Revised on 03/28/2016

FIRE DEPARTMENT • CITY OF NEW YORK

STUDY MATERIAL FOR THE CERTIFICATE OF FITNESS EXAMINATION

G-46

STORAGE, HANDLING, USE, AND REFILLING OF NON-FLAMMABLE COMPRESSED GASES

***Note:*

Handling & filling of CO_2 (no storage)

**example: driver of a truck with a CO_2 tank

→ **Obtain G-82 C of F**

Storage & Handling & Use of CO_2

**example: CO_2 user with CO_2 on premises in quantity greater than 4,500 SCF

→ **Obtain G-46 C of F**

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NOTICE OF EXAMINATION

Title: **Examination for Certificate of Fitness for Handling, Use, Storage And Refilling Of Non-Flammable Gas Cylinders (G-46).**

Date of Exam: Written exams are conducted Monday through Friday (except legal holidays) 8:00 AM to 2:30 PM.

G-46 Certificate of Fitness can be obtained by passing a written exam or qualifying for an exemption on the basis of education and experience.

REQUIREMENTS FOR WRITTEN EXAM

Applicants who need to take the exam must apply in person and bring the following documents:

1. Applicants must be at least 18 years of age.
2. Applicants must have a reasonable understanding of the English language.
3. Applicant must provide two forms of identifications; at least one identification must be government issued photo identification, such as a State-issued Driver's License or Non Driver's License or a passport.
4. Applicants must present a letter of recommendation from his/her employer. The letter must be on official letterhead, and must state the applicant's full name, experience and the address where the applicant will work. If the applicants are self-employed or the principal of the company, they must submit a notarized letter attesting to their qualifications. For more info:
   - Sample of recommendation letter: http://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-samplerec-letter.pdf
   - Sample of self-employed letter: http://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-sample-selfrec-letter.pdf
5. Applicants must present a completed application for certificate of fitness (A-20 Form). http://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-application-form.pdf
6. Applicants not currently employed may take the exam without the recommendation letter. If the applicants pass the exam, FDNY will issue a temporary letter with picture for the job seeking purpose. The C of F card will not be issued unless the applicants are employed and provide the recommendation letter from his/her employer.

7. Special Note for the G-46 exam:

***Note:*

Handling & filling of CO_2 (no storage)

**example: driver of a truck with a CO_2 tank

→ **Obtain G-82 C of F**

Storage & Handling & Use of CO_2

**example: CO_2 user with CO_2 on premises in quantity greater than 4,500 SCF

→ **Obtain G-46 C of F**

8. **APPLICATION FEES:**

The **$25** application fee for the exam can be paid by one of the following methods:

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

For fee waivers submit: ***(Only government employees who will use their C of F 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

A convenience fee of 2.49% will be applied to all credit card payments.

9. **EXAM INFORMATION**

The **G-46** exam will consist of **30** 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 45 minutes to complete the test. A passing score of at least 70% is required in order to secure a Certificate of Fitness.

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-g46-noe-study-materials.pdf

10. If all the requirements are meet and pass the exam a certificate will be issued the same day. Applicant who fails the exam will receive a failure

report. To retake the exam applicants will need to submit a new application and payment.

ALTERNATIVE ISSUANCE PROCEDURE (AIP)

This certificate of fitness can be obtained by qualifying for an exemption of an exam on the basis of education and experience. Applicants who qualify for AIP must apply online. For more detail information applicants must review the **G-46** AIP information.
http://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-g46-aip.pdf

RENEWAL REQUIREMENTS

This Certificate of Fitness must be renewed every ***THREE YEARS***. The renewal fee is **$15**. FDNY also reserves the right to require the applicants to take a re-examination upon submission of renewal applications.

You will receive a courtesy notice of renewal 90 days before the expiration date. However, it is your responsibility to renew your Certificate. It is very important to renew your C of F before it expires. Renewals submitted 90 days (up to one year) after the expiration date will incur a $25 penalty in addition to the renewal fee. Certificates expired over one year past expiration date will not be renewed. New exams will be required.

To change a mailing address:

- Submit a letter requesting the change of mailing address and a copy of your C of F with $5.00 fee.

To change a work location,

- Submit a letter from your current employer (on company letterhead) confirming that you are an employee and stating your new work location with a copy of your C of F with a $5.00 fee.

To request a replacement certificate:

- Submit a driver's license or passport, social security number and mailing address with $5.00 fee.

The certificate can be renewed **On-line**, **by Mail** or **in Person**.

- **Renewal online**

If you are an individual, make sure you have your 12 digit Certificate of Fitness Access ID. This can be found on your Renewal Notice. If you do not have your Renewal Notice, your Access ID is your 8 digit Certificate of Fitness number and the last four digits of your social security number. If you are submitting renewals on behalf of a company's employees, the company must be approved by FDNY and have an 8 digit Company Code. To request approval, email pubrenew@fdny.nyc.gov.

Renewal fee can be paid by one of the following methods:

- Credit card (American Express, Discover, MasterCard, or Visa)
- Debit card (MasterCard or Visa)

- E-check

A fee exempted applicants cannot renew online only by mail or in person.

If all the requirements are met, the certificate of fitness will be mailed out within 10 days.
For online renewal go to: https://paydirect.link2gov.com/FDNYCOF/ItemSearch

- **Renewal by mail**

Mail your Renewal Notice (if you did not receive a Renewal Notice, a copy of your certificate), along with your fee payment

Personal or company check or money order (made payable to the New York City Fire Department)

For fee waivers submit: ***(Only government employees who will use their C of F 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

and if applicable, supporting documents to:

NYC Fire Department (FDNY)
Cashier's Unit
9 MetroTech Center, 1st Floor
Brooklyn, NY 11201

If all the requirements are met, the certificate of fitness will be mailed out within four to six weeks.

- **Renewal in person**

Submit your completed Renewal Form, Renewal Notice or certificate number and fee payment to:

NYC Fire Department (FDNY)
Cashier's Unit
9 MetroTech Center, 1st Floor
Brooklyn, NY 11201

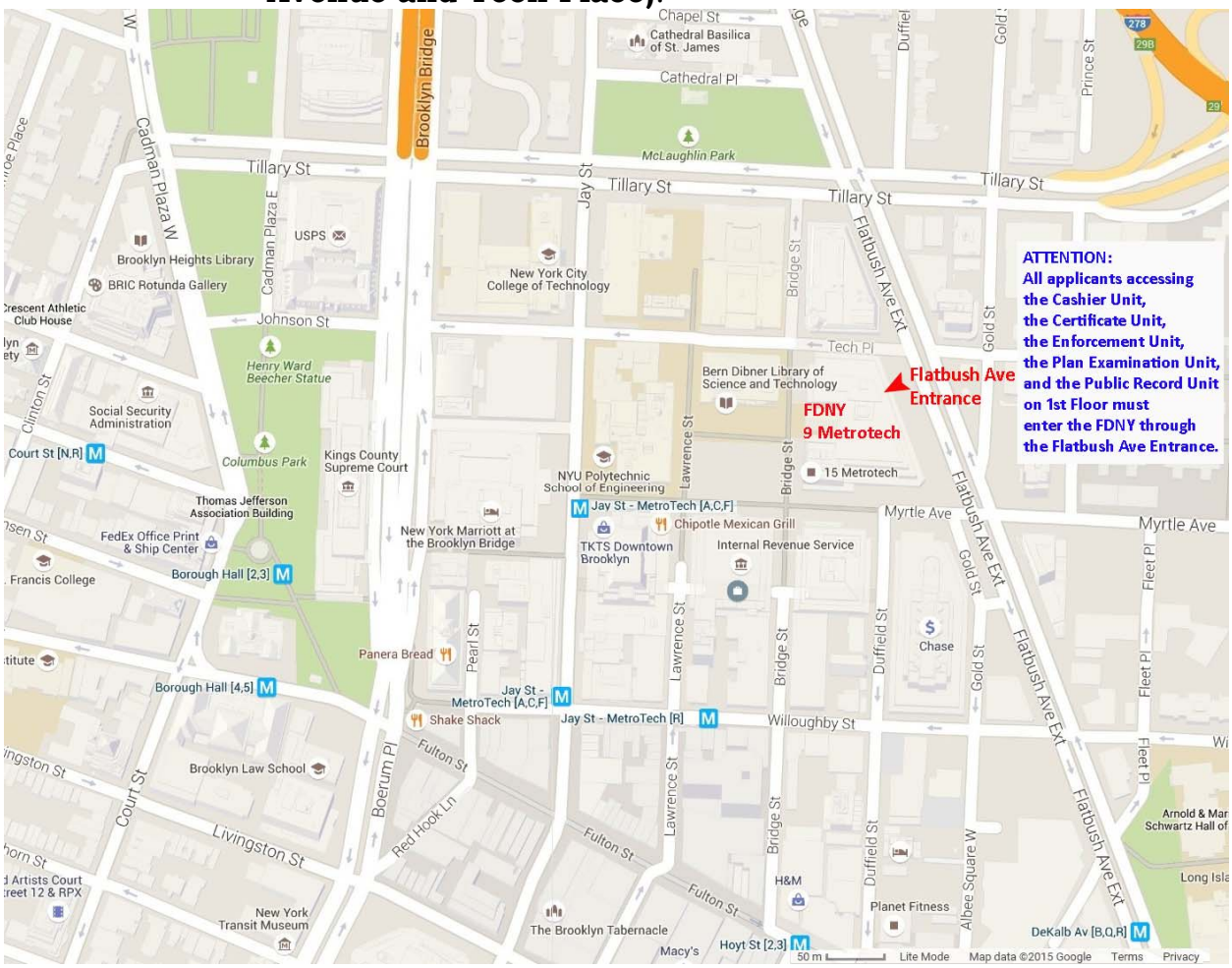
Renewal fee can be paid by one of the following methods:

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

If all the requirements are met, the certificate of fitness will be issued the same day.

