shall be designed to operate at a negative pressure relative to the surrounding area. The ventilation system shall be installed in accordance with the construction codes, including the Mechanical Code.

Where containers of medical gases in quantities greater than the MAQ per control area are located inside buildings or structures, they MUST be stored within a 1-hour rated room or within gas cabinets specifically designed for medical gas storage as follows.

**(A) Gas cabinets specifically designed for medical gas storage**
The gas cabinets shall be constructed in accordance with the regular gas cabinets and the following:

1. The average velocity of ventilation at the face of access ports or windows shall not be less than 200 feet per minute (61 m/s) with a minimum of 150 feet per minute (46 m/s) at any point of the access port or window.
2. Connected to an exhaust system.
3. Internally protected by a sprinkler system.

**(B) One-hour rooms**
A 1-hour room shall be a room separated from the remainder of the building or structure by fire barriers with a fire-resistance rating of not less than 1 hour.

Openings between the room and interior spaces shall be protected by self-closing smoke and draft-control assemblies having a fire protection rating of not less than 1 hour. **Rooms shall be protected by a sprinkler system**

**Exception**: The sprinkler requirement does not apply to pre-existing medical gas storage rooms.

Gas containers shall not be stored in a tightly closed space. Rooms having an exterior wall shall be provided with at least two vents in such wall, each having not less than 36 square inches free area. One vent shall be within 6 inches of the floor and one shall be within 6 inches of the ceiling.

Rooms with no exterior wall shall be exhausted through a duct to the outdoors. Supply and exhaust ducts shall be enclosed in a 1-hour-rated shaft enclosure from the room to the outdoors. Approved mechanical ventilation shall comply with the requirements of the Mechanical Code and be provided at a minimum rate of 1 cubic foot per minute per square foot of the area of the room.

Additionally, NFPA 99 requires that where the total volume of medical gases connected and in storage is greater than 3000 SCF at STP, indoor supply locations shall be provided with dedicated mechanical ventilation systems that draw air from within 1 foot of the floor and operate continuously. A means of makeup air shall be provided.

Bulk Nitrous Oxide System (having a storage capacity of more than 28,000 SCF of nitrous oxide) and Bulk Oxygen System (having a storage capacity of more than 20,000 SCF of oxygen) must be located aboveground out of doors or shall be installed in a building of fireresistive or noncombustible/limited-combustible construction, adequately vented, and used for that purpose exclusively.

4.3.3 Safety requirements for storing gases in enclosures
Oxidizing agents shall not be stored with flammable gases. Enclosures for medical gases shall serve no other purpose and shall not communicate directly

with anesthetizing or storage locations for flammable anesthetizing agents.

Where enclosures (interior or exterior) for medical gas supply systems are located near sources of heat, such as furnaces, incinerators, or boiler rooms, they shall be of construction that protects cylinders from reaching temperatures 130°F.

Storage of full and/or empty cylinders is permitted in the same enclosure. If stored within the same enclosure, empty cylinders shall be segregated from full cylinders.

Enclosures for medical gas supply systems shall be provided with doors or gates. If the enclosure is outside and/or remote from the single treatment facility, it shall be kept locked.

Cylinders, whether full or empty, shall not be stored in enclosures containing medical air compressor sources, medical vacuum supply systems, or Waste Anesthesia Gas Disposal (WAGD) supply systems. An individual cylinder placed in patient room for immediate use by a patient shall not be required to be stored in an enclosure.

4.3.4 Other safety requirements

Oxidizing gases, such as oxygen and nitrous oxide, shall not be stored with any flammable gas. Oxidizing gases in portable containers must NOT exceed an individual capacity of 250 SCF for maintenance purposes, patient care or operation of equipment in Group A, B, E, I, or R occupancies (refer to Appendix B).

Freestanding cylinders shall be properly supported in a proper cylinder stand or cart. Cylinders shall not be chained to portable or movable apparatus such as beds and oxygen tents.

When cylinders are in use, they shall be attached to a proper cylinder stand or to a therapy apparatus of sufficient size to render the entire assembly stable.

## 4.4 Storage requirements of oxidizing gases used in medical facilities

### (A). Oil or Grease

Oxidizing gas cylinders, containers, and associated equipment shall be protected from contact with oil or grease. Specific precautions shall include the following:

(1) Oil, grease, or readily flammable materials shall never be permitted to come in contact with oxidizing gas cylinders, valves, regulators, gauges, or fittings.
(2) Regulators, fittings, or gauges shall never be lubricated with oil or any other flammable substance.
(3) Oxidizing gas cylinders or apparatus shall never be handled with oily or greasy hands, gloves, or rags.

4.4.1 Alarm system

Medical gas system must be continuously monitored by alarm systems required by the NYC Building Code. The alarm systems are designed to provide information and warnings to medical and engineering staff about the supply of medical gases supplied from a central source (manifolds, compressed air plant etc.) & piped to the point of use.

There are three main types of alarm systems used in medical gas system: area alarm system, local alarm system and master alarm system.

**A. AREA ALARM SYSTEMS**

These systems monitor the operating pressures in the pipeline distribution system for specific areas of the healthcare facility: Level 1 and Level 2 medical gas systems. In other words, they are required for all life support, critical care (e.g., post anesthesia recovery, intensive care units, emergency departments, etc.), and anesthetizing locations. The systems are usually stand alone panels which are not required to be monitored at the master alarm panels. They provide visible and audible indication if an alarm condition occurs, for example, the pressure in the lines in the specific areas being monitored increases or decreases by 20 percent from the normal line pressure.

Area alarms shall be located at a nurse's station or other similar location that will provide for surveillance. Area alarm panels for medical gas systems shall indicate if the pressure in the lines in the area being monitored increases or decreases by 20 percent from the normal line pressure.

**B. LOCAL ALARM SYSTEMS**

Local alarms shall be installed to monitor the function of the air compressor system(s), medical– surgical vacuum pump system(s), WAGD systems, and instrument air systems. The local alarm systems can be considered an extension of the master alarm systems. The master alarm shall include at least one signal from the source equipment to indicate a problem with the source equipment at this location. This master alarm signal shall activate when any of the required local alarm signals for this source equipment activates.

**C. MASTER ALARM SYSTEMS**

Medical gas master alarms are among the most crucial pieces of equipment in a healthcare facility. Problems or deficiencies with these alarms present a distinct hazard to patient safety. It monitors the operation and condition of the source of supply, the reserve source (if any), and the pressure in the main lines of each medical gas system.

The master alarm system shall consist of two or more alarm panels located in at least two separate locations, as
follows:

(1) One master alarm panel shall be located in the office or work space of the on-site individual responsible for the maintenance of the medical gas and vacuum piping systems.

(2) In order to assure continuous surveillance of the medical gas and vacuum systems while the facility is in operation, the second master alarm panel shall be located in an area of continuous observation (e.g., the telephone switchboard, security office, or other continuously staffed location).

Exception: Level 2 or Level 3 medical gas system or Type 2 medical gas system (refer to Appendix C for the information of Type 1 and Type 2 gas systems) are only require single alarm panel that is located in an area of continuous surveillance while the facility is in operation.

