

**STUDY MATERIALS FOR THE  
CERTIFICATE OF FITNESS  
CONSOLIDATED EXAM**

# **G-98**

**G-98 COVERS THE FOLLOWING:**

- G-14 HANDLE HYDROGEN**
- G-20 DIRECT HYDROGEN: USE COOL GENERATORS**
- G-52 STORAGE AND USE OF FLAMMABLE/COMBUSTIBLE GASES**
- G-55 ETHYLENE OXIDE/STERILIZERS**

## About these study materials

These study materials will help you prepare for the written examination for the certificate of fitness for handling and storage of flammable gases. The study materials include information taken from the Fire Prevention Code, NFPA Standards, and the Fire Prevention Rules of the New York City Fire Department. The study materials do not contain all the information you need to know in order to handle and store flammable gases safely and efficiently. 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 material.

## About the Test

You must pass a multiple-choice test to qualify for the certificate of fitness. A score of 70% correct is required in order to pass the test. All questions have four answer options. Only one answer option is correct for each question. If you do not answer a question, or if you mark more than one option, your answer will be scored as incorrect. Read each question carefully before marking your answer. There is no penalty for guessing.

## Sample Questions

1. What sports team plays at Shea Stadium in New York?
  - A. Mets
  - B. Giants
  - C. Jets
  - D. Cardinals

The correct answer is "A". You would mark "A" on your answer sheet.

2. Who was the first President of the United States?
  - A. George Jefferson
  - B. George Washington
  - C. Bill Clinton
  - D. George Bush

The correct answer is "B". You would mark "B" on your answer sheet.

## Introduction

This document outlines New York City Fire Department regulations for the safe handling and storage of flammable gases in technical establishments. One primary regulation is that at least one certificate of fitness holder must be on duty at all times when the technical establishment is open. The fire commissioner may require additional certificate of fitness holders in some locations. The certificate of fitness holders are responsible for ensuring that all fire department regulations related to the safe handling and storage of flammable gases are obeyed on the premises. Some of the regulations related to storage dictate that all portable, storage and shipping containers must meet the Department of Transportation (DOT) design specifications.

## Basic Definitions

Several terms frequently used to describe characteristics of flammable gases and other hazardous materials are described below. The certificate of fitness holder must know these terms and understand their meanings.

### **Fire**

Fire is a chemical reaction known as combustion. It involves the rapid oxidation of a combustible material and the release of energy in the form of heat and light. Oxygen, heat, and fuel in proper proportions create a fire. If any one of the three elements is removed, a fire cannot exist.

### **Flammable Gas**

Flammable gases may be ignited when mixed with air in certain concentrations (e.g., acetylene, MAPP, methane and hydrogen).

### **Flammable (Explosive) Limits**

Flammable limits include all types of a flammable gas in the air that may be ignited. The lowest concentration that may be ignited is called the "lower flammable limit" (LFL) of the gas. The highest concentration is called its "upper flammable limit" (UFL). Mixtures outside these limits are either too "lean to burn" or too "rich to burn." The concentrations between the upper and lower limits are located within what is called the flammable range. Many gases have wide flammable ranges. Conditions above either normal temperature or pressure tend to increase the flammable ranges of gases.

### **Flammable Liquid**

Any liquid mixture, substance or compound that will emit a flammable vapor at a temperature below 100° Fahrenheit when tested in a Tagliabue open cup tester. (e.g., acetone and ethyl alcohol.)

### **Flashpoint**

The minimum temperature of a liquid at which sufficient vapor is produced to form an ignitable mixture in the air near the liquid's surface. Liquids with low flashpoints represent a greater fire hazard than those with high flashpoints. It is important to note that it is the vapors produced by the liquid that can ignite and explode not the liquid itself.

### **Combustible Liquid**

Any liquid, solid mixture, substance, or compound that emits a flammable vapor at temperatures between 100° Fahrenheit and 300° Fahrenheit when tested in a Tagliabue open cup tester. (E.g., fuel oil.)

## **Volatile Inflammable Oil**

Any oil or liquid that will generate a flammable vapor at a temperature below 100 degrees Fahrenheit when tested in a Tagliabue open cup tester. This refers to liquid products of coal tar, shale oil and petroleum. (E.g., benzene, xylol, gasoline, and naphtha.)

## **Flammable Solid**

A solid substance other than one classified as an explosive which is liable to cause a fire through friction, absorption of moisture, spontaneous chemical changes, or as a result of retained heat from manufacturing or processing. (E.g., white phosphorous, nitrocellulose, metallic sodium and potassium, and zirconium powder.)

## **Explosive Material**

Any quantity of Class A, Class B or Class C explosive as classified by the DOT. Any other chemical or mixture used as the propelling or exploding material in a cartridge or other explosive device is also considered a chemical.

## **Ignition Temperature**

The ignition temperature of a solid, liquid, or gas, is the minimum temperature to which it must be heated for it to ignite.

## **Oxidizing Material**

Any substance that readily yields oxygen to support combustion. (e.g., potassium permanganates, sodium nitrate, and hydrogen peroxide.)