A convenience fee of 2.49% will be applied to all credit card payments for original or renewal certificates.

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



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 *Handling, Use, Storage and Refilling of Non-Flammable Compressed Gases.* 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, handle, and refill non-flammable 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 30, FC Section 3704, FC Section 4004.2, and the NFPA 55, Chapter 7 (2010 Ed.), NFPA 99, Chapter 5 and 9 (2005 Ed.) and CGA-P1.

The test covers the main body of the booklet only. The four appendixes are provided for your reference only. **The tables which appear in the main body of this booklet will be provided to you when you take the test at Metrotech, however, this booklet will not be provided to you during the test.**

About the Test

30 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 and refilling of **non-flammable** compressed gases in compressed gas **containers** and **systems**. A non-flammable gas is a gas at 68°F or less at 14.7 pounds per square inch absolute (psia) of pressure which:

1. Is NOT 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 E681; or
2. DOES NOT have 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 E681.

The test covers the main body of the booklet only. The four appendixes are provided for your reference only. **The tables which appear in the main body of this booklet will be provided to you when you take the test at Metrotech, however, this booklet will not be provided to you during the test.**

The examples of non-flammable gases including, but not limited to the following gases:

Gases	Nonliquefied Compressed Gas	Liquefied Gas	Physical Hazards	Additional Gas Properties	
				Corrosive	Toxic/ Highly toxic
Ammonia*		X	Nonflammable	X	
Argon	X		Nonflammable		
Carbon Dioxide		X	Nonflammable		
Helium	X		Nonflammable		
Nitrogen	X		Nonflammable		
Sulfur Dioxide		X	Nonflammable	Note.	X
Sulfur Hexafluoride		X	Nonflammable		
Air	X		Oxidizer		
Chlorine		X	Oxidizer	Note.	X
Nitrous Oxide		X	Oxidizer		
Oxygen	X		Oxidizer		

Note. Corrosive in the presence of moisture.

*: Anhydrous ammonia is classified by the Department of Transportation as nonflammable. However, ammonia vapor in high concentrations (16-25% by weight in air) will burn. It is unlikely that such concentrations will occur except in confined spaces or in the proximity of large spills. The fire hazard from ammonia is increased by the presence of oil or other combustible materials.

This booklet incorporates the safety requirements of

(1) storage, handling and use of non-flammable gases (previously known as the G-46)
(2) refilling compressed gases at pressure greater than 15 psi (previously known as the G-16)
(3) storage and use of liquefied chlorine gas (previously known as the G-13)

1.1 Certificate of Fitness

The storage, handling, use and refilling of non-flammable compressed gases shall be supervised by a person holding a G-46 certificate of fitness:

(1) Handling and use: The handling and use of compressed gases in quantities requiring a permit, including **non-piped medical gas** systems, shall be under the personal supervision of a person holding a G-46 certificate of fitness.

(2) Storage: The storage of compressed gases in quantities requiring a permit, including medical gases that are not piped, shall be under the general supervision of a person holding a G-46 certificate of fitness.

(3) Filling of containers: The transfer of nonflammable compressed gases between containers shall be performed by a person holding a G-46 certificate of fitness.

The Certificate of Fitness holders are responsible for ensuring that all Fire Department regulations related to the safe using, handling and storage of nonflammable compressed gases are obeyed on the premises.

The following materials are **NOT** covered in the G-46 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)
Piped medical gas systems	FC 3006, Fire Rule 4830-01	Supervision of medical piped medical gas systems (G-71)
Cryogenic fluid	FC Ch. 32 FC Ch. 30	Supervision of storage, handling, and use of commercial cryogenic systems (G-79)
Handling and filling carbon dioxide	Fire Rule 3004-01	Handling and filling carbon dioxide (G-82)
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 nonflammable compressed gases.

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.

On the other hand, all installations are required to comply with the operational and maintenance requirements of the 2008 Fire Code. Operational and maintenance requirements include such things as securing permits and certificates of fitness, posting signage, proper housekeeping, periodic testing, periodic maintenance, keeping logs and providing portable fire extinguishers.

More often than not, "pre-existing" installations will be storing nonflammable compressed gases 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 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 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.

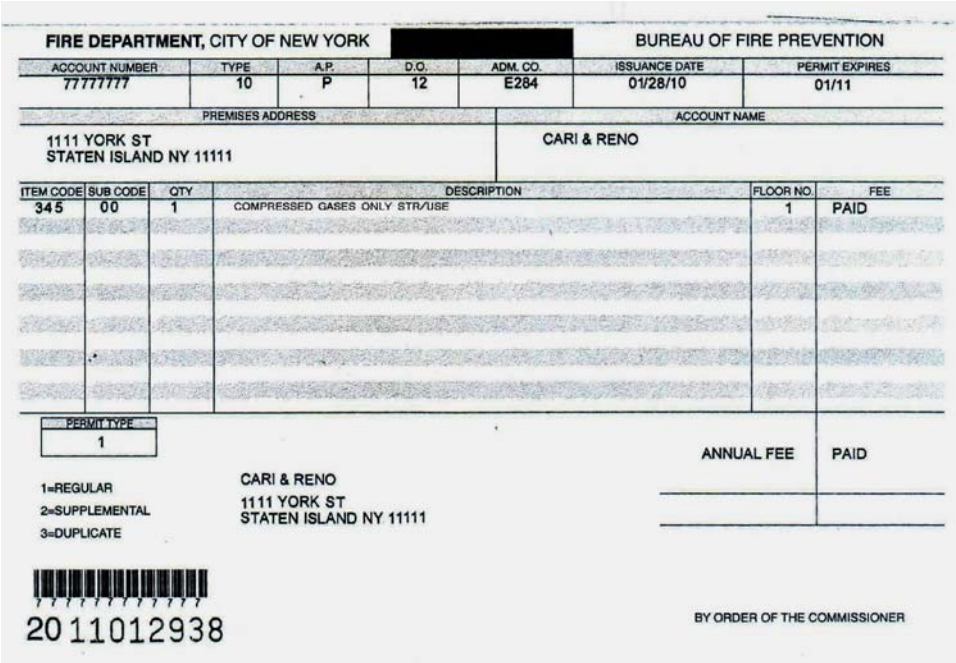
Please note that installations that were "lawfully" existing prior to July 1, 2008 but not under the purview of the FDNY (no FDNY permit established) may be considered "pre-existing" installations provided they were in compliance with nationally recognized standards and the NYC Building Code at the time of installation. More often than not most "pre-existing" installations will be storing nonflammable compressed gases 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 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 operational and maintenance requirements 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.

1.3 Types of Permits

(1) Site-specific permit

Such permit authorizes the permit holder to store, handle and use nonflammable compressed gases 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 construction site.