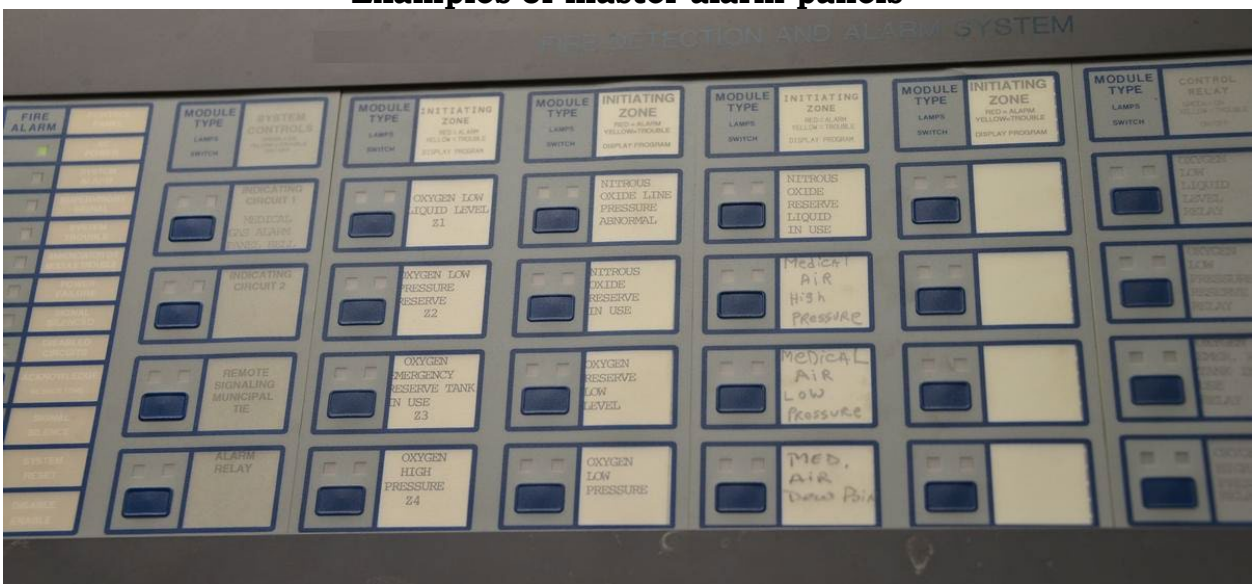

A master alarm panel shall be located in an area of continuous observation (e.g. continuously staffed location)

Master alarm panels for medical gas systems shall each include the following signals:

(1) An alarm indication when, or just before, changeover occurs in a medical gas system that is supplied by a manifold or other alternating-type bulk system that has as a part of its normal operation a changeover from one portion of the operating supply to another
(2) An alarm indication for a bulk cryogenic liquid system when the main supply reaches an average day's supply, indicating low contents
(3) An alarm indication when, or just before, the changeover to the reserve supply occurs in a medical gas system that consists of one or more units that continuously supply the piping system while another unit remains as the reserve supply and operates only in the case of an emergency
(4) An alarm indication for cylinder reserve pressure low when the content of a cylinder reserve header is reduced below one average day's supply
(5) For bulk cryogenic liquid systems, an alarm when or at a predetermined set point before the reserve supply contents fall to one day's average supply, indicating reserve low
(6) Where a cryogenic liquid storage unit is used as a reserve for a bulk supply system, an alarm indication when the gas pressure available in the reserve unit is below that required for the medical gas system to function
(7) An alarm indication when the pressure in the main line of each separate medical gas system increases 20 percent or decreases 20 percent from the normal operating pressure

(8) An alarm indication when the medical–surgical vacuum pressure in the main line of each vacuum system drops to or below 12 in. gauge HgV
(9) An alarm indication(s) from the local alarm panel(s) to indicate when one or more of the conditions being monitored at a site is in alarm
(10) A medical air dew point high alarm from each compressor site to indicate when the line pressure dew point is greater than +35°F
(11) AWAGD low alarm when the WAGD vacuum level or flow is below effective operating limits
(12) An instrument air dew point high alarm from each compressor site to indicate when the line pressure dew point is greater than −22°F

**Examples of master alarm panels**




## 4.5 Handling and Use of Compressed Gases

4.5.1 Compressed gas systems

Compressed gas systems shall be suitable for the use intended and shall be designed and installed by persons competent in such design and installation. Compressed gas devices and systems shall be listed or approved. Compressed gas system controls shall be designed to prevent materials from entering or leaving process or reaction systems at other than the intended time, rate or path. Automatic controls shall be designed to be fail-safe. **Piping systems for gases shall not be used as a grounding electrode.**

Venting of gases shall be directed to an approved location. Venting shall comply with the requirements of the Mechanical Code.

4.5.2 Upright use.

Compressed gas containers, except those designed for use in a horizontal position, and all compressed gas containers containing nonliquefied gases, shall be used in an upright position with the valve end up. The axis of a container being used in an upright position may be inclined as much as 45 degrees from the vertical provided that it is properly secured. Use of nonflammable liquefied gases in the inverted position when the compressed gas is in the liquid state shall be allowed provided that the container is properly secured and the dispensing apparatus is designed for such liquefied gas use.

**Exception**: Compressed gas containers with an internal volume less than 0.174 SCF may be used in a horizontal position.

4.5.3 Transfilling compressed gas containers.

The practice of transferring compressed gases from large to small cylinders by anyone other than the manufacturer or distributor is not recommended, except performed by a C of F holder and it is performed in safe and well-ventilated locations.

Mixing of compressed gases in cylinders shall be prohibited. Transfer of any gases from one cylinder to another in patient care areas of health care facilities shall be prohibited.

Compressed gas containers must not contain gases capable of combining chemically, nor should the gas service be changed by other than the manufacture or distributor.

4.5.4 Moving containers

Where removable caps are provided for valve protection, such caps should be kept on cylinders at all times except when cylinders are in use. Do not lift cylinders by the cap.

Containers shall be moved using an approved method. Avoid dragging or sliding cylinders. Never drop cylinders nor permit them to strike against each other or against other surfaces violently.

It is safer to move cylinders even short distances by using a suitable truck. Where 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. The cart or truck shall be sturdily constructed of materials compatible with the material being moved. Carts and trucks used to move materials shall not obstruct or be left unattended in any corridor, exit enclosure, or other means of egress. Incompatible materials shall not be moved on the same cart or truck.

Carts and trucks utilized for moving compressed gas containers indoors shall be designed to provide a stable base for such movement during handling and shall have a means of restraining containers to prevent accidental dislodgement. Compressed gas containers placed on carts and trucks shall be individually restrained. Carts and trucks shall be provided with a device that will enable the operator to safely control movement by providing stops or speed-reduction devices.

**Ropes, chains or slings shall not be used to suspend compressed gas containers unless such containers have been designed for such handling**. Valves of compressed gas containers shall not be used for lifting.

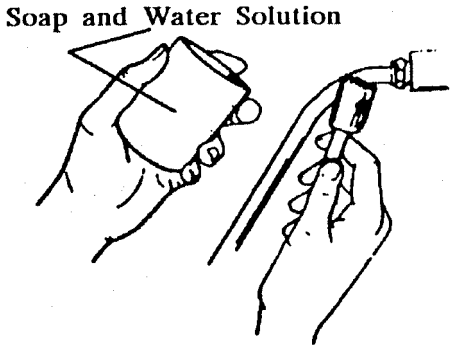
4.5.5 Check for leaks

The gas containers, valves, hoses, and related equipment should be inspected for physical damage. Special care should be taken to identify any defects that may cause a leak. **Any defective components that are discovered must be marked and be replaced before the equipment may be used again.** If any leak of gases is detected, move the gas container to an isolated, well-ventilated area away from combustible materials. Post signs that describe the hazard. The **Certificate of Fitness holder must not attempt to do any repairs, but only take the equipment out of service.** This equipment is very sensitive and must be repaired by the manufacturer only.