## **Cubic Feet Water Container Capacity**

A measurement unit used to describe the volume of a storage container. It indicates the maximum amount of water that can be stored in a container.

## **PSI**

Is a measurement unit used by the New York City fire department when describing the pressure of a gas inside a cylinder. The letters PSI stand for pounds per square inch.

## **SCF**

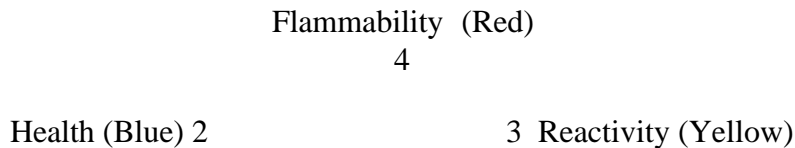
SCF stands for Standard Cubic Feet, and is used by the industry to measure capacity.

## **Material Safety Data Sheet (MSDS)**

The material safety data sheet (MSDS) for a given material is provided by its manufacturer. It contains specific information about the health and physical hazards of the material. It also lists the protective equipment required when handling the material. Frequently it describes the material's physical characteristics and the 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 should refer to the MSDS when questions arise about how to handle, use, or store a flammable gas.

## Hazard Signal Arrangements

A simple hazard classification system has been developed by the National Fire Protection Association (NFPA). It is used to quickly identify the flammability, reactivity, and health hazards associated with a material. The classification system is referred to as the Hazard Signal Arrangement. This system uses the term "material" to represent all liquids, gases and solids. Under the classification system, each material is given three ratings that represent the material's flammability, health, and reactivity hazards (in that order). Each rating ranges from 0 to 4. The higher the hazard signal number, the greater the degree of hazard associated with the material. The hazard signals are also color-coded: red for flammability, blue for health, and yellow for reactivity. A hazard classification sign may be posted on shipping and storage containers. The classification numbers are always arranged in triangular fashion, as shown in the diagram below.



### Flammability Hazard

The flammability signal describes the conditions under which the material will burn. Brief descriptions of the degrees of flammability hazard are given below.

- 4 Materials that will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature.
- 3 Materials that can be ignited under almost all ambient temperature conditions.
- 2 Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.
- 1 Materials that must be preheated before ignition can occur.
- 0 Materials that will not burn.

### Health Hazard

The health hazard signal indicates the property of a material to cause injury by contact, inhalation, or ingestion. The health hazards may be due to the characteristic properties of the material. They may also be due to the toxic products created when the material is ignited. The hazard signal is based on the greatest hazard that could exist under fire or other emergency conditions. In general, the health hazard is based on a single exposure which may vary from a few seconds up to an hour. The physical exertion demanded in emergency situations may increase the hazardous effects of the material.

Types of exposure and the associated health hazards that can occur as a result are described below.

Inhalation - nausea, headaches, muscular weakness, drowsiness and asphyxiation.

Skin contact - irritation, cracking, and rashes.

Eye contact - burning and irritation.

Ingestion - irritation of mouth, throat, and digestive tract.

The common health hazards from the burning of ordinary combustible materials are not included in the hazard signal arrangement. For example, injuries caused by the heat from a fire or force of an explosion are not included. Brief descriptions of the degrees of health hazard are given below.

- 4 Extremely hazardous materials that may, on very short exposure, cause death or major injury even when prompt medical treatment is given. These materials must not be approached without specialized protective clothing and a self-contained breathing apparatus because they can penetrate the standard protective, rubber clothing. No skin surface should be exposed to these materials.
- 3 Materials which on short exposure can cause serious temporary or injury even if prompt medical treatment is given. Full standard, protective clothing and a self-contained breathing apparatus must be worn when handling these materials. No skin surface should be exposed.
- 2 Materials which on intense or continued exposure can cause temporary or possible injury unless prompt medical treatment is given. A self-contained breathing apparatus must be worn when handling these materials.
- 1 Materials which on exposure would cause irritation but only minor residual injury even if no treatment is given. It is recommended that a self-contained apparatus be worn when handling these materials.
- 0 Materials which on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials. No protective equipment is required when handling these materials.

### **Reactivity Hazard**

The reactivity hazard signal deals with the degree of susceptibility of materials to release energy by themselves or in combination with other materials. Some materials rapidly release energy by themselves through self-reaction or polymerization. Other materials can undergo violent eruptive or explosive reactions if contacted with water or extinguishing agents. The violence of these reactions may be increased by heat and pressure.

Because of the wide variations of accidental combinations possible in fire or other emergencies, these extraneous hazard factors (except for the effect of water) cannot be applied in the hazard signal classification system. Extraneous factors must be considered on an individual basis in order to establish safe handling and storage procedures for the materials. Guidance for making these decisions is included in NFPA 49 and Hazardous Chemicals Data. This information should also be included in the material's MSDS. Brief descriptions of the degrees of reactivity hazard are given below.