FIRE DEPARTMENT, CITY OF NEW YORK [redacted] BUREAU OF FIRE PREVENTION

ACCOUNT NUMBER	TYPE	A.P.	D.O.	ADM. CO.	ISSUANCE DATE	PERMIT EXPIRES
7777777	10	P	12	E284	01/28/10	01/11

PREMISES ADDRESS	ACCOUNT NAME
1111 YORK ST STATEN ISLAND NY 11111	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

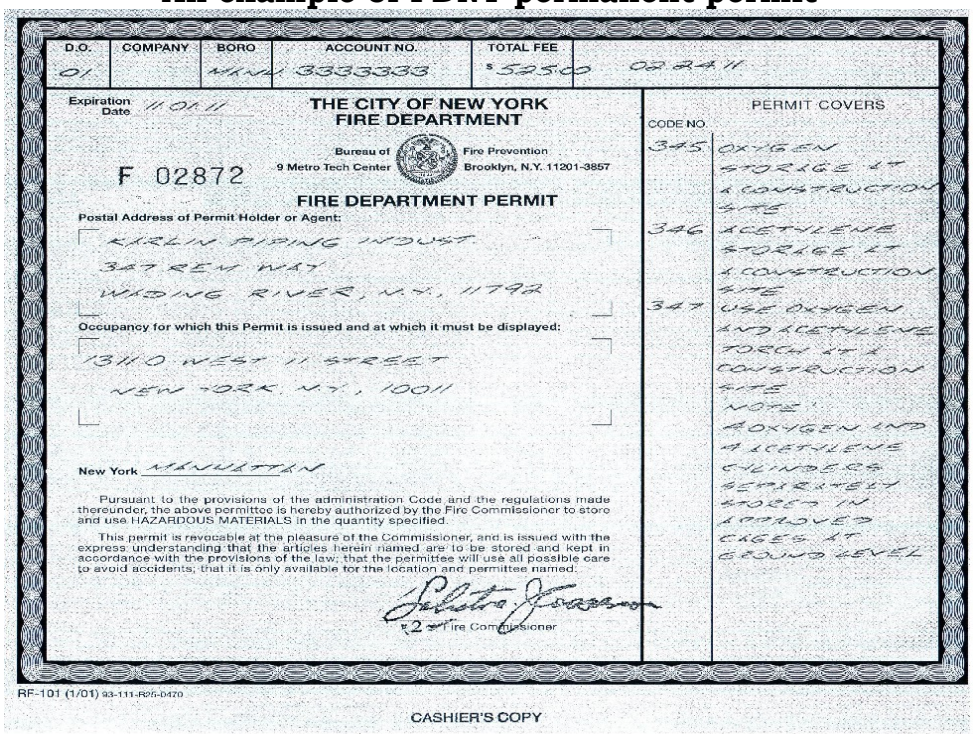
CARI & RENO
1111 YORK ST
STATEN ISLAND NY 11111

ANNUAL FEE PAID

2011012938

BY ORDER OF THE COMMISSIONER

An example of FDNY permanent permit



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

Expiration Date 11 01 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 REM WAY
WADING 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 MANHATTAN

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-R05-0470

CASHIER'S COPY

An example of FDNY temporary permit

(2) Citywide permit
Such permit authorizes the permit holder to store, handle, use, sell or transport nonflammable compressed gases, or conduct an operation on a citywide basis, for which a permit is required by Fire Department. A citywide permit is valid to conduct an operation at one or more locations provided the duration of such activity at any individual location does not exceed 30 days. Periods of activity in excess of 30 days at any one location shall require a site-specific permit.

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

Type of Gas	Amount (SCF)
Corrosive	400
Nonflammable and nonoxidizing, except carbon dioxide	3,000
Carbon dioxide	4,500
Oxidizing	504
Highly toxic	Any Amount
Toxic	Any Amount
Unstable (reactive)	Any Amount

1.4 Material Safety Data Sheets (MSDS)

Material Safety Data Sheet (MSDS) information should be readily available. The material safety data sheet (MSDS) 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 MSDS may list appropriate and inappropriate extinguishing agents. The Certificate of Fitness holder must refer to the MSDS when questions arise about how to handle, use, or store hazardous chemicals or materials. The MSDS may also be requested by health care personnel to facilitate proper medical care in the event of chemical exposure.

1.5 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
₩	Reacts violently or explosively with water
₩ 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 "₩" 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

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.

CORROSIVE GAS. A gas that causes visible destruction of or irreversible alterations in living tissue by chemical action at the site of contact. (refer to Appendix A for examples)

DOTn. United States Department of Transportation.

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.

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 department 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.

HIGHLY TOXIC GAS. A chemical that has a median lethal concentration (LC_{50}) in air of 200 ppm by volume or less of gas or vapor, or 2 mg/L or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 g and 300 g (0.44 lb and 0.66 lb) each. For purpose of FC, chlorine gas is classified as a highly toxic gas. (refer to Appendix A for examples)

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.

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. (refer to Appendix A for examples)

PERSONAL SUPERVISION. Supervision by the holder of any department certificate who is required to be personally present on the premises, or other proximate location acceptable to the department, 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 id inside diameter to allow a calculation for transportation viz., speed, volumes etc. (od = id + 2 * wt)

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).

TOXIC GAS. A gas with a median lethal concentration (LC_{50}) in air of more than 200 ppm, but not more than 2000 ppm by volume of gas or vapor, or more than 2 mg/L, but not more than 20 mg/L of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 g and 300 g (0.44 lb and 0.66 lb) each. For purpose of FC, chlorine gas is classified as a highly toxic gas. (refer to Appendix A for examples)

UNSTABLE (REACTIVE) MATERIAL. A material, other than an explosive, which in the pure state or as commercially produced, will vigorously polymerize, decompose, condense or become self-reactive and undergo other violent chemical changes, including explosion, when exposed to heat, friction or shock, or in the absence of an inhibitor, or in the presence of contaminants, or in contact with incompatible materials. Unstable (reactive) materials shall be classified as follows:

Class 1. Materials that in themselves are normally stable but which can become unstable at elevated temperatures and pressure.

Class 2. Materials that in themselves are normally unstable and readily undergo violent chemical change but do not detonate. This class includes materials that can undergo chemical change with rapid release of energy at normal temperatures and pressures, and that can undergo violent chemical change at elevated temperatures and pressures.

Class 3. Materials that in themselves are capable of detonation or of explosive decomposition or explosive reaction but which require a strong initiating source or which must be heated under confinement before initiation. This class includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.

Class 4. Materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures. This class includes materials that are sensitive to mechanical or localized thermal shock at normal temperatures and pressures.

3. GENERAL REQUIREMENTS OF COMPRESSED GAS

3.1 Containers

Compressed gas containers shall be designed and fabricated in accordance with the specifications of the ASME Boiler and Pressure Vessel Code or DOTn regulations, or be otherwise approved. 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.**

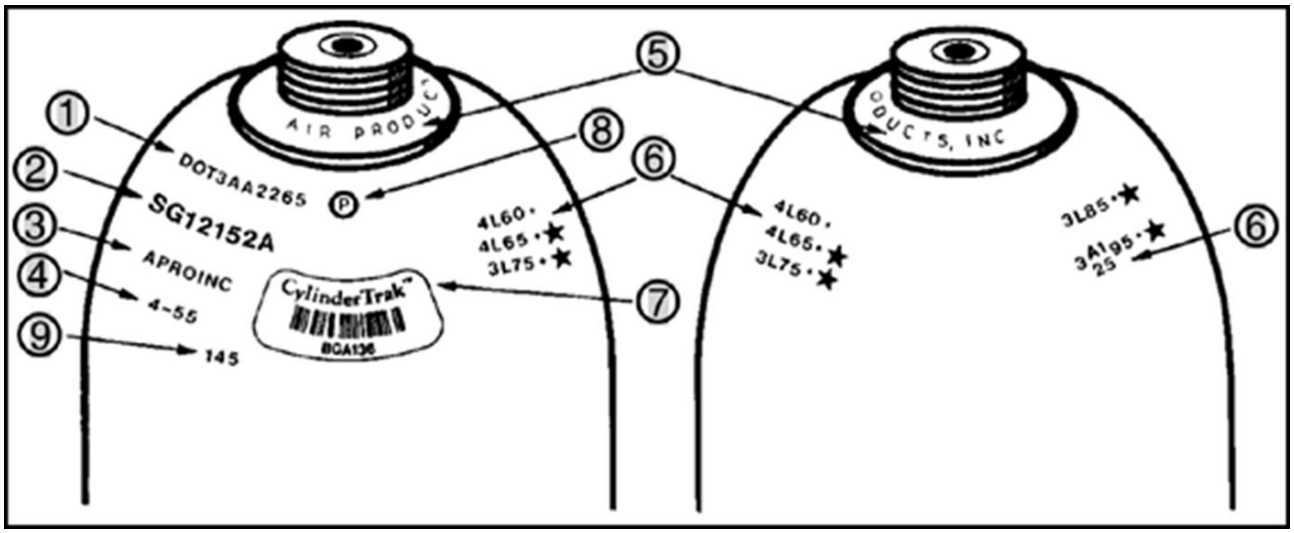
Areas used for the storage, handling and use of compressed gas containers and systems shall be **provided with approved lighting by natural or artificial means**. Compressed gas containers and systems shall not be used for any purpose other than as a vessel for the materials that they are designed to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

3.2 Markings and Signs

<u>(1) Label all compressed gas containers clearly</u>
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. **Do not rely solely on the color of the container to identify the contents**. **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 containers 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".