After the new container has been connected to the appliance, all connections must be checked for leaks. Most of these leaks occur at the top of the gas container in areas such as the valve threads, pressure safety device, valve stem and valve outlet.

These areas must be checked using a soap and water solution. **NEVER CHECK FOR LEAKS WITH A FLAME.** First make sure that all connections are tight. Then open the container valve. Each connection is checked by brushing or spraying a soap and water mixture on the connection. The connection should be checked to see if any air bubbles are present. If no air bubbles are visible there is no leak. However, if bubbles are present there may be a problem with the

connection. The suspected fittings should be disconnected and cleaned. Then the connection is tightened and the checking procedure is repeated. If the bubbles are still visible, there is a problem with the connection. The fittings should be repaired or replaced before the equipment is used again. **A lighted flame (for example, a match) should never be used when checking a connection for a leak. Always ensure the leak detection fluid is compatible to the gas that the container stored.**



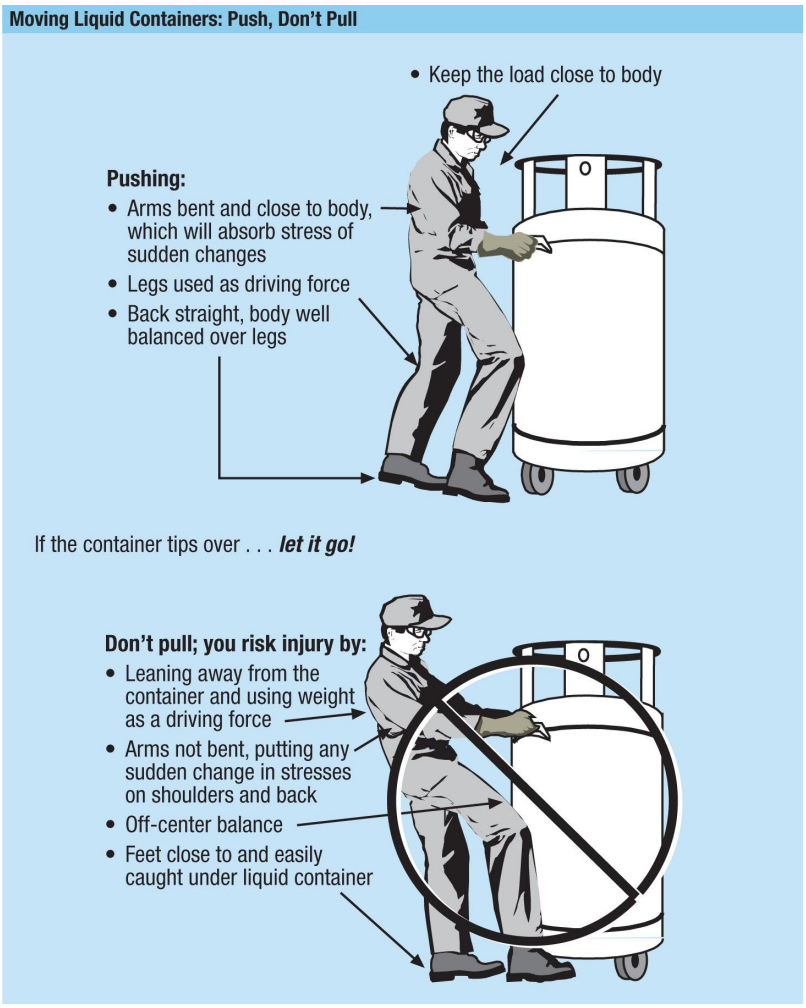

If a compressed gas container leaks and the leak cannot be remedied by simply tightening a valve gland or packing nut, close the valve and attach a tag stating that the compressed gas container is unserviceable. Remove the leaking compressed gas container outdoors to a well ventilated location. Notify the gas supplier and follow his instructions as to the return of the compressed gas container.

## 4.6 Handling and Use of Cryogenic Liquids

4.6.1 Safety Practices

Materials that are soft and pliable at normal temperatures may become hard and brittle when immersed in a liquefied gas. Skin should not be exposed to a liquefied gas or its vapors because exposure can have a burn-like effect on the skin. Even brief exposure can have an adverse impact on the body's delicate tissues. For example, the eyes may be severely damaged if splashed with liquid oxygen. Damage to the skin can also occur if it touches a non-insulated pipe or vessel used to carry or store a liquefied gas. The cold metal can cause the skin to stick fast and then tear when an attempt is made to withdraw from the metal. The certificate of fitness holder must exercise great care to ensure that only compatible materials are exposed to liquefied gases.

Heat leak, which causes vaporization of liquefied gases, is always present in liquefied gas systems. When a liquefied gas vaporizes, enormous pressures can develop inside the storage tank. Similarly, vapors trapped between two closed valves can create enormous pressures. If these pressures become too high, the tank will rupture and may cause an explosion. A pressure relief device must be installed in each storage tank and in all sections of the distribution system where vapors may be trapped. Pressure relief devices are designed to release the vapors into the atmosphere in a controlled manner when the pressure build-up reaches dangerous levels. The certificate of fitness holder must check and record pressures and the liquefied gas levels inside all storage tanks every shift. When necessary, the equipment must be adjusted to the correct settings.



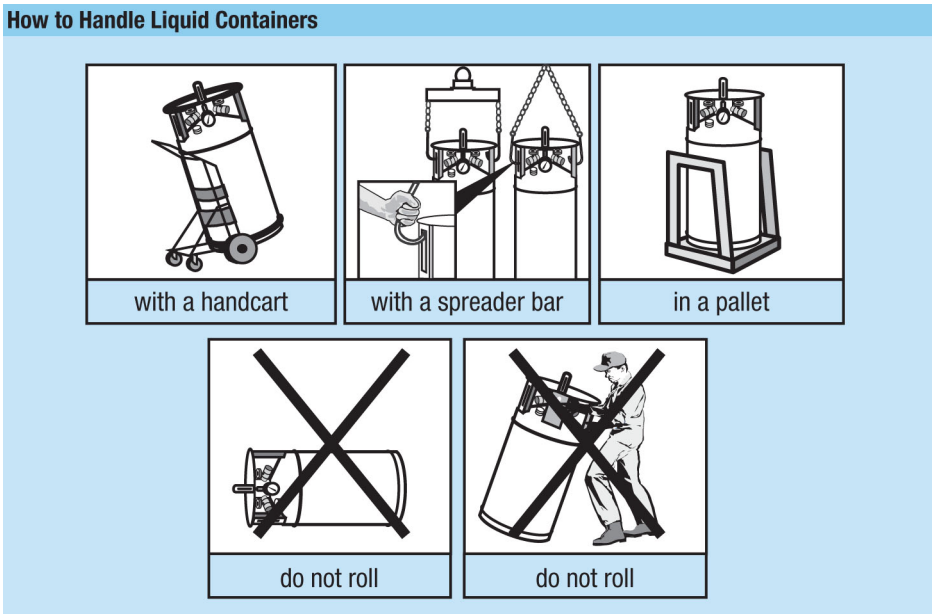

## (A) Moving cryogenic containers

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 falling on you or a coworker, in the even it becomes unstable.

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.