- 4 Materials which in themselves are readily capable of explosion or of explosive decomposition or reaction at normal temperatures and pressures.
- 3 Materials which in themselves are capable of explosion or explosive reaction but require a strong initiating source, or which must be heated under confinement before initiation. Also materials which react explosively with water.
- 2 Materials which in themselves are normally unstable and readily undergo violent chemical change but do not explode. Also materials which may react violently with water or which may form potentially explosive mixtures with water.

- 1 Materials which in themselves are normally stable, but which can become unstable at elevated temperatures and pressures. Also materials which may react with water with some release of energy, but not violently.
- 0 Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.

## **Flammable Gases**

The following paragraphs give a brief overview of the safety precautions, rules, guidelines, work practices, and emergency procedures for the handling and storage of flammable gases. The name of each flammable gas is followed by its hazard signal classification for flammability, reactivity, and health. The certificate of fitness holder must know the properties of each of these flammable gases and their handling and storage requirements. He or she must also know the procedures that must be followed when dealing with fire or leak emergencies for these gases.

Acetylene - (Hazard Signal: 4 Flammability 0 Reactivity 1 Health)

Pure gaseous acetylene is odorless, colorless, flammable and slightly lighter than air. However, the acetylene used in standard manufacturing applications and chemical synthesis is not 100% pure, and it has a distinctive, garlic-like odor. Acetylene is also referred to as ethine or ethyne in the field.

Acetylene burns in air with an intensely hot, luminous and smoky flame. The ignition temperatures of acetylene-air and acetylene-oxygen mixtures are affected by pressure, temperature and water vapor content. For example, an air mixture containing 30 percent acetylene by volume at atmospheric pressure can be ignited at about 581° Fahrenheit (305° C). In air at atmospheric pressure the upper flammable limit (UFL) is about 80 percent acetylene by volume, and the lower flammability limit (LFL) is 2.5 percent acetylene by volume. However, if an ignition source is present, 100 percent acetylene will break down with violence under certain conditions. Acetylene can be liquefied and solidified with relative ease. In both its liquid and solid states, acetylene explodes with extreme violence when ignited unless special storage precautions are taken. It is unlawful to generate, manufacture, transport or sell liquefied acetylene in New York City.

## **Compressed Gas Cylinders**

Acetylene must be shipped and stored in Department of Transportation (DOT) approved cylinders only. The maximum authorized cylinder pressure is 250 psig at 70° Fahrenheit, with a variation of about 2.5 psig rise or fall per degree F of temperature change.

All acetylene cylinders are designed to prevent the break down of the gas. This is achieved by including a porous packing material (e.g., asbestos) and acetone inside each cylinder. The porous material divides the cylinder's interior into tiny pockets where the "free" acetylene can collect in extremely small quantities. The acetone is used to saturate the porous material and much of the gaseous acetylene is dissolved in the acetone. The combination of porous material and the acetone allows acetylene to be contained in cylinders at moderate pressure without danger of explosive decomposition. While storage in a horizontal position does not make the acetylene in cylinders less stable or less safe, it does increase the likelihood of acetone loss, which will result in a lower flame quality when the cylinder is used. Therefore, it is always preferable to store acetylene cylinders in the upright position.

Because of the extreme dangers involved, acetylene must never be used in standard manufacturing processes at pressures above 15 psig. Special permission may be granted by the fire commissioner to use acetylene at pressures exceeding 15 psig when specialized equipment is installed. Never, under any circumstances, attempt

to transfer the acetylene from one cylinder to another, to refill acetylene cylinders, or to mix any other gas with acetylene in a cylinder. Do not attempt to charge acetylene into any cylinders except those constructed for acetylene.

## **Health Hazards**

Acetylene can be inhaled in rather high concentrations without chronic harmful effects. Unlike many flammable gases, exposure to acetylene does not irritate the eyes, nose or throat. However, when inhaled it may cause headache, difficulty in breathing or loss of consciousness. In fact, acetylene has been used as an anesthetic in medical applications. Prolonged exposure to an acetylene enriched atmosphere may cause death by suffocation. Suffocation occurs when the atmosphere cannot sustain life because the oxygen level is reduced by the acetylene. When a person is exposed to high concentrations of acetylene he/she should be moved to a location where there is fresh air. If breathing difficulties occur, oxygen should be given and a physician contacted promptly. If breathing has stopped, artificial respiration must be administered. It is recommended that a protective mask be worn when working in areas with a high concentration of acetylene.

## **Reactivity**

When acetylene comes into contact with copper, silver or mercury under certain conditions, explosive compounds are formed. The certificate of fitness holder must ensure that only compatible equipment is used in acetylene distribution systems and related equipment. When doubts arise about the compatibility of a particular material, the certificate of fitness holder must contact the gas supplier for clarification.