<u>(2) Markings on non-medical piping systems</u>

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**. Piping that is used to convey more than one gas at various times shall be marked to provide clear identification and warning of the hazard. 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**.

Exceptions:

1. Piping that is designed or intended to carry more than one compressed gas at various times shall have appropriate signs or markings posted at the manifold, along the piping and at each point of use to provide clear identification and warning.

2. Piping within gas-manufacturing plants, gas-processing plants and similar occupancies shall be marked in an approved manner.

3.3 Related Equipment

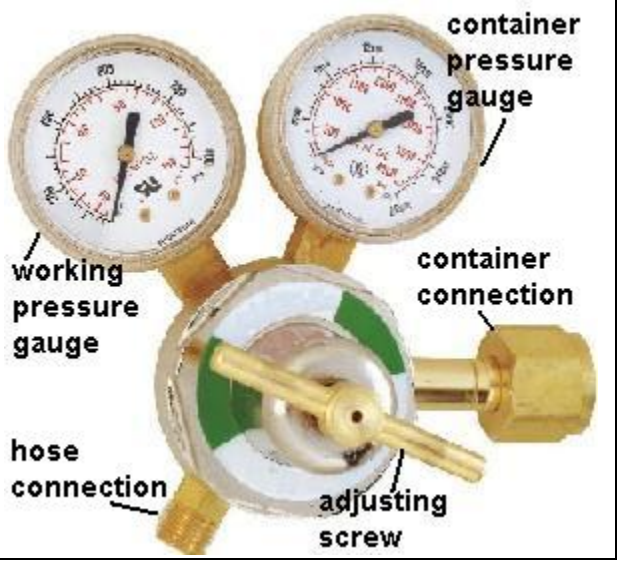
(1) Control valve

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. The pressure-relief device shall have the capacity to prevent the maximum design pressure of the container or system from being exceeded. 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. 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 Tubing

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**.

Readily accessible manual valves, or automatic remotely-activated fail-safe emergency shutoff valves, shall be installed on supply piping and tubing at the point of use and at the tank, container or other source of supply.

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. Backflow prevention or check valves shall be provided when the backflow of hazardous materials could create a hazardous condition or cause the unauthorized discharge of hazardous materials.

Excess flow control

Where gases having a hazard ranking of health hazard Class 3 or 4, or reactivity Class 3 or 4 in accordance with NFPA 704 are conveyed in pressurized piping above 15 pounds per square inch gauge (psig), an approved means of leak detection and emergency shutoff or excess flow control shall be provided. Where the piping originates from within a hazardous material storage room or area, the excess flow control shall be located within the storage room or area. Where the piping originates from any other source of supply, the excess flow control shall be located as close to the source of supply as practical.

Exceptions:
1. Piping for inlet connections designed to prevent backflow.
2. Piping for pressure relief devices.

Supply piping and tubing for gases having a health-hazard ranking of 3 or 4 in accordance with NFPA704 shall be in accordance with ANSI B31.3 and the piping and tubing utilized for the transmission of highly toxic, toxic or highly volatile corrosive gases shall have welded, threaded or flanged connections throughout, except where connections are located within a ventilated enclosure if the material is a gas.

3.4 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.

3.4.1 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. Nesting of compressed gas containers **at container filling or servicing facilities or in seller's warehouses not accessible to the public**. Nesting shall be allowed provided the nested containers, if dislodged, do not obstruct any required means of egress.
4. 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.
5. Securing stationary compressed gas containers to a foundation designed for such use in accordance with the construction codes, including the Building Code.

3.4.2 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 or filled. 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 or filled. Keep container valve closed at all times, except when the container is in active use.

3.4.3 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-46 certificate of fitness holder.

3.5 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) Incompatible materials.

Compressed gas containers shall be separated from each other based on the hazard class of their contents. Compressed gas containers shall be separated from incompatible materials.

Incompatible materials, shall be separated while in storage except for stored materials in individual containers each having a capacity of not more than 5 pounds. Separation shall be accomplished by:

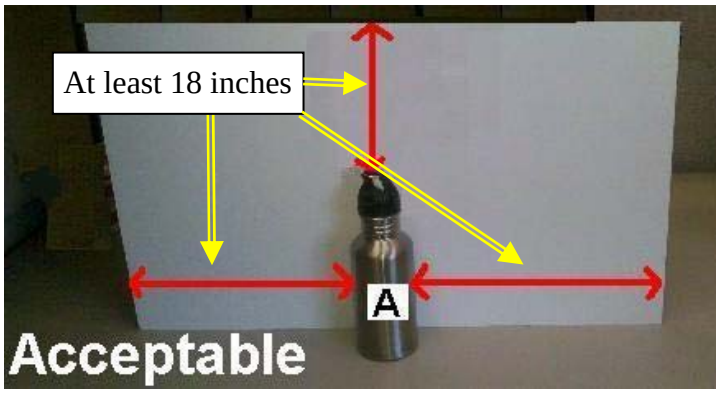
- Segregating incompatible materials in storage by a distance of not less than 20 feet.

Or

- Isolating incompatible materials in storage by a noncombustible partition extending not less than 18 inches above and to the sides of the stored material.

Or

- Storing compressed gases in gas cabinets or exhausted enclosures in accordance with the Fire Code. Materials that are incompatible shall not be stored within the same cabinet or exhausted enclosure.



(2) Combustible waste and vegetation.

Do not store compressed gas containers near flammable or combustible substances such as oil, gasoline or waste. **Combustible waste and vegetation shall be kept a minimum of 10 feet from compressed gas containers and systems.** 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.

(3) 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**.

(4) 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.

(5) Falling objects.

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

(6) 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 valve-protective caps.

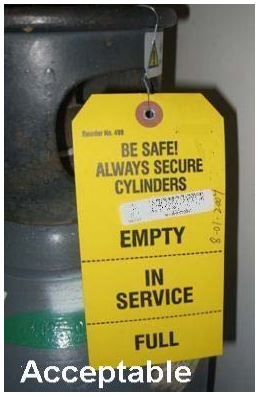
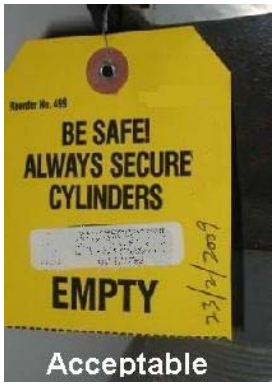
(7) Wiring and equipment.

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.

3.6 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
		

4. STORAGE, HANDLING, AND USE OF COMPRESSED GAS

4.1 Storage of Compressed Gases

4.1.1 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.

Unless otherwise exempted by the Fire Department, hazard identification signs as set forth in NFPA 704 for the compressed gas 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.

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.

4.1.2 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.

4.1.3 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.

4.2 Exhausted Enclosures, and Gas Cabinet

Indoor storage and use areas and storage buildings shall be provided with mechanical exhaust ventilation or natural ventilation in accordance with Fire Code. Where gases having a hazard ranking of 3 or 4, as defined in NFPA 704 are used, mechanical exhaust ventilation shall be provided to capture fumes, mists or vapors at the point of generation, except for the gases that do not generate harmful fumes, mists or vapors. When mechanical ventilation is provided, the systems shall be operational during such time as the building or space is occupied.

4.2.1 Exhausted enclosures

Where an exhausted enclosure is used to increase maximum allowable quantity per control area or 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.

4.2.2 Gas cabinets

Where a gas cabinet is used to increase the maximum allowable quantity per control area or 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.

4.3 Handling and Use of Compressed Gases

4.3.1 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.

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

4.3.2 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.

4.3.3 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.

4.3.4 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.

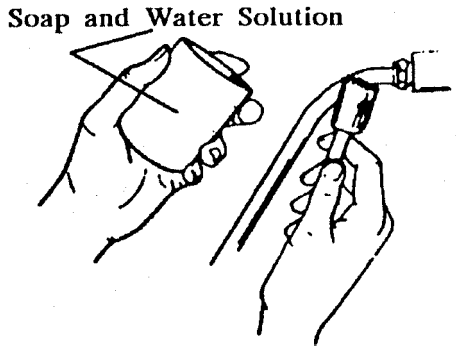
4.3.5 Check for Leaks

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.**



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. If the gas is toxic, place an appropriate sign at the compressed gas container, warning against these hazards. Notify the gas supplier and follow his instructions as to the return of the compressed gas container.

5. SPECIAL REQUIREMENTS FOR NONFLAMMABLE GASES WITH SPECIFIC HAZARDS

5.1 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 rooms in accordance with the storage regulations.