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

**(B) Transferring Liquid Oxygen**

Transferring of liquid oxygen from one container to another shall comply with the following regulations:

(a) Transfer to reservoirs or portable units over 50 psi shall include the following:
   (1) A designated area separated from any portion of a facility wherein patients are housed, examined, or treated by a fire barrier of 1 hour fire-resistive construction; and
   (2) The area is mechanically ventilated, is sprinklered, and has ceramic or concrete flooring; and
   (3) The area is posted with signs indicating that transferring is occurring, and that smoking in the immediate area is not allowed.

(4) The individual filling the portable container has been properly trained in the filling procedures.

(b) Transfer to portable containers at 50 psi and under shall include the following:

(1) The area is well-ventilated, and has noncombustible flooring; and
(2) The area is posted with signs indicating that smoking in the area is not allowed; and
(3) The individual filling the portable container has been properly trained in the filling procedure; and
(4) The guidelines of CGAPamphlet P-2.6, *Transfilling of Low- Pressure Liquid Oxygen to be Used for Respiration,* and CGA Pamphlet, P-2.7, *Guide for the Safe Storage, Handling and Use of Portable Liquid Oxygen Systems in Health Care Facilities,* are met.

4.6.2 Protective Clothing and Equipment

Eye and hand protection for handling cryogenic/refrigerated liquids should be used by all workers with any chance of exposure to liquids or boil-off vapors. Appropriate eye and hand protection serves primarily to protect workers against splashing and possible cold contact burns. Safety glasses are recommended during transfer and normal handling of cryogens. If severe spraying or splashing may occur, a face shield or safety goggles should be worn for additional protection. Insulated gloves should always be worn when handling anything that comes in contact with cold liquids and vapors. Gloves should be loose fitting so that they can be removed quickly if liquids are spilled into them. Trousers should be left outside of boots or work shoes.

4.6.3 Ventilation

All gases should be used and stored in well-ventilated areas. All of the gases except oxygen can cause a person to suffocate by replacing breathable air in an enclosed workplace. However, workers will not be aware of the presence of such gases without a tool to help them detect the gases. Therefore, oxygen sensors equipped with an audible alarm shall be provided in dispensing areas to continuously monitor the level of oxygen in the area. The alarm shall actuate when oxygen concentration drops below 19.5 percent.

## 5. COMMON MEDICAL CRYOGENIC FLUIDS AND COMPRESSED GASES

### 5.1 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. Most of them have no color as a liquid, although liquid oxygen is light blue. However, the extremely cold liquid and vapor has a built-in warning that appears whenever they are exposed to the atmosphere. The cold boil-off gases condense the moisture in the air, creating a visible fog. The fog normally extends over a larger area than the vaporizing gas.

### 5.2 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. The gas therefore may suffocate the employee.

In any accidental release, the greatest concern must be with what the gas will do during or after its evaporation. Those hazards include the ability to support combustion, along with its 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. The most common cryogenic fluids used in medical facilities are the cryogenics that support combustion and inert cryogenics.

The cryogenics that support combustion include 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 has produced 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.

Inert gases are, of course, those gases that will not enter into chemical reaction. This group of cryogenic liquids includes liquid helium Liquid nitrogen is to all intents and purposes 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 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 comes 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. Cryogenic fluids can cause materials such as carbon steel, plastics, and rubber to become brittle and fracture.

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. (CGA)

| **OXYGEN CONTENT (% by volume)** | **EFFECTS AND SYMPTOMS (at atmospheric pressure)** |
|---|---|
| 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 is recommended to be available for use to prevent suffocation when entering areas where there is a potential for low oxygen concentration.

For the rooms that may have insufficient oxygen, a sign indicating "*Open Door and Allow Room to Ventilate Before Entering*" should be posted at the entrance.

### 5.3 Air


Air exists as a colorless, odorless, tasteless, and fully life sustaining mixture of gases that make up the earth's atmosphere. Under normal atmospheric conditions, air is a mixture of approximately 20.9% oxygen, 79.1% nitrogen.

## 5.4 Carbon Dioxide


Carbon Dioxide gas is colorless. At low concentrations, the gas is odorless. At higher concentrations it has a sharp, acidic odor. Carbon dioxide is mainly used by the food industry, the oil industry, and the chemical industry. Carbon Dioxide is also used in critical care areas of the hospital. Fore example, it is commonly used as an insufflation gas for minimal invasive surgery to enlarge and stabilize body cavities to provide better visibility of the surgical area, or used for respiratory stimulation during and after anaesthesia, or crotheapy, etc.

It will act as an asphyxiant and an irritant. Carbon Dioxide is heavier than air and should not be allowed to accumulate in low lying areas. Carbon Dioxide is a powerful cerebral dilator. At concentrations between 2 and 10%, Carbon Dioxide can cause nausea, dizziness, headache, mental confusion, increased blood pressure and respiratory rate. Above 8% nausea and vomiting appear. Above 10%, suffocation and death can occur within minutes.

Contact with the cold gas can cause freezing of exposed tissue. Moisture in the air can lead to formation of carbonic acid that can irritate the eyes. All forms of Carbon Dioxide are noncombustible.

*ACCIDENTAL RELEASE MEASURES*
Evacuate all personnel from affected area. Increase ventilation to release area and monitor oxygen level. Use appropriate protective equipment (SCBA). If leak is from cylinder or cylinder valve call the supplier emergency telephone number. If leak is in user's system close cylinder valve and vent pressure before attempting repairs.

## 5.5 Helium


***Gaseous helium***
Helium is a nontoxic, odorless, colorless, nonflammable gas stored in cylinders at high pressure. It 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. As with any gas with differing density from air, inhaling a small volume of helium temporarily changes the timbre and quality of the human voice.

It can cause rapid suffocation when concentrations are sufficient to reduce oxygen levels below 19.5%. It is lighter than air and may collect in high points or

along ceilings. Self-Contained Breathing Apparatus (SCBA) may be required by rescue workers.

***Liquid helium***

Helium is used in cryogenics (its largest single use, absorbing about a quarter of production), particularly in the cooling of superconducting magnets, with the main commercial application being in MRI scanners. Liquid helium is used in superconductivity experiments and investigations of low-temperature physics.

*ACCIDENTAL RELEASE MEASURES*
Stop leak if possible without personal risk. Keep unnecessary people away, isolate hazard area and deny entry. Stay upwind and keep out of low areas.

## 5.6 Nitrogen


***Gaseous nitrogen***
Elemental nitrogen is a colorless, odorless, tasteless, and mostly inert diatomic gas at standard conditions, constituting 78.09% by volume of Earth's atmosphere. Nitrogen gas has a variety of applications, including serving as an inert replacement for air where oxidation is undesirable.

***Liquid nitrogen***
Typically, nitrogen is shipped and stored in a liquid state inside cryogenic cylinders or cryogenic tanks at temperatures slightly above its boiling point of -320°F. When a bulk nitrogen distribution system is installed in a healthcare facility it must be capable of delivering nitrogen at 160 psig at it maximum flow rate. Nitrogen may also be shipped and stored inside cylinders at pressures up to 2200 psig. These cylinders are generally color-coded black.

It 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.

*ACCIDENTAL RELEASE MEASURES*
Evacuate all personnel from affected area. Increase ventilation to release area and monitor oxygen level. Use appropriate protective equipment (SCBA). If leak is from container or its valve, call the supplier emergency telephone number. If leak is in user's system close cylinder valve and vent pressure before attempting repairs.