## **Equipment**

All piping used in an acetylene distribution system must be constructed of steel or wrought iron pipe. Fittings (e.g., valves, joints, etc.) may be constructed using rolled, forged or cast steel or malleable iron. However, fittings are typically made of brass or nickel alloys. All joints must be welded or made up of threaded fittings. The use of copper, silver and mercury in any part of the distribution system is prohibited because under certain conditions they form readily explosive compounds with acetylene. However, it is generally considered acceptable to use brass fittings containing less than 65 percent copper in the alloy and certain nickel alloys in the distribution system.

## **Methyl Acetylene-Propadiene Mixture (Hazard Signal: Not listed) (MAPP)**

Methyl Acetylene-Propadiene (MAPP) is a colorless, flammable gas with a garlic-like odor. It consists of a mixture of gases all comprised of carbon and hydrogen. In its natural state, MAPP is a highly unstable mixture. When used in manufacturing applications, it is stabilized by mixing it with quantities of propane, butane, and isobutane. In the field, MAPP is also referred to as MAPP GAS, MPS, APACHE GAS, aliene-methyl acetylene mixture, methyl acetylene-aliene mixture, and propadiene-methyl acetylene mixture. Its ignition temperature is 850° Fahrenheit. Its UFL is 60%, and its LFL is 2.5%.

MAPP GAS is used as a multipurpose industrial fuel gas offering excellent performance, safety and economy. It is commonly used for flame hardening, metallizing, welding, brazing, soldering, preheating, scarfing and stress relieving as well as flame cutting. MAPP may be used as a compressed gas or a liquefied compressed gas to supply bulk distribution systems.

## **Compressed Gas Cylinders**

When stored in DOT approved cylinders, MAPP GAS is insensitive to shock and won't explode when a cylinder is dented, dropped, or hammered. MAPP GAS can be used safely at full cylinder pressures of up to 94

psig at 70 degrees F. The cylinders have safety relief devices installed at the neck of the cylinder. The devices are designed to prevent an explosion by opening and venting the gas into the atmosphere when the pressure in the cylinder reaches a dangerous level. The cylinders are easy to handle because they weigh less than most similarly sized cylinders. For example, a full 70-lb. MAPP GAS cylinder weighs only 120 lbs. A comparable standard acetylene cylinder contains only 20 lbs. of acetylene, but weighs approximately 240 lbs. Various sized cylinders are used by fabricators with small fuel gas requirements. When used in a liquified state, MAPP is stored in DOT-approved cryogenic cylinders or ASME approved storage tanks.

### **Health Hazards**

MAPP GAS has no adverse impact on the eyes or skin. Although its toxicity is rated "very slight", when inhaled in high concentrations, it causes breathing difficulties and acts as an anesthetic and a narcotic. When a person is exposed to a high concentration of MAPP GAS, he/she should be moved to a location where there is fresh air. If breathing difficulties occur, oxygen should be given and a physician contacted promptly. If breathing has stopped, artificial respiration must be administered. It is recommended that a protective mask be worn in areas where there is a high concentration of MAPP.

### **Reactivity**

MAPP GAS is chemically unreactive to most common materials, including steel, brass, most plastics and rubber. However, under certain conditions it forms explosive compounds when it comes into contact with alloys containing more than 67% copper at high pressures. The certificate of fitness holder must ensure that only compatible equipment is used in an MAPP supply system. When doubts arise about the compatibility of a particular material, the certificate of fitness holder must contact the gas supplier for clarification.

### **Equipment**

All piping used in an MAPP distribution system must be constructed of steel or wrought iron pipe. Fittings (e.g., valves, joints, etc.) must be constructed from rolled, forged, or cast steel or malleable iron. However, fittings are typically made of brass or nickel alloys. All joints must be welded or made up of threaded fittings. The use of copper, silver and mercury in any part of the distribution system is prohibited because under certain conditions they form readily explosive compounds with MAPP GAS. However, it is generally considered acceptable to use brass fittings containing less than 65 percent copper in the alloy and certain nickel alloys in the distribution system.

### **Methane** (Hazard Signal: 4 Flammability 0 Reactivity 1 Health)

Methane is a colorless, odorless, and tasteless flammable gas. Methane can be produced commercially from natural gas and petroleum using various methods. When ignited in an enclosed area it may explode. It is dissolved in alcohol or ether, and slightly soluble in water. It is also called marsh gas or methyl hydride in the field. Methane is widely used as a fuel gas in chemical and manufacturing applications.

#### **Compressed Gas Cylinders**

Methane may be shipped in DOT approved compressed gas cylinders at pressures up to 6000 psig at 70° Fahrenheit. The 3A and the 3AA type cylinders are most commonly used in industrial applications. However, according to DOT regulations, any cylinder authorized for the shipment of a non-liquefied compressed gas may be used in methane service. All cylinders used for the shipment of methane must be hydrostatically tested every 5 years.