Table 5- 1.Maximum allowable quantity of nonflammable gases, **storage and used in closed systems**, per **indoor** control area

Building protected throughout by a sprinkler system?	Floor Level		# of Control Areas per Floor	Non-flammable Gases							
				NOT in Gas Cabinets or Exhausted Enclosures (SCF)				in Gas Cabinets or Exhausted Enclosures (SCF)			
				Oxidizing gas	Corrosive gas[a]	Highly toxic gas	Toxic gas	Oxidizing gas	Corrosive gas[a]	Highly toxic gas	Toxic gas
NO	Above Grade	>9	1	75	40.5	Not Allowed	40.5	150	81	1	81
		7-9	2	75	40.5		40.5	150	81	1	81
		4-6	2	187.5	101.25		101.25	375	202.5	2.5	202.5
		3	2	750	405		405	1,500	810	10	810
		2	3	1,125	607.5		607.5	2,250	1,215	15	1,215
		1	4	1,500	810		810	3,000	1,620	20	1,620
	Below Grade	1	3	1,125	607.5		607.5	2,250	1,215	15	1,215
		2	2	750	405		405	1,500	810	10	810
		> 2	0	Not Allowed				Not Allowed			
				Oxidizing gas	Corrosive gas[b]	Highly toxic gas	Toxic gas	Oxidizing gas	Corrosive gas[b]	Highly toxic gas	Toxic gas
YES	Above Grade	>9	1	150	81	Not Allowed	81	300	162	2	162
		7-9	2	150	81		81	300	162	2	162
		4-6	2	375	202.5		202.5	750	405	5	405
		3	2	1,500	810		810	3,000	1,620	20	1,620
		2	3	2,250	1,215		1,215	4,500	2,430	30	2,430
		1	4	3,000	1,620		1,620	6,000	3,240	40	3,240
	Below Grade	1	3	2,250	1,215		1,215	4,500	2,430	30	2,430
		2	2	1,500	810		810	3,000	1,620	20	1,620
		> 2	0	Not Allowed				Not Allowed			

a. A single container of anhydrous ammonia containing not more than 150 pounds in a single control area in a building not protected throughout by a sprinkler system shall be considered a maximum allowable quantity.

b. Two containers of anhydrous ammonia, each containing not more than 150 pounds in a single control area shall be considered a maximum allowable quantity provided the building is protected throughout by a sprinkler system.

Table 5- 2. Maximum allowable quantity of **unstable(reactive) gases storage,** per **indoor** control area

Building protected throughout by a sprinkler system?	Floor Level		# of Control Areas per Floor	Unstable (reactive) nondetonable gases							
				NOT in Gas Cabinets or Exhausted Enclosures (SCF)				in Gas Cabinets or Exhausted Enclosures (SCF)			
				Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4
NO	Above Grade	>9	1	37.5	12.5	2.5	Not Allowed	75	25	5	Not Allowed
		7-9	2	37.5	12.5	2.5		75	25	5	
		4-6	2	93.75	31.25	6.25		187.5	62.5	12.5	
		3	2	375	125	25		750	250	50	
		2	3	562.5	187.5	37.5		1,125	375	75	
		1	4	750	250	50		1,500	500	100	
	Below Grade	1	3	562.5	187.5	37.5		1,125	375	75	
		2	2	375	125	25		750	250	50	
		> 2	0	Not Allowed				Not Allowed			
				Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4
YES	Above Grade	>9	1	75	25	5	0.5	150	50	10	1
		7-9	2	75	25	5	0.5	150	50	10	1
		4-6	2	187.5	62.5	12.5	1.25	375	125	25	2.5
		3	2	750	250	50	5	1,500	500	100	10
		2	3	1,125	375	75	7.5	2,250	750	150	15
		1	4	1,500	500	100	10	3,000	1,000	200	20
	Below Grade	1	3	1,125	375	75	7.5	2,250	750	150	15
		2	2	750	250	50	5	1,500	500	100	10
		> 2	00	Not Allowed				Not Allowed			

Table 5- 3. Maximum allowable quantity of **unstable(reactive) gases use**, per **indoor** control area

Building protected throughout by a sprinkler system?	Floor Level		# of Control Areas per Floor	Unstable (reactive) nondetonable							
				NOT in Gas Cabinets or Exhausted Enclosures (SCF)				in Gas Cabinets or Exhausted Enclosures (SCF)			
				Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4
NO	Above Grade	>9	1	Not Limited	12.5	0.5	Not Allowed	Not Limited	25	1	Not Allowed
		7-9	2		12.5	0.5			25	1	
		4-6	2		31.25	1.25			62.5	2.5	
		3	2		125	5			250	10	
		2	3		187.5	7.5			375	15	
		1	4		250	10			500	20	
	Below Grade	1	3		187.5	7.5			375	15	
		2	2		125	5			250	10	
		> 2	0	Not Allowed				Not Allowed			
				Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4
YES	Above Grade	>9	1	Not Limited	25	1	0.1	Not Limited	50	2	0.2
		7-9	2		25	1	0.1		50	2	0.2
		4-6	2		62.5	2.5	0.25		125	5	0.5
		3	2		250	10	1		500	20	2
		2	3		375	15	1.5		750	30	3
		1	4		500	20	2		1,000	40	4
	Below Grade	1	3		375	15	1.5		750	30	3
		2	2		250	10	1		500	20	2
		> 2	00	Not Allowed				Not Allowed			

Table 5- 4.Maximum allowable quantity of nonflammable gases per **outdoor** control area

Gases	Class	Storage (SCF)	Use (SCF)
Oxidizing gases		1,500	1,500
Corrosive gases		810[a]	810[a]
Highly toxic gases		20[b]	20[b]
Toxic gases		810	810
Unstable (reactive) gases, nondetonable	4	10	2
	3	50	10
	2	250	250
	1	750	Not Limited

a. Two containers of anhydrous ammonia, each container containing not more than 150 pounds, shall be considered a MAQ in an outdoor control area.
b. Allowed only when used in approved exhausted gas cabinets, exhausted enclosures or under fume hoods.

5.2 Oxidizing Gases

This section shall govern the storage, handling and use of compressed oxidizing gases. The handling and use of compressed **oxidizing gases** in quantities requiring a permit shall be under the personal supervision of a G-46 certificate of fitness holder. The storage of compressed **oxidizing gases** in quantities requiring a permit shall be under the general supervision of a G-46 C of F holder.

5.2.1 General requirements

Oxidizing gases must be separated from all classes of flammable gas by at least 20 feet. 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).

Compressed gas systems conveying oxidizing gases shall be provided with approved emergency shutoff valves that can be activated at each point of use and each source.

(A). Sources of ignition

Smoking

It shall be unlawful to smoke in the following locations, and "No Smoking" signs shall be provided in English as a primary language and in symbols:

1. In rooms or areas where oxidizing gases are stored or used in open systems in amounts requiring a permit.
2. Within 25 feet of outdoor oxidizing gases storage, handling and use areas, including dispensing areas.

Open flames
Open flames and devices that generate or operate at a high temperature shall be kept a safe distance from oxidizing gases in storage or use.

(B). 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.

5.2.2 Quantities exceeding the MAQ per control area

If the storage of oxidizing gas is exceeding the MAQ per control area, the outdoor storage areas for the oxidizing gases shall be located in accordance with Table 5-5.

Table 5- 5. Oxidizing gases— Distance from storage to exposures[a]

Quantity of gas stored (scf)	Distance to a building not associated with the manufacture or distribution of oxidizing gases or public street, private road or lot line (feet)	Distance between storage areas (feet)
greater than 3,000 up to 50,000	5	5
greater than 50,000 up to 100,000	10	10
greater than 100,000	15	15

a. The distances do not apply when protective structures having a minimum fire-resistance rating of 2 hours interrupt the line of sight between the storage container and the exposure. The protective structure shall be at least 5 feet from the exposure. The configuration of the protective structure shall be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations.

5.3 Nonflammable Medical Gas (non-piped system)

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 this section.

5.3.1 Storage Location

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 greater than the maximum allowable quantity per control area (refer to the table on page 22-29 of this study material) are located inside buildings or structures, they shall be stored in a 1-hour gas storage room or a gas cabinet.

One-hour gas storage 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. Supply and exhaust ducts shall be enclosed in a 1-hour-rated shaft enclosure from the room to the outdoors. Approved mechanical ventilation shall be provided for the room. Rooms shall be protected by a sprinkler system.

Gas cabinets. Gas cabinets shall comply with the regulations on page 23 of this study material 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 with a minimum of 150 feet per minute at any point of the access port or window.
2. Connected to an exhaust system.
3. Internally protected by a sprinkler system.