## 5.7 Nitrous Oxide


***Gaseous nitrous oxide***

Nitrous oxide, commonly known as laughing gas. It is an oxide of nitrogen. At room temperature, it is a colorless, non-flammable gas, with a slightly sweet odor and taste. It is used in surgery and dentistry for its anesthetic and analgesic effects. It is known as "laughing gas" due to the euphoric effects of inhaling it, a property that has led to its recreational use as a dissociative anesthetic. It is also used as an oxidizer in rocketry and in motor racing to increase the power output of engines. At elevated temperatures, nitrous oxide is a powerful oxidizer similar to molecular oxygen.

***Liquid nitrous oxide***

It 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.

*ACCIDENTAL RELEASE MEASURES*

Immediately evacuate all personnel from danger area. Use self-contained breathing apparatus where needed. Nitrous oxide is an asphyxiant. Lack of oxygen can kill. Vapors can spread from spill. Contact with flammable materials may cause fire or explosion. Test for sufficient oxygen, especially in confined areas, before allowing reentry. Use self-contained breathing apparatus where needed. Shut off leak if without risk. Ventilate area of leak or move cylinder to a well ventilated area.

## 5.8 Oxygen


Oxygen is an odorless, colorless, nonflammable gas stored in cylinders at high pressure. It is an oxidizing gas and vigorously accelerates combustion. Keep away from oils or grease. Rescue personnel should be aware of the extreme fire hazards associated with oxygen-enriched (greater than 23%) atmospheres, and that self contained breathing apparatus (SCBA) may be required.

Breathing oxygen at concentration exceeding 80% at atmospheric pressure for more than a few hours may cause nasal stuffiness, cough, sore throat, chest pain and breathing difficulty. Breathing oxygen at higher pressure increases the likelihood of adverse effects within a shorter time period. Breathing pure oxygen under pressure may cause lung damage and also central nervous system effects resulting in dizziness, poor coordination, tingling sensation, visual and hearing

disturbances, muscular twitching, unconsciousness and convulsions. Breathing oxygen under pressure may cause prolongation of adaptation to darkness and reduced peripheral vision.

Although oxygen cannot be ignited, it is a strong supporter of combustion. Oxygen aids in the ignition and burning of other materials and gases. Some combustibles, such as some oils, burn in oxygen with near explosive violence. Both gaseous oxygen and liquefied oxygen are commonly used in healthcare facilities.

***Gaseous Oxygen***

Seamless steel cylinders are used to store gaseous oxygen at pressures up to 2200 pounds per square inch gauge (psig). Each cylinder must have a safety disk installed in the control valve connection. This disk will burst and release the oxygen into the atmosphere when the oxygen pressure in the cylinder reaches a dangerous level. For example, the disk will burst if the pressure increases because the cylinder has been exposed to extreme temperatures. According to DOT color coding specifications, cylinders used to store gaseous oxygen must be painted green. However, the certificate of fitness holder should not rely on the color coding system for identification. Instead, he or she should identify the cylinder's contents by reading the DOT markings stamped at the cylinder's neck or written on the cylinder's label. If the contents of the cylinder cannot be identified by one of these methods, the cylinder must be returned to supplier without using it.

***Liquid oxygen***

Exists at cryogenic temperature, approximately -300°F at atmospheric pressure. It retains all of the properties of gaseous oxygen, but, in addition, when allowed to warm to room temperature at atmospheric pressure, it will evaporate and expand to fill a volume 860 times its liquid volume.

Oxygen becomes a pale blue liquid when it is cooled to -297°F. To store liquid oxygen, cryogenic cylinders and tanks are used. Each cryogenic cylinder and tank has two walls, and an insulating material is placed in a vacuum that exists between the walls. The combined effect of the insulating material and the vacuum minimizes vaporization due to heat leaks. Liquid oxygen is typically stored in large tanks mounted in fixed locations or on flatbed trucks. Standard sized liquid oxygen cylinders are usually placed in a single location because they are extremely heavy and not easily transported. Small, portable liquid oxygen cylinders are sometimes installed in strategic locations in a healthcare facility, but portable cylinders are primarily used for home care applications.

When liquid oxygen is released into an area under normal atmospheric conditions, the liquid oxygen vaporizes and causes a highly visible fog. The fog occurs because the cold boil-off gases condense the moisture in the air. When one volume of liquid oxygen is vaporized, it will produce approximately 860 volumes of gas at atmospheric pressure and room temperature. When liquid

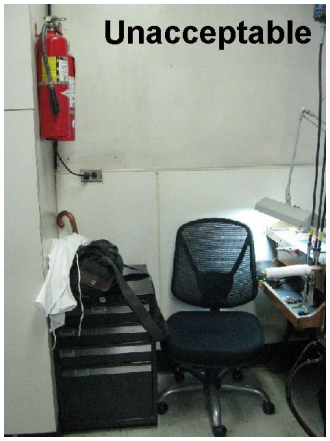
oxygen is released into an open area, the oxygen quickly dissipates. However, when liquid oxygen is released into a confined area, the concentration of oxygen may dramatically increase and create an oxygen-rich atmosphere that can pose a serious threat to life and property when exposed to an ignition source. The certificate of fitness holder can determine the oxygen concentration in a given area using a commercially available oxygen monitor.

*ACCIDENTAL RELEASE MEASURES*

Evacuate all personnel from affected area. Shut off source of oxygen if possible. Increase ventilation to release area. Personnel who have been exposed to high concentrations of oxygen should stay in a well-ventilated or open area for 30 minutes before going into a confined space or near an ignition source.
If leak is from container or its valve, call the supplier emergency telephone number. If leak is in user's system close cylinder valve and vent pressure before attempting repairs.

## 6. FIRE EXTINGUISHER AND EMERGENCY RESPONSES

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 the fire extinguisher having 40 pounds or less, its top must not be more than 5 ft above the floor
(2) The fire extinguishers must be accessible and unobstructed.

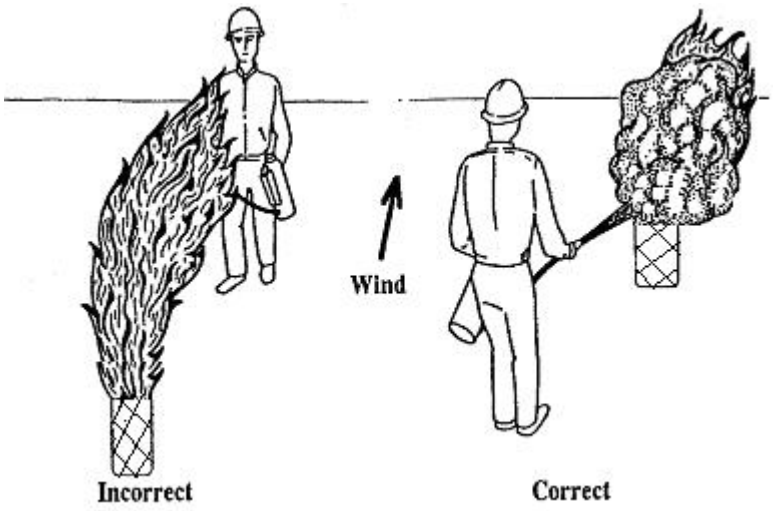

(1) The bottom of the fire extinguisher must be at least 4 in above the floor.
(2) The fire extinguisher must be properly mounted.


In the event of a fire extinguisher has been discharged, a fully charged replacement is required before work can resume. Portable fire extinguishers are important in preventing a small 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 by the building fire extinguishing systems or trained firefighters only.