## Health Hazards

Methane vapors are not irritating to eyes, nose or throat. Methane is a simple asphyxiant, but it is generally considered non toxic. Inhalation of higher concentrations eventually causes a feeling of pressure on the forehead and eyes and dizziness, but the sensation ends after returning to fresh air. Prolonged exposure to a methane-enriched atmosphere may cause death by suffocation. Suffocation occurs when the atmosphere cannot sustain life because the oxygen level is reduced by the methane. When a person is exposed to high concentrations of methane, he/she should be moved to a location where there is fresh air. If breathing difficulties occur, oxygen should be given and a physician contacted promptly. If breathing has stopped, artificial respiration must be administered. It is recommended that a self-contained breathing apparatus be worn in areas where there is a high concentration of methane.

## Equipment

All piping used in a piped methane system must be constructed of steel or wrought iron pipe. Fittings (e.g., valves, joints, etc.) must be constructed from rolled, forged, or cast steel or malleable iron. However, they are typically made of brass or nickel alloys. All joints must be welded or made up of threaded fittings. The use of copper, silver and mercury in any part of the distribution system is prohibited because under certain conditions they form readily explosive compounds with methane. However, it is generally considered acceptable to use brass fittings containing less than 65% copper in the alloy and certain nickel alloys in the distribution system.

**Hydrogen** (Hazard Signal: 4 Flammability 0 Reactivity 0 Health)

Hydrogen is a colorless, odorless, tasteless and non-toxic flammable gas. It is the lightest gas known, and it exists in a gaseous state at atmospheric temperatures and pressures. At atmospheric pressure hydrogen's LFL is 4 percent and its UFL is 74 percent. Once ignited, hydrogen burns in air with an almost invisible pale blue flame.

Large quantities of hydrogen are consumed in many chemical manufacturing operations. It is also used with oxygen in oxyhydrogen welding and cutting. For example, it is used in certain brazing operations and the welding of aluminum, magnesium, and lead. Hydrogen may be used as a compressed gas or a liquefied compressed gas to supply bulk distribution systems.

## Compressed Gas Cylinders

Hydrogen is shipped and stored in DOT-approved cylinders at pressures up to 2200 psig. All hydrogen cylinders have safety relief devices at the neck of the cylinder. The devices are designed to prevent an explosion by opening and venting the gas into the atmosphere when the pressure in the cylinder reaches a dangerous level. The pressure inside the cylinder is likely to reach a dangerous level when the cylinder is exposed to extreme temperatures.

## Health Hazard

Although it is non-toxic, hydrogen may cause asphyxiation when released to a confined area because it displaces the oxygen in the air. Exposure to high concentrations of hydrogen may cause unconsciousness without giving any early warning signs. When a person is exposed to hydrogen, he/she should be moved to a location where there is fresh air. If breathing difficulties occur, oxygen should be given and a physician contacted promptly. If breathing has stopped, artificial respiration must be administered. It is recommended that a self-contained breathing apparatus be worn when working in an area where there is a high concentration of hydrogen in the atmosphere.

## **Equipment**

All piping used in an piped hydrogen system must be constructed of steel or wrought iron pipe. Fittings (e.g., valves, joints, etc.) must be constructed from rolled forged or cast steel or malleable iron. However, they are typically made of brass or nickel alloys. All joints must be welded or made up of threaded fittings. The use of cast iron in any part of the distribution system is prohibited.

## **Safety Procedures**

Hydrogen cylinders should not be cracked before connecting regulators to the cylinder because the gas is highly flammable and "self-ignition" may occur when the hydrogen is released.

## **Cylinders**

Flammable gasses must be stored in DOT-approved cylinders only. All DOT approved cylinders are equipped with the fusible metal plugs. The plugs are designed to open and vent the gas into the surrounding atmosphere when the cylinder is exposed to extreme temperatures. The venting of the gas is necessary in order to prevent an explosion. Typically, the plugs are positioned at the top and/or bottom of the cylinders. Approved cylinders must have the following DOT markings clearly stamped near the neck of the cylinder:

- DOT specification number
- Serial number and the user's, purchaser's or maker's identifying symbol
- Date of manufacture
- Cylinder test date
- Tare weight of the cylinder in pounds and ounces.

The certificate of fitness holder must make sure that the DOT markings are not modified or changed. The contents of a cylinder should be determined by reading the DOT marking on the cylinder or by reading the label attached to the neck of the cylinder. The certificate of fitness holder should never rely solely on the color of the cylinder as a means for identifying the contents of a cylinder. When it is not possible to read the DOT markings or the label, the cylinder should not be used and it must be returned to the supplier for replacement. The cylinders must be hydrostatically tested every 10 years and should be stamped with the month and year. The certificate of fitness holder should check the test date on all cylinders. Cylinders that have not been tested at least once every 10 years must not be used. They must be returned to the manufacturer.

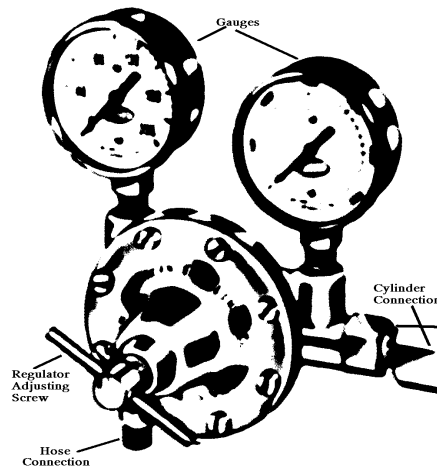
## **Hazards**

The certificate of fitness holder must make sure that no attempt is made to transfer any compressed gas from a cylinder into a container or another cylinder. This practice is extremely hazardous and may result in an explosion.