5.3.2 Storage requirements of oxidizing gases

Oxidizing gases, such as oxygen and nitrous oxide, shall not be stored with any flammable gas, liquid, or vapor. Oxidizing gases such as oxygen and nitrous oxide shall be separated from combustibles or materials by one of the following:

(1) A minimum distance of 20 ft

(2) A minimum distance of 1.5 m (5 ft) if the entire storage location is protected by an automatic sprinkler system designed.

(3) An enclosed cabinet of noncombustible construction having a minimum fire protection rating of ½ hour

A precautionary sign, readable from a distance of 5 ft, shall be displayed on each door or gate of the storage room or enclosure.

Examples of Acceptable Signs

5.3.3 Elimination of sources of ignition.

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. Sparking toys shall not be permitted in any patient care area. 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).

5.3.4 Safety requirements for storing gases in enclosures

Flammable gases shall not be stored with oxidizing agents. 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.

5.3.5 Other Safety requirements

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.

5.4 Nonflammable Highly Toxic and Toxic Gases

This section shall govern the storage, handling and use of compressed oxidizing gases. The handling and use of compressed **highly toxic and toxic gases** in quantities requiring a permit shall be under the personal supervision of a G-46 certificate of fitness holder. The storage of compressed **highly toxic and toxic gases** in quantities requiring a permit shall be under the general supervision of a G-46 C of F holder.

It shall be unlawful to store, handle or use highly toxic and toxic compressed gases in:

1. Group A, E, I, R or U occupancies (refer to Appendix B.)
2. Offices in Group B, F, M or S occupancies (refer to Appendix B), or any other areas of such occupancies that are accessible to the public.

5.4.1 Gas rooms, Gas cabinets, and exhausted enclosures

Gas room
Where a gas room is provided to comply with the requirements of highly toxic or toxic compressed gases storage the gas storage rooms should be in accordance with the following regulations:

(1) The gas rooms must be dry, cool and well ventilated.
(2) The gas rooms shall be constructed in accordance with the construction code and be protected with a sprinkler system. The ventilation system for gas rooms shall be installed in accordance with the construction codes and shall be designed to operate at a negative pressure relative to the surrounding area.

Gas cabinets.
The maximum number of containers located in a single gas cabinet shall not exceed three, except that cabinets containing containers not over 1 pound net contents are allowed to contain up to 100 containers.

Gas cabinets and exhausted enclosures shall be protected by a sprinkler system. Alternative fire extinguishing systems shall not be used in lieu of a sprinkler system.

Exhausted enclosures
The exhaust ventilation from gas room shall be directed to an exhaust system. Gas rooms shall be protected throughout by a sprinkler system. Alternative fire extinguishing systems shall not be used in lieu of a sprinkler system.

5.4.2 General requirements

Storage of portable containers with highly toxic gas shall be located in gas cabinets, exhausted enclosures or fume hoods.

5.4.3 Quantities exceeding the MAQ per control

The storage, handling or use of highly toxic and toxic gases in amounts exceeding the MAQ per control area shall be in accordance with this section.

(A). Local exhaust for portable container
A means of local exhaust shall be provided to capture leaks from portable containers. The local exhaust shall consist of portable ducts or collection systems designed to be applied to the site of a leak in a valve or fitting on the container. The local exhaust system shall be located in a gas room. Exhaust shall be directed to a treatment system (refer to the Appendix C).

(B). Leaking containers

One or more gas cabinets or exhausted enclosures shall be available on the premises to capture the gas from the containers until such time as the leaking container can be removed from the premises and disposed of lawfully.

Exceptions:

1. Where containers are located within gas cabinets or exhausted enclosures.
2. Where approved containment vessels or containment systems are provided in accordance with the following requirements:
   a) Containment vessels or containment systems shall be capable of fully containing or terminating a release.
   b) Trained personnel shall be available at an approved location.
   c) Containment vessels or containment systems shall be capable of being transported to the leaking container.

The gas cabinets and exhausted enclosures for the leaking containers must be located in gas rooms and connected to an exhaust system.

(C). General indoor requirements.

All portable containers stored, handled or used indoors shall be located within gas cabinets, exhausted enclosures or gas rooms. All other containers shall be located within gas rooms or exhausted enclosures. The room or other area in which gas cabinets or exhausted enclosures are located shall be provided with exhaust ventilation. Gas cabinets or exhausted enclosures shall not be used as the sole means of exhaust for any room or area.

(D). General outdoor requirements.

Use of portable container with highly toxic or toxic gas in outdoors shall be located in gas cabinets or exhausted enclosures to direct the toxic gas. Gas cabinets or exhausted enclosures are to prevent the migration of the air contaminants into the breathing zones of people outdoors.

Weather protection for portable containers.

Outdoor highly toxic and toxic gases storage areas sheltered by overhead noncombustible construction shall be provided for portable containers located outdoors and not within gas cabinets or exhausted enclosures. The storage area shall be protected throughout by a sprinkler system.

Exception: A sprinkler system is not required when:

1. All materials under the weather protection structure, including hazardous materials and the containers in which they are stored, are noncombustible.
2. The weather protection structure is located not less than 30 feet from combustible materials or structures or is separated from such materials or structures using a fire barrier.

5.5 Nonflammable Corrosive Gases.

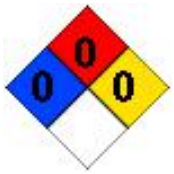
Corrosive gases and vapors are hazardous to all parts of the body; certain organs, such as the eyes and the respiratory tract, are particularly sensitive. The severity of the effect from the gas is related to the solubility of the material in the body fluids. Highly soluble gases (e.g. ammonia, hydrogen chloride) cause severe nose and throat irritation, while substances of lower solubility (e.g. nitrogen dioxide, phosgene, sulfur dioxide) can penetrate deep into the lungs.

The general precautions of storage, handling and use of corrosive gases:

- Corrosive gases should be used in a chemical fume hood to control exposure or use PPE.
- Protect all exposed skin surfaces from contact with corrosive or irritating gases and vapors (e.g. using PPE).
- Cylinders used and then return to storage should have all appurtenances (regulators, control valves, etc.) removed from the valve outlet and should preferably be flushed with dry nitrogen or air to keep them in good working order.
- When corrosive gases are to be discharged into a liquid a trap, check valve, or a vacuum break device should be employed to prevent dangerous reverse flow.
- A good supply of water should be available to handle emergency leaks. Most corrosive gases can be absorbed in water.

6. COMMON NON-FLAMMABLE COMPRESSED GASES

6.1 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 19.5-23.5% oxygen, 76.5-80.5% nitrogen.

6.2 Ammonia

Ammonia is an irritating and colorless liquefied compressed gas packaged in cylinders. It is lighter than air with a characteristic pungent smell
Ammonia, either directly or indirectly, is also a building-block for the synthesis of many pharmaceuticals and is used in many commercial cleaning products.
Ammonia can cause severe eye, skin and respiratory tract burns.

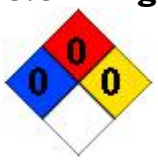
The storage of anhydrous ammonia can pose fire or explosive risks. For example, at least five people are dead and more than 160 injured after an explosion at an anhydrous ammonia fertilizer plant in the small Texas town of West in April, 2013. Anhydrous ammonia is a widely used, efficient form of nitrogen fertilizer. When used in agriculture, it's compressed into a clear, colorless liquid and stored at extremely low temperatures. Anhydrous ammonia can rapidly cause dehydration and severe burns if it combines with water in the body. **It poses an immediate fire and explosion hazard when it is in high concentrations (16-25% by weight in air).** Exposure to very high concentrations of gaseous ammonia can result in lung damage and death. Although ammonia is regulated in the United States as a non-flammable gas, it still meets the definition of a material that is toxic by inhalation.

Wear self-contained breathing apparatus (SCBA) when entering release area if concentrations exceed allowable exposure limits. Fully protective suits are required in large releases. Always be aware of fire and explosion potential in the case of large releases.

ACCIDENTAL RELEASE MEASURES
Evacuate immediate area. Eliminate any possible sources of ignition, and provide maximum explosion-proof ventilation. Shut off source of leak if possible. Isolate

any leaking cylinder. If leak is from container, pressure relief device or its valve, contact your supplier. If the leak is in the user's system, close the cylinder valve, safely vent the pressure, and purge with an inert gas before attempting repairs. Ammonia vapors can be controlled with water spray, however; runoff may be contaminated. Releases that exceed 100 lbs (45.4 kgs) during a 24-hour period must be reported. All responders must be adequately protected from exposure. Levels of Ammonia should be below levels
listed in Section 2 (Composition / Information on Ingredients) and the atmosphere must have at least 19.5% oxygen before personnel can be allowed in the area without self-contained breathing apparatus (SCBA).