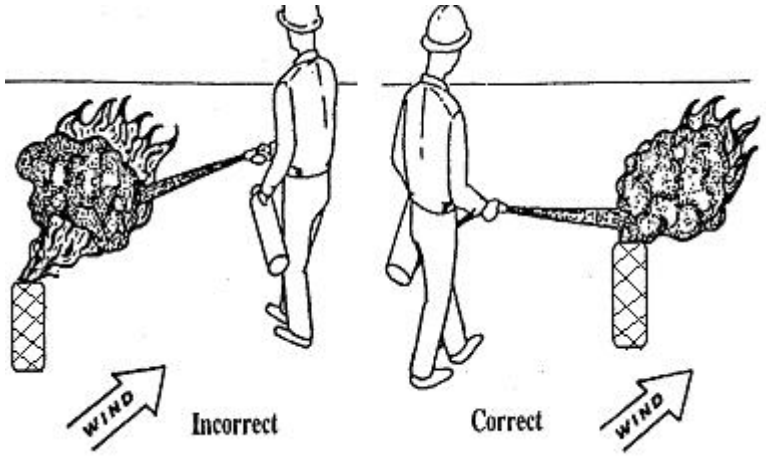

In case of any fire, 911 must be called. Fire extinguishers must be used in accordance with the instructions painted on the side of the extinguisher. They clearly describe how to use the extinguisher in case of an emergency. The Certificate of Fitness holder should be familiar with the use of portable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

## 6.1 Operation Instructions for a Fire Extinguisher

Special care must be taken when extinguishing a gas fire caused by a leak. The easiest way to extinguish the fire is to shut off by using the Emergency Shut Off valve until the flame is extinguished. **In case of any fire, Fire Department must be notified.** 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 correct ways to approach a fire are shown below.




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. The correct way to direct the dry chemical stream is shown below.




**For the piped gas, the gas supply must be shut off first and then call 911.** This is safer than allowing the flammable gas (e.g. acetylene or LPG) 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 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) and the gas supply is limited (e.g. it is from a cylinder), allow the flame to burn itself out and call 911.** In the mean time, you should try to control the scene and prevent the fire spreading to the surrounding materials. **The trained Certificate of Fitness holders should only consider extinguishing fires when they are limited in size and spread such that they can readily be extinguished using a portable fire extinguisher.** 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 by the building fire extinguishing systems or trained firefighters only.

## 6.2 Different Types of Fire Extinguishers

The Certificate of Fitness holder must be familiar with the different types of fire extinguishers that are present. He/she must know how to operate the extinguishers in a safe and efficient manner. He/she must know the difference between the various types of extinguishers and when they should be used. A description of the five 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, these extinguishers 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 $CO_2$, dry chemical or foam is most effective.

***Class C*** fires involve 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.

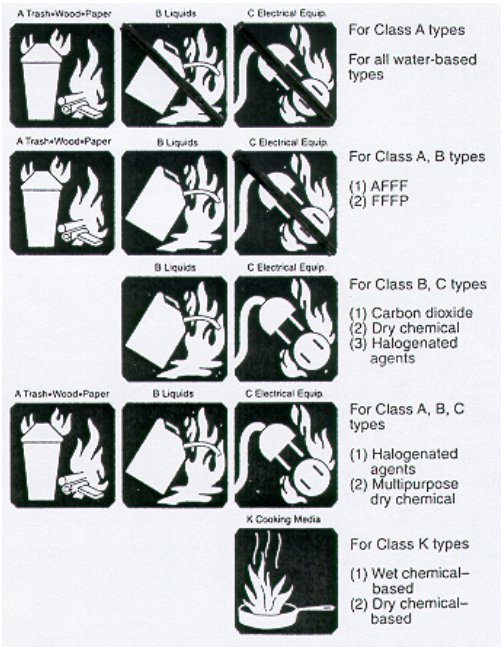
A multi-purpose dry chemical fire extinguisher may be used to extinguish more than 2 Classes fires. Examples of some fire extinguishers are shown below.

Examples of fire extinguishers

| 10-B:C (10BC) | 3-A:40-B:C(3A40BC) |
|---|---|
|  |  |

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

| CLASSES OF FIRES | TYPES OF FIRES | PICTURE SYMBOL |
|---|---|---|
| A | Wood, paper, cloth, trash & other ordinary materials. | |
| B | Gasoline, oil, paint and other flammable liquids. | |
| C | May be used on fires involving live electrical equipment without danger to the operator. | |
| D | Combustible metals and combustible metal alloys. | |
| K | Cooking media (Vegetable or Animal Oils and Fats) | |




**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.

## 6.3 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 record must be kept on the back of the PFE tag or by an approved electronic method that provides a permanent record.

**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. The information of the annual inspection record must be indicated on the new PFE tag.

## 6.4 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


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

## 6.5 Emergency Procedures

6.5.1 Fire notification

Anyone becoming aware of any fire is required to immediately notify the emergency operator (911). The New York City 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 department. You should also notify the building's designated fire safety person who is familiar with the building and can meet the responding emergency units upon their arrival, and direct them quickly to the fire area.

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 addition to calling 911, you should also activate the fire alarm system manual pull station. Activation of the manual pull station will sound the alarm in the building.

The C of F holder may need to initiate an orderly evacuation when required by the hazard presented by any release and take reasonable steps to isolate the hazard until the Fire Dept. arrives. The Certificate of Fitness holder must answer any questions asked by them 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 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.

6.5.2 Significant release

In the event of a significant release of cryogenic fluids or compressed gases that poses a threat to employees and/or the environment, immediately evacuate the area and notify the emergency operator (911). The New York City Fire Department will respond. You are then required to notify your supervisor.

## 7. 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 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 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.

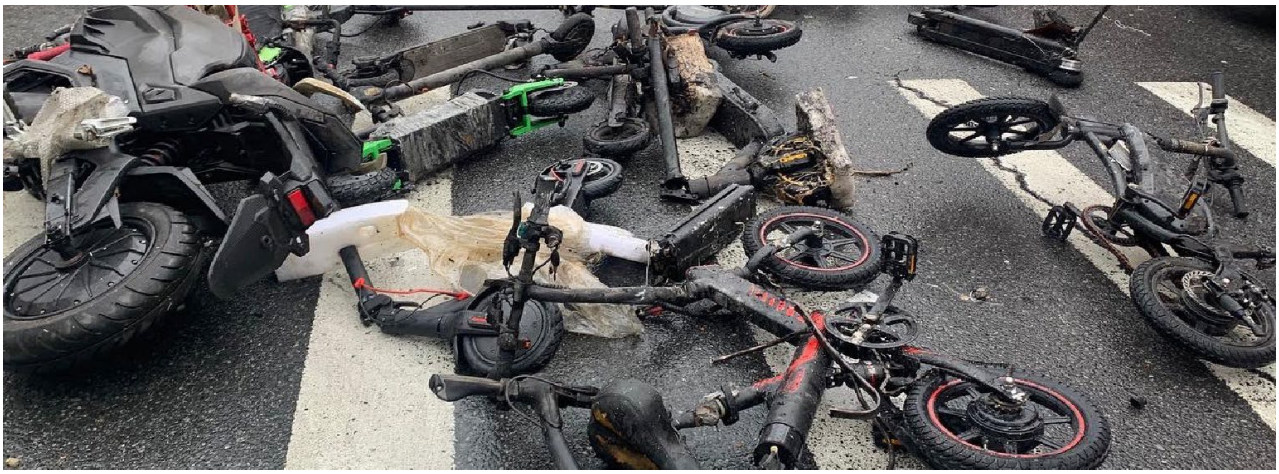

**Fire Extinguishers**
**do not work**
on lithium-ion batteries fires.

**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.



**APPENDIX A. FDA PUBLIC HEALTH ADVISORY**

# Guidance for Hospitals Nursing Homes, and Other Health Care Facilities

## *FDA PUBLIC HEALTH ADVISORY*

Comments and suggestions regarding this document should be submitted within 90 days of publication in the *Federal Register* of the notice announcing the availability of the guidance. Submit comments to Dockets Management Branch (HFA-305), Food and Drug Administration, 5630 Fishers Lane, rm. 1061, Rockville, MD 20852. All comments should be identified with the docket number listed in the notice of availability that publishes in the *Federal Register*.