## **Pressure Regulation Devices**

Compressed gas may be used only when an approved pressure regulation device is installed to control the gas flow from the cylinder or distribution outlet station. The certificate of fitness holder is responsible for making sure that compressed gas is never used without a pressure regulation device. Typically, two types of regulation devices are used in technical establishments: the regulator and the flow meter. The regulator has one gauge

that measures the pressure of the gas in the cylinder and another gauge that registers the rate of gas withdrawal from the cylinder. An example of a typical regulator is shown below.



**REGULATOR**

The flow meter measures the rate of gas flow from the cylinder. The gas flow through the flow meter is controlled by turning the adjusting knob on the flow meter. The certificate of fitness holder must know how to operate all pressure regulation devices used at his or her facility.

Needle valves or similar devices without regulating mechanisms should not be used in place of pressure reducing regulators. These devices may allow excessive pressures to build up, causing damage to equipment or injury to personnel.

Threads and connections on the pressure regulation devices are designed such that they can only be used to control the discharge of a particular gas. For example, the threads or connections on an acetylene regulator will not fit the threads on a hydrogen cylinder. Regulators must not be modified or used where they were not intended to be used. Each regulator should be labeled in a manner that identifies the type of system where the regulator should be used.

Regulators, gauges, valves, and piping used in technical establishments must be cleaned to industry standards prior to being placed into service. The certificate of fitness holder must keep a supply of clean replacement regulators, gauges, and flow meters available in case of emergency at the facility. Defective regulation devices must be replaced immediately and arrangements must be made to have them repaired by the supplier or the manufacturer.

### **Connecting Pressure Regulation Devices**

Before the regulator is connected to an acetylene, MAPP gas or Methane cylinder, the cylinder's control valve should be cracked open for an instant. This clears the valve of dust or dirt particles that may have accumulated. When cracking the valve, the certificate of fitness holder must position him/herself so that the valve points away from his/her body. Hydrogen cylinders must not be cracked before connecting regulators to the cylinder because hydrogen is highly flammable and "self-ignition" may occur when the hydrogen is released. Regulators should not be connected to cylinders in confined areas or next to open flames or other sources of ignition (e.g., welding operations). After the regulator has been connected, the certificate of fitness holder should check for leaks using the soap and water solution test. The cylinder's control valve should be opened slowly. Never force the control valve as it may damage the valve. When a valve is stuck, the cylinder must be returned to the manufacturer for replacement. When in use, the cylinder's control valve must be kept free of obstruction so that it can be closed quickly in case of an emergency. Some cylinders must be opened using a special wrench.

When a wrench is required, it must be kept on the valve spindle when the cylinder is in use. When the cylinders are not in use, it is considered good practice to close the cylinder valve, disconnect the regulator and replace the cylinder's protective caps.

## **Storage of Cylinders**

When returning cylinders to storage sites, certificate of fitness holders are responsible for the proper storage of gas cylinders. Certificate holders must ensure that safe storage procedures are followed.

These storage enclosures must not be housed in below grade areas (e.g., basement cellars, etc.). Extra cylinders that are not in use must be stored in approved storage enclosures. Storage enclosures must have a fire resistive rating of at least two hour and must meet the specifications outlined in the New York City Building Code. They must be adequately ventilated and capable of protecting the cylinders against extreme temperatures, the weather, and physical damage. Storage enclosures may be ventilated by installing louvers on the sides of the storage enclosure and/or by means of a mechanical exhaust system. When a mechanical exhaust system is installed, its controls must be positioned outside the storage enclosure's door. The electrical system (lighting fixture/wiring/switches) in the storage enclosure must be explosion-proof type.

In all storage enclosures, the cylinders must be stored:

- Protected against falling objects or work activity in the area.
- 20 feet from all flammable and combustible liquids, gases, and other combustible materials such as paper.
- 25 feet from open flames, ordinarily electrical equipment or other sources of ignition
- 50 feet from intakes of ventilation or air conditioning equipment and/or air compressors or other flammable gas storage.
- Systems more than 3,000 SCF's in one room must be separated by at least 50 feet.

In addition, the requirements of storage sites vary upon the amount of SCF's being stored. Since holders may have difficulty in determining the SCF in any one location, the permissible amount may vary depending upon the size of the cylinder.

Assuming that most cylinders contain approximately 226 cubic feet of gas are 9" x 56", 2000 psi at 70° Fahrenheit. The chart below lists the proper storage amounts. Variables such as different size cylinders, higher pressure, and other factors will reduce the number of cylinders legally permitted.