6.3 Argon



Under ambient conditions, this is a colorless, odorless, tasteless gas with no odor at high pressure. Argon is the third most common gas in the Earth's atmosphere. Argon is mostly used as an inert shielding gas in welding and other high-temperature industrial processes where ordinarily non-reactive substances become reactive; for example, an argon atmosphere is used in graphite electric furnaces to prevent the graphite from burning. Argon gas also has uses in incandescent and fluorescent lighting, and other types of gas discharge tubes. Argon makes a distinctive blue-green gas laser.

It may cause rapid suffocation and may cause dizziness and drowsiness. Self-contained breathing apparatus and protective clothing may be required by rescue workers.

ACCIDENTAL RELEASE MEASURES
Immediately contact emergency personnel. Keep unnecessary personnel away. Use suitable protective equipment. Shut off gas supply if this can be done safely. Isolate area until gas has dispersed.

6.4 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 used by the food industry, the oil industry, and the chemical industry.

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 Air Products emergency telephone number. If leak is in user's system close cylinder valve and vent pressure before attempting repairs.

6.5 Chlorine

It is a yellow-green with distinct and irritating odor gas under standard conditions. It is HIGHLY TOXIC and CORROSIVE. May be fatal if inhaled. Strong oxidizer. Most combustibles will burn in chlorine as they do in oxygen. Principal applications of chlorine are in the production of a wide range of industrial and consumer products. For example, it is used in making plastics, solvents for dry cleaning and metal degreasing, textiles, agrochemicals and pharmaceuticals, insecticides, dyestuffs, household cleaning products, etc.

ACCIDENTAL RELEASE MEASURES
Air release:
Reduce vapors with water spray. Collect runoff for disposal as potential hazardous waste.
Soil release:
Dig holding area such as lagoon, pond or pit for containment. Dike for later disposal. Trap spilled material at bottom in deep water pockets, excavated holding areas or within sand bag barriers. Absorb with sand or other non-combustible material. Add an alkaline material (lime, crushed limestone, sodium bicarbonate, or soda ash).
Water release:
Add an alkaline material (lime, crushed limestone, sodium bicarbonate, or soda ash). Absorb with activated carbon. Collect spilled material using mechanical equipment.

6.6 Helium

Helium is a nontoxic, odorless, colorless, nonflammable gas stored in cylinders at high pressure. 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. Other major uses were pressurizing and purging systems, maintenance of controlled atmospheres, and welding. 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.

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.

6.7 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.

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 Air Products emergency telephone number. If leak is in user's system close cylinder valve and vent pressure before attempting repairs.

6.8 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.

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.

6.9 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 80% or more oxygen 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.

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 Air Products emergency telephone number. If leak is in user's system close cylinder valve and vent pressure before attempting repairs.

6.10 Sulfur Dioxide

Sulfur Dioxide is a nonflammable, colorless, irritating, liquefied compressed gas packaged in cylinders. It has a suffocating odor, detectable at 3-5 ppm, and leaves an acidic taste in the mouth (0.3-1 ppm). It is a toxic, corrosive gas that can cause severe chemical burns if inhaled or upon skin contact.

Some dried fruits are preserved using Sulfur Dioxide to prevent discoloration of the fruit. Sulfur Dioxide is also used in bleaching materials and as a fumigant. Sulfur Dioxide is also used in bleaching materials and as a fumigant.

ACCIDENTAL RELEASE MEASURES
Evacuate immediate area. If spill is small, ventilate area or remove cylinder to an outdoor location. Use appropriate protective equipment. If spill is large, evacuate all personnel from affected area. Increase ventilation to release area. Use appropriate protective equipment. Materials that are contacted by releasing product must be decontaminated. Regardless of spill size, shut off source of leak if possible. Isolate any leaking cylinder. If leak is from container, pressure relief device or its valve, contact your supplier. If leak is in user's system, close cylinder valve, safely vent pressure and purge with inert gas before attempting repairs.

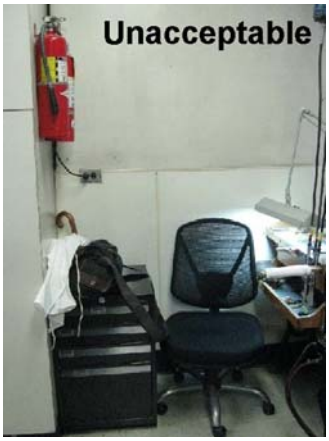
6.11 Sulfur Hexafluoride

Sulfur hexafluoride is an inorganic, colorless, odorless, and non-flammable greenhouse gas. It is generally transported as a liquefied compressed gas. It is most used as a gaseous dielectric medium in the electrical industry, an inert gas for the casting of magnesium, and as an inert filling for insulated glazing windows.

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.

7. 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.

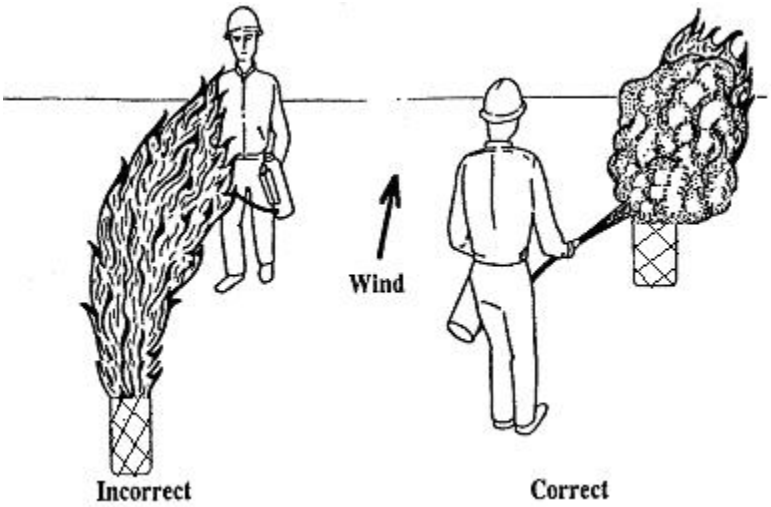
weight ≤ 40 lbs →

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.

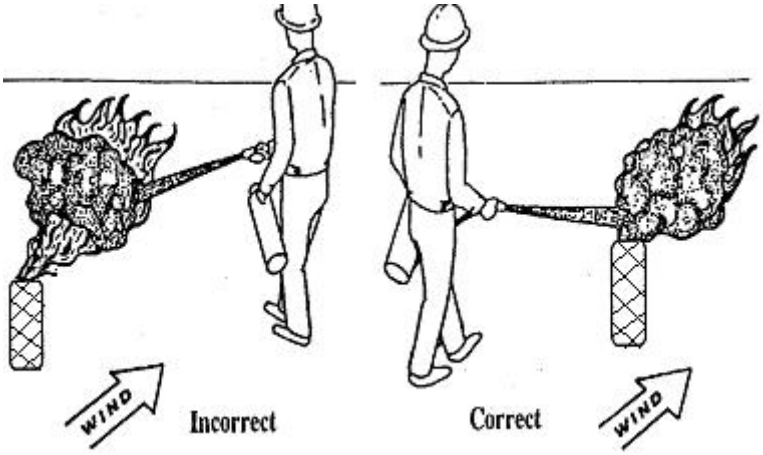
In case of any fire, 911 must be called. Fire extinguishers must be used in accordance with the instructions painted on the side of the extinguisher. They clearly describe how to use the extinguisher in case of an emergency. The Certificate of Fitness holder should be familiar with the use of portable 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.

7.1 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.

7.2 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.

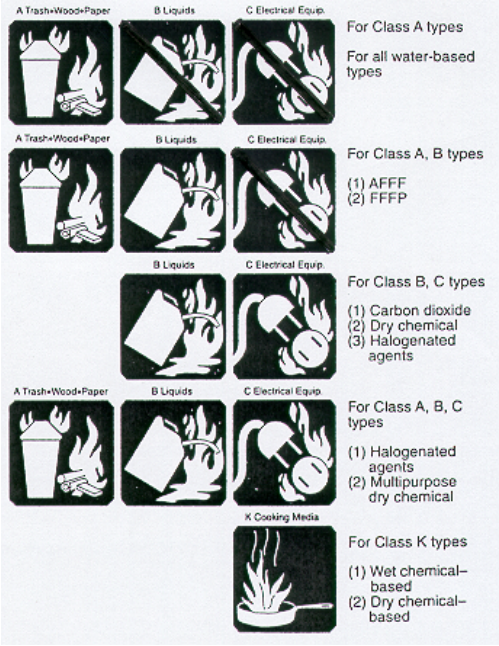
A multi-purpose dry chemical fire extinguisher may be used to extinguish more than 2 Classes fires. Examples of some fire extinguishers are shown below.

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.	D
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.