For questions regarding this document contact Duane Sylvia (301) 594-0095.

**U.S. Department of Health and Human Services**
**Food and Drug Administration**
**Center for Drug Evaluation and Research (CDER)**

**March 2001**
**Compliance**

# Guidance for Hospitals, Nursing Homes, and Other Health Care Facilities

# FDA Public Health Advisory[1]

This guidance represents the Food and Drug Administration's (FDA's) current thinking on this topic. It does not create or confer any rights for or on any person and does not operate to bind FDA or the public. An alternative approach may be used if such approach satisfies the requirements of the applicable statutes and regulations.

## I. INTRODUCTION

This guidance is intended to alert hospitals, nursing homes, and other health care facilities to the hazards of medical gas mix-ups. The Food and Drug Administration (FDA) has received reports during the past 4 years from hospitals and nursing homes involving 7 deaths and 15 injuries to patients who were thought to be receiving medical grade oxygen, but were receiving a different gas (e.g., nitrogen) that had been mistakenly connected to the oxygen supply system. This guidance makes recommendations that will help hospitals, nursing homes, and other health care facilities avoid the tragedies that result from medical gas mix-ups.

## II. BACKGROUND

On December 7, 2000, a nursing home in Bellbrook, Ohio, reported 2 patient deaths and 8 patients injured following a mix-up in their oxygen supply system. The nursing home had supposedly received a shipment of four cryogenic vessels[2] containing medical grade oxygen. Included in the delivery, however, was a cryogenic vessel of industrial grade nitrogen. The nursing home was running low on oxygen and sent a maintenance employee to connect a new oxygen vessel to the oxygen supply system. The employee selected the

[1] This guidance was developed by the Office of Compliance in the Center for Drug Evaluation and Research (CDER), Food and Drug Administration.

[2] Cryogenic vessels are used to contain material that is stored at very low temperatures.

nitrogen vessel and discovered, correctly, that he was unable to connect the vessel to the oxygen system — as a safeguard, the connectors for oxygen vessels are specially fitted so they are compatible only with oxygen delivery systems. The employee removed a fitting from an empty oxygen vessel and installed it on the nitrogen vessel. He then connected the deadly product to the oxygen system. Several days later, 2 of the injured patients died from exposure to industrial nitrogen, bringing the death total from this one incident to 4.

On April 22, 1998, a hospital in Idaho discovered that a large cryogenic vessel of industrial nitrogen had been connected to the oxygen system supplying the operating rooms, labor and delivery rooms, and emergency room. The hospital discovered that the medical gas delivery person initially had been unable to connect the incompatible nitrogen vessel outlet fitting to the oxygen system, but had used a wrench to disconnect the nitrogen fitting and replace it with an oxygen fitting. Two patients died as a result of this medical gas mix-up.

In October 1997, a hospital in Nebraska received a shipment of medical grade oxygen in large cryogenic vessels. The shipment included one cryogenic vessel of industrial grade argon that was properly labeled. The hospital was running low on oxygen and sent a maintenance employee to connect an oxygen vessel to the oxygen supply system. Without examining the label, the employee selected the argon vessel, and, discovering he was unable to connect the vessel to the oxygen supply system, he removed a fitting from an empty oxygen vessel, installed it on the argon vessel, and connected the deadly product to the oxygen system. Argon was administered to a patient undergoing minor surgery. The patient died.

On December 2, 1996, a childrens' home located in New York reported adverse reactions experienced by nine patients due to the inhalation of carbon dioxide. An employee of the home, asked to attach a large cryogenic vessel of medical grade oxygen, unknowingly selected a carbon dioxide vessel from the home's inventory. He noted that the fitting on the carbon dioxide vessel was not compatible with the connector on the oxygen system. Nonetheless, he removed an oxygen fitting from an empty vessel, installed it on the carbon dioxide vessel, and attached it to the oxygen supply system. Two patients were injured critically, and four patients experienced varying stages of respiratory distress.

All four cases reveal striking similarities:

> The person connecting the vessel to the oxygen system (e.g., the delivery person or the facility employee) was not properly trained and did not understand that connection incompatibility is a built in safeguard.
>
> Prior to installing the cryogenic vessel to the oxygen supply system, the person making the connection did not examine the drug label applied to the cryogenic vessel to ensure that the product was medical oxygen.

The Agency has identified additional practices that may contribute to continuing medical gas mix-ups resulting in injury and death:

Although recommended by the Compressed Gas Association, many of the large cryogenic vessels used to contain medical gases do not have permanently brazed, or welded, connections or fittings that cannot be removed.

Unfortunately, not all medical gas vessels are labeled using 360-degree wrap-around labels.

Separate storage areas often are not provided either in the delivering vehicle or at the receiving facility to sufficiently separate medical grade products from industrial grade products.

As a result, many medical gases are improperly or poorly labeled; the wrong gases are delivered accidentally to hospitals, nursing homes, and other health care facilities; and poorly trained personnel are connecting the wrong vessels to oxygen supply systems, despite connection incompatibilities. Patients continue to suffer injury or death.

## III. RECOMMENDATIONS

All of the incidents described above could have been avoided if a few simple safety procedures had been followed. It is important that ***all*** employees handling a medical gas be alerted to and reminded of the possible hazards associated with using medical gas.

The Agency recommends implementing the following:

1. If your facility receives medical gas deliveries, you should store medical grade products separately from industrial grade products. The storage area for medical grade products should be well defined with one area for receiving full cryogenic vessels and another area for storing empty vessels.

2. All personnel who will be handling medical gases should be trained to recognize the various medical gas labels. Personnel should be trained to examine all labels carefully.

3. If your supplier uses 360-degree wrap-around labels to designate *medical oxygen*, personnel should be specifically trained to make sure each vessel they connect to the oxygen system bears such a label.

4. Make sure that all personnel in your facility who are responsible for changing or installing cryogenic vessels are trained to connect medical gas vessels properly. Personnel should understand how vessels are connected to the oxygen supply system and be alerted to the serious consequences of changing connections.

5. You should emphasize repeatedly that the fittings on these vessels should ***not be changed*** under any circumstances. If a cryogenic vessel fitting does not seem to connect to the oxygen supply system fitting, the supplier should be contacted immediately. The vessel should be returned to the supplier to determine the fitting or connection problem.

6. Once a cryogenic vessel is connected to the oxygen supply system, but ***prior*** to introducing the product into the system, a knowledgeable person should ensure that the correct vessel has been connected properly.

We urge you to take every opportunity to promote the importance of properly handling medical gases. Alert all personnel in your facility, but especially those who are directly responsible for handling medical gas, to the potential hazards involved.