The following chart must be followed:

NATURE OF LOCATION	LESS THAN 3,000 SCF OR LESS THAN 14 CYLINDERS	3,000 - 15,000 SCF OR 14 - 69 CYLINDERS	IN EXCESS OF 15,000 SCF OR MORE THAN 70 CYLINDERS
OUTDOORS	YES	YES	YES
IN A SEPARATE BUILDING	YES	YES	YES
IN A SPECIAL ROOM	YES	YES	PROHIBITED
INSIDE BUILDING NOT IN A SPECIAL ROOM AND EXPOSED TO OTHER OCCUPANCIES	YES	PROHIBITED	PROHIBITED

Cylinders must be stored according to the following rules:

- Cylinders containing different gases should be stored apart and signs must be posted indicating the contents of the cylinders. Cylinders containing flammable gases must not be stored in the same room as oxidizing gases, especially oxygen and chlorine.
- Cylinders should be protected against tampering by unauthorized individuals.
- The storage enclosure should be grounded to protect against lightning and static electricity.
- Cylinders must be stored in their upright position with their protective caps in place.
- Fire extinguishing equipment must be located near the storage enclosures. The certificate of fitness holder must know how to operate these extinguishers in case of an emergency.
- Full and empty cylinders should be stored separately, and mandatory fire safety signs must be posted inside the storage enclosure. These signs must indicate the contents of the cylinders and a flow diagram for the gas supply system.
- A sign must be posted outside the storage enclosures indicating what gases are stored inside. An example of a sign indicating that hydrogen is stored inside an enclosure is shown below.

HYDROGEN - FLAMMABLE GAS NO SMOKING - NO OPEN FLAMES
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### Smoking

A no smoking sign must be posted that use the wording "**DANGER-FLAMMABLE GAS KEEP FIRE OR FLAME AWAY--NO SMOKING**". The sign(s) should be ten inches high and fourteen inches wide or fourteen inches high and ten inches wide. The word DANGER shall be on a red oval bordered in white which shall be on a black background at the upper part of the sign. The other required wording should be in black on a white background in the lower part of the sign. Smoking is never permitted in areas where flammable gas cylinders are stored and/or used.

## **Transporting Cylinders**

When transporting gaseous cylinders from one location to another, they should be secured in the upright position on a specially designed hand truck. During transport, the valve must be closed, regulators must be removed and protective caps must be in place. The cylinders must never be dragged or rolled from one location to another because these movements may damage the cylinders. When transported on a motor vehicle, the cylinders should be secured in the upright position so that the valves are less likely to be damaged because of collisions with stationary objects.

## **Leaks**

If gas leaks from the cylinder valve or the fusible safety plugs, the cylinder must be moved to a well-ventilated open space free of potential ignition sources. The cylinder valve should be opened slightly to allow the gas to escape slowly into the atmosphere. When the cylinder is empty it must be labeled as defective and returned to the supplier for repair.

## **Soap and Water Solution Test**

Sometimes the certificate of fitness holder will have to identify and correct a leak in the system. Typically, leaks are easily identified and are repaired by tightening valve connections. However, slow leaks may be difficult to identify. In such cases, the certificate of fitness holder should perform a soap and water solution test to identify the leak. The steps involved in performing a soap and water solution test on the connection between a regulator and an hydrogen cylinder are briefly described below:

- Connect the regulator, tighten the connection, and slowly open the cylinder's valve.
- Brush the solution on the connection and look for bubbles caused by a slow leak.
- When bubbles are detected, tighten the regulator connection and apply the solution again.
- If bubbles are still present, there may be a problem with the regulator and it should be replaced.
- The new regulator should also be tested. If the leak persists, there may be a problem with the cylinder. In such cases, the cylinder should be replaced by returning the defective cylinders to the manufacturer.
- Never attempt to repair faulty regulators or cylinders. They must be sent to the supplier for repair.

## **Fire Prevention and Protection Systems**

Fire protection and fire prevention systems are required in all storage areas when flammable gases are stored. The certificate of fitness holder must make sure that these systems are maintained in good working order at all times. Some of these systems are briefly described below.

## **Fire Alarms**

Generally, smoke and/or heat detectors are used as fire alarm devices. They are designed to automatically sound the alarm when a fire is detected. An alarm will sound on the premises and a signal may also be sent to a central monitoring station. The personnel at the central monitoring station will then notify the fire department. The smoke and heat detectors must be tested annually. These inspections must be conducted by a person

holding a certificate of fitness for the maintenance and testing of smoke and heat detectors. During these inspections, the certificate of fitness holder will adjust the smoke and heat detectors where necessary. Any defective detectors that are discovered must be replaced immediately.

## **Sprinklers**

Sprinkler systems are designed such that water is automatically discharged when a fire occurs. The system consists of an arrangement of piping connected to a reliable water supply. Sprinkler heads are installed at intervals along the piping. Under normal conditions, the sprinkler heads are kept in the closed position by a fusible link. The fusible link is designed to melt when the temperature in the room reaches an unsafe level. When the fusible link melts, water is forcefully discharged at a controlled rate onto the fire. The discharge of the water suppresses the fire and prevents it from spreading.