7.3 Fire Extinguisher Inspections

The extinguishers are required to be inspected monthly. The owner of the premises is responsible to designate a person to perform a monthly inspection. This inspection is a "quick check" that a fire extinguisher is available and will operate. It is intended to give reasonable assurance that the fire extinguisher is fully charged and operable. This is done by verifying that it is in its designated place, that it has not been actuated or tampered with, and that there is no obvious or physical damage or condition to prevent its operation. The information of the monthly inspection record must include the date the inspection was performed, the person performing the inspection, and those portable fire extinguishers found to require corrective action. Such recordkeeping must be either attached to the extinguisher or on an inspection checklist maintained on file. Labels or markings indicating fire extinguisher use, or classification, or both shall be placed on the front of the fire extinguisher. At least once per year, all fire extinguishers must be maintained by a FDNY approved company and a W-96 Certificate of Fitness holder.

Monthly inspection tag.

7.4 Emergency Procedures

7.4.1 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.

7.4.2 Significant release

In the event of a significant release 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.

Appendix A. Examples of Different Gas Categories

Oxidizing gases:
Common oxidizing gases include Carbogen, Heliox, *Oxygen, Ozone, Oxides Of Nitrogen, Fluorine,* and *Chlorine*. Oxidizing gases may be found in different occupancies, including hospital, industrial facilities, research laboratories.

Highly toxic and toxic gases:
Common highly toxic gases include *Arsine, Cyanogens, Diborane, Fluorine, Germane, Hydrogen Cyanide, Nitric Oxide, Nitrogen Dioxide, Ozone, Phosphine, Hydrogen Selenide, Stibine* and *Chlorine (Fire Code define chlorine as a highly toxic gas).*

Common toxic gases include *Boron Trichloride, Boron Trifluoride, Hydrogen Fluoride, Hydrogen Sulfide, Phosgene, Silicon Tetrafluoride*.

Toxic or highly toxic materials in solid state are usually the least hazardous while toxic or highly toxic materials in gaseous state are the most hazardous. Toxic materials are commonly found in use in the form of pesticides and insecticides, which may be for household use.

Fumigation and insecticidal fogging operations are examples of the use of pesticides and insecticides. Chlorine is a highly toxic material and is commonly used for pure water treatment.

Corrosive gases:
Common corrosive gases include *Chlorine, Fluorine, Ammonia*. Corrosive materials may be found in all of types of occupancies, including research laboratories, hospitals, industrial facilities, warehouses and retail stores.

Unstable(reactive) gases:
Common unstable (reactive) gases include *Butadiene (Unstabilized), Ethylene Oxide, Vinyl Chloride*. Unstable (reactive) materials are used in a variety of industrial applications, including food processing and the manufacture of plastics, textile, fireworks, explosives, rocket propellants, special fuel systems and dyes. They may also be found in the preparation of certain medicines or fumigants.

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, 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 Classrooms (with 75 persons or more) Courtrooms, Houses of worship Museums, School auditoriums
A-4	Indoor sporting events or activities with spectator seating	Swimming pools 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 Civic administration offices Educational occupancies above the 12th grade (not in Group A) Nonproduction Laboratories 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, 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 Manufacturing motor vehicles Dry cleaning using or storing combustible solvents Food processing (except meat slaughtering) Production laboratories (moderate hazards)
F-2	Low-hazard: involve non-combustible, non-flammable materials, or low-hazardous production	Appliances, Glass products Production laboratories (low hazards) 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 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 Flammable gas
H-3	Materials that readily support combustion or present a physical hazard	Flammable or combustible liquids are used in close system Flammable solids 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 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 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 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 Motor fuel-dispensing facilities 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 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 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 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 Towers

Appendix C. Treatment Systems
(FC 3704.2.2.7)
The exhaust ventilation from gas cabinets, exhausted enclosures and gas rooms, and local exhaust systems required by local exhaust for portable containers and piping and controls-stationary containers shall be directed to a treatment system. The treatment system shall be utilized to handle the accidental release of gas and to process exhaust ventilation.

Exceptions:

3. Highly toxic and toxic gases—storage. A treatment system is not required for containers in storage when the following controls are provided:
   1.1. Valve outlets are equipped with gas-tight outlet plugs or caps.
   1.2. Handwheel-operated valves have handles secured to prevent movement.
   1.3. Approved containment vessels or containment systems are provided in accordance with Section 3704.2.2.3.
4. Toxic gases—use. Treatment systems are not required for toxic gases supplied by portable containers not exceeding 660 gallons (2 498 L) liquid capacity when the following controls are provided:
   2.1. A gas detection system with a sensing interval not exceeding 5 minutes.
   2.2. An approved automatic-closing fail-safe valve located immediately adjacent to container valves. The fail-safe valve shall close when gas is detected at the permissible exposure limit (PEL) by a gas detection system monitoring the exhaust system at the point of discharge from the gas cabinet, exhausted enclosure, ventilated enclosure or gas room. The gas detection shall comply with the requirements listed in Appendix D.

Treatment systems shall be capable of diluting, adsorbing, absorbing, containing, neutralizing, burning or otherwise processing the contents of the largest compressed gas container. Where a total containment system is used, the system shall be designed to handle the maximum anticipated pressure of release to the system when it reaches equilibrium.

Treatment systems shall be designed to reduce the maximum allowable discharge concentrations of the gas to one-half immediate dangerous to life and health (IDLH) at the point of discharge to the atmosphere. Where more than one gas is emitted to the treatment system, the treatment system shall be designed to handle the worst-case release based on the release rate, the quantity and the IDLH for all compressed gases stored or used.

Treatment systems shall be sized to process the maximum worst-case release of gas based on the maximum flow rate of release and the entire contents from the largest container utilized.

Stationary containers shall be labeled with the maximum rate of release for the compressed gas contained based on valves or fittings that are inserted directly into the container. Where multiple valves or fittings are provided, the maximum flow rate of release for valves or fittings with the highest flow rate shall be indicated. Where liquefied compressed gases are in contact with valves or fittings, the liquid flow rate shall be utilized for computation purposes. Flow rates indicated on the label shall be converted to SCF.

The maximum flow rate of release for portable containers shall be calculated based on the total release from the container within 5 minutes for containers with nonliquefied content and 30 minutes for containers with liquefied content. When portable containers are equipped with approved excess flow or reduced flow valves, the worst-case release shall be determined by the maximum achievable flow from the valve as determined by the valve manufacturer or compressed gas supplier. Reduced flow and excess flow valves shall be permanently marked by the valve manufacturer to indicate the maximum design flow rate. Such markings shall indicate the flow rate for air under normal temperature and pressure.

Appendix D. Gas Detection Systems
(FC 3704.2.2.10)
A gas detection system shall be provided to detect the presence of gas at or below the permissible exposure limit (PEL) or ceiling limit of the gas for which detection is provided. The system shall be capable of monitoring the discharge from the treatment system at or below one-half the IDLH limit.

> **Exception:** A gas detection system is not required for toxic gases when the physiological warning properties for the gas are at a level below the accepted PEL for the gas.

The gas detection system shall initiate a local alarm and transmit a signal to a continuously attended control station on the premises whenever it detects the presence of the gas in the atmosphere. The alarm shall be both visual and audible and shall provide warning both inside and outside the area where gas is detected.

> **Exception:** Signal transmission to a continuously attended control station is not required where not more than one container of highly toxic or toxic gas is stored.

The gas-detection system shall automatically close the shutoff valve at the source on gas supply piping and tubing related to the system being monitored for whichever gas is detected.

> **Exception:** Automatic shutdown is not required for reactors utilized for the production of highly toxic or toxic compressed gases where such reactors are:
> 1. Operated at pressures less than 15 pounds per square inch gauge (psig).
> 2. Continuously attended.
> 3. Provided with readily accessible emergency shutoff valves.

Valve closure. When the gas-detection sampling point initiating the gas-detection system alarm is at a use location or within a gas valve enclosure of a branch line downstream of a piping distribution manifold, the shutoff valve in the gas valve enclosure for the branch line located in the piping distribution manifold enclosure shall automatically close. Under all other circumstances, shutoff valves shall comply with the following automatic closure requirements:

1. When the gas-detection sampling point initiating the gas detection system alarm is within a gas cabinet or exhausted enclosure, the shutoff valve in the gas cabinet or exhausted enclosure for the specific gas detected shall automatically close.
2. Where the gas-detection sampling point initiating the gas detection system alarm is within a gas room and compressed gas containers are not in gas cabinets or exhausted enclosures, the shutoff valves on all gas lines for the specific gas detected shall automatically close.
3. Where the gas-detection sampling point initiating the gas detection system alarm is within a piping distribution manifold enclosure, the shutoff valve for the container of specific gas detected supplying the manifold shall automatically close.