## IV. REPORTING ADVERSE EVENTS OR ERRORS TO FDA

Medical gases are prescription drugs. Therefore, all medical gas manufacturers who receive reports of death or serious injury associated with the use of medical gases are required under 21 CFR 310.305 and/or 314.80 to report those incidents to the FDA.

Hospitals, nursing homes, and other health care facilities should submit reports to CDER (301-594-0095) or directly to FDA's voluntary reporting program, MedWatch, by phone (800) FDA-1088, by facsimile (800) FDA-0178, or by mail to MedWatch, Food and Drug Administration(HFA-2), 5600 Fishers Lane, Rockville, Maryland, MD, 20857-9787.

## APPENDIX B. OCCUPANCY DESCRIPTION

| Occupancy | Occupancy Description | Examples |
|---|---|---|
| Group A | Assembly: for gathering together people | |
| A-1 | With fixed seating, intended for the production and viewing of the performance arts or motion pictures | Theaters,<br>Concert halls |
| A-2 | Food and/or drink consumption | Banquet halls, Cafeterias, Bars, Restaurants |
| A-3 | Worship, recreation or amusement, and other assembly uses not classified elsewhere in Group A | Art galleries, Bowling alleys<br>Classrooms (with 75 persons or more)<br>Courtrooms, Houses of worship<br>Museums, School auditoriums |
| A-4 | Indoor sporting events or activities with spectator seating | Swimming pools<br>Tennis courts |
| A-5 | Participation in or viewing outdoor activities | Grandstands, Bleachers, Stadiums |
| Group B | Business: Office, professional, service-type transaction, public or civic services | Banks<br>Civic administration offices<br>Educational occupancies above the 12th grade (not in Group A)<br>Nonproduction Laboratories<br>Radio and television stations not admitting an audience |
| Group E | Educational: 5 or more persons at any one time for educational purposes offered to children through he 12th grade and where no more than 2 children under the age of 2 | Schools,<br>Day care facilities where no more than two children are under the age of 2 |
| Group F | Factory: for assembling, disassembling, fabricating, finishing, manufacturing, packaging, repair, cleaning or processing operation that are not in Group H | |
| F-1 | Moderate-hazard | Aircraft repairs, Bakeries<br>Manufacturing motor vehicles<br>Dry cleaning using or storing combustible solvents<br>Food processing (except meat slaughtering)<br>Production laboratories (moderate hazards) |
| F-2 | Low-hazard: involve non-combustible, non-flammable materials, or low-hazardous production | Appliances, Glass products<br>Production laboratories (low hazards)<br>Nonflammable plastic products |

| Occupancy | Occupancy Description | Examples |
|---|---|---|
| Group H | High Hazard: for manufacturing, processing, generation or storage of materials that constitute a physical or health hazard in quantities in excess of the those found in BC table 307.7(1) and table 307.7(2) | |
| H-1 | Materials that present a detonation hazard | Explosive Materials<br>Denotable water-active materials |
| H-2 | Uses present a deflagration hazard or a hazard from accelerated burning | Flammable or combustible liquids are used in open system<br>Flammable gas |
| H-3 | Materials that readily support combustion or present a physical hazard | Flammable or combustible liquids are used in close system<br>Flammable solids<br>Oxidizing cryogenic fluid |
| H-4 | Materials that are health hazards | Corrosive, Toxic materials |
| H-5 | Semiconductor fabrication facilities using hazardous production materials (HPM) in excess of the permitted aggregate quantity | |
| Group I | Institutional: people are cared for or live in a supervised environment | |
| I-1 | Housing persons, on a 24-hours basis, capable of self-preservation and responding to an emergency situation without physical assistance from staff | Alcohol and drug abuse rehabilitation centers<br>Halfway houses |
| I-2 | Medical, surgical, nursing or custodial care, on a 24-hour basis, of more than 3 persons, who are not capable of self-preservation or responding to an emergency situation without physical assistance from staff | Hospitals, Nursing homes<br>Metal hospitals where patients are not under restraint |
| I-3 | More than 5 persons who are detained under restraint or security reason | Mental hospitals where patients are under restraint<br>Prisons, Jails, Detention centers |
| I-4 | Day care facilities, occupied by persons of any age who receive custodial care (without overnight) by individuals other than parents, guardians, or relatives in a place other than at the home. | Day nurseries |
| Group M | Mercantile: display and sale of merchandise | Department stores, Drug stores<br>Motor fuel-dispensing facilities<br>Wholesale stores |
| Group R | Residential: for dwelling or sleeping purposes when not classified as Group I | |

| Occupancy | Occupancy Description | Examples |
|---|---|---|
| R-1 | Occupied for a period less than one month | Hotels, Homeless shelters<br>School student dormitories not in R-2 Group |
| R-2 | More than 2 dwelling units for shelter and sleeping accommodation on a long-term basis for a month or more | Apartment houses, Apartment hotels<br>Student apartments |
| R-3 | No more than 2 dwelling units on a long-term basis for a month or more | One- and two-family dwellings<br>Group homes |
| Group S | Storage: for storage when not classified as a hazardous occupancy | |
| S-1 | Moderate-hazard storage occupancy for any flammable or combustible materials | Storage of Aerosol, Boots and shoes, Woolen clothing, Furniture Leather, Wax candles, etc |
| S-2 | Low hazard storage occupancy for non-combustible materials | Storage of Electrical motors, Food products, Glass, etc |
| Group U | Utility & Miscellaneous: structures of an accessory character, or not classified in any specific occupancy | Carports, Fences more than 6 feet high<br>Towers |

## APPENDIX C. PATIENT GAS SYSTEMS: TYPE I AND TYPE II

Type I and Type II patient gas systems are used in pre-existing medical gas systems, which were, established prior 2008.

**The Requirements Patient Gas Systems -- Type II,**
Type II systems cover nonflammable gas system installations that:
(a) Have not more than 3000 SCF total capacity of all gases (excluding nitrogen) connected and in storage at one time, except that the total capacity of all gases shall be permitted to be increased to 5000 SCF (excluding nitrogen) if oxygen is used in a DOT Specification 4L (liquid) cylinder,
and
(b) Have a listed pressure regulator directly connected to each cylinder,
and
(c) Supply only a single treatment facility and also as a minimum comply with the specific requirements:

1.) Two cylinders of oxygen and two cylinders of nitrous oxide (if used) if storage is remote, or two cylinders of oxygen and one cylinder of nitrous oxide (if used) if storage is not remote.
2.) The cylinders for each gas service shall be manifolded so that the cylinders can alternately supply the piping system. Each bank shall contain at least an average day's supply. When the content of the primary bank is unable to supply the system, the secondary bank shall be capable of being manually switched to supply the system. Automatic switchover shall be permitted.
3.) When the supply system is remote, the switchover shall be automatic.

or
(d) Supply a maximum of two single treatment facilities and also as a minimum comply with the specific requirements:
1.) Two cylinders of oxygen and two cylinders of nitrous oxide (if used).
2.) The cylinders for each gas service shall be manifolded so that the cylinders can alternately supply the piping system. Each bank shall contain at least an average day's supply. When the content of the primary bank is unable to supply the piping system, the secondary bank shall automatically operate to supply the piping system.

**The Requirements Patient Gas Systems -- Type I**

Medical gas systems not specifically provided for in the type II systems mentioned above, such as systems within a hospital served by a central supply system or systems serving three or more treatment facilities, as may be found in a medical or dental office building, shall comply in all respects with Type I systems.