## **Standpipe Systems**

Generally a standpipe system is in most technical establishments. This system consists of a series of pipes and hoses that may be used to discharge water in case of a fire emergency. The certificate of fitness holder must know how to operate the standpipe system in case of an emergency.

## **Fire Extinguishers**

Fire extinguishers must be provided throughout the technical establishment. These extinguishers must be positioned such that there is at least one within at least fifty feet from any location inside the laboratory. Generally, the dry-chemical extinguishers are installed in the laboratories and storage areas. However, the Fire Commissioner may require other types of extinguishers depending on the nature of the materials used in the facility. The certificate of fitness holder must know how and when to operate all fire extinguishers installed in the facility. Three classes of fires and the appropriate extinguishers are described below.

### **Class A Fires**

Class A fires occur when ordinary combustible materials are ignited. For example, wood and paper fires are class A fires. Water type extinguishers should be used to extinguish these fires because they cool the fire while quenching the flame.

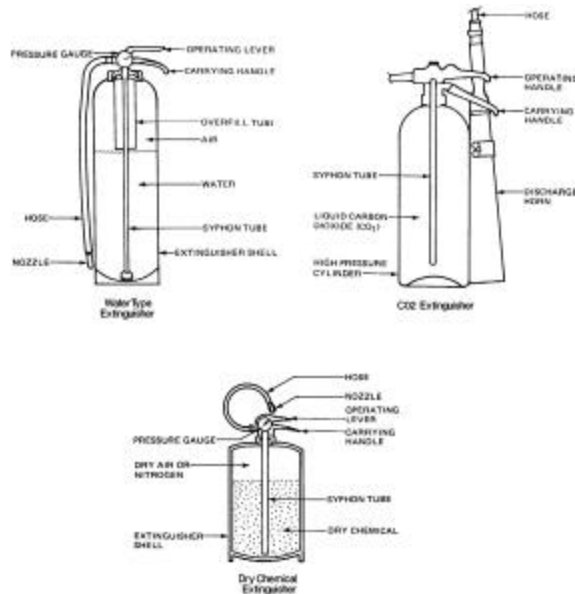
### **Class B Fires**

Class B fires occur when flammable liquids, gases or greases are ignited. These fires must be extinguished by smothering the flame. The flame may be smothered using carbon dioxide, dry chemical or foam extinguishers. Water type extinguishers will not effectively extinguish class B fires.

### **Class C Fires**

Class C fires occur when electrical equipment catches fire. These fires must be fought with fire extinguishers that do not conduct electricity. Carbon dioxide and dry chemical extinguishers must be used to extinguish electrical fires. Foam and water type extinguishers must not be used to extinguish electrical fires.

Examples of water type, carbon dioxide and dry chemical extinguishers are show below.



### Fire Extinguishers

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.

#### Symbols Painted on Fire Extinguishers

A symbol with a shaded background and a slash indicates that the extinguisher must not be used for that type of fire. The certificate of fitness holder must understand these symbols and must make sure that the fire extinguishers are kept in good working order at all times. Generally, operation instructions are clearly painted on the side of the fire extinguisher. They clearly describe how to use the extinguisher in case of an emergency. An example of these instructions is shown below.



### Operation Instructions for a Fire Extinguisher

Water spray or fog can be effective in extinguishing fires involving flammable gases. It may be used to knock down the vapors. It can also be used to cool down storage containers and materials positioned close to the fire. Automatic sprinklers are similar to water spray systems in extinguishing effectiveness. Their principal value is in absorbing the heat from the fire and keeping the surroundings cool until the fire either burns out or is extinguished by other means. Automatic sprinklers have a very good record of fire control. The selection of the extinguishing method used should be made with some degree of caution. The size and type of fire anticipated must be taken into consideration when selecting an extinguishing agent and its rate and

method of application. The certificate of fitness holder must contact the manufacturer when there is some doubt about the type of extinguishing agent that should be used.

## **Fire Blankets**

Fire blankets may be provided in some facilities. They are usually located in a metal case mounted on the wall. When clothing catches fire, the blanket may be used to smother the flames. However, the blanket can also be used to smother small fires when there are no extinguishers available. The certificate of fitness holder must make sure that the fire blanket is easily accessible at all times.

## **Emergency Procedures**

The certificate of fitness holder must know the locations of and how to operate all fire extinguishing devices, control devices, and fire alarm stations installed at the facility. In case of a fire explosion, major spill or emergency, the certificate of fitness holder must notify the fire department by phone immediately. The certificate of fitness holder must know the telephone number of the fire department Borough Communication Office.

The borough phone numbers are listed below. These phone numbers must be posted near the phones most likely to be used in case of an emergency.

Manhattan	(212) 999-2222
Bronx	(212) 999-3333
Brooklyn	(718) 999-4444
Queens	(718) 999-5555
Staten Island	(718) 999-6666

Then the local fire alarm must be sounded. In some cases, the activation of the fire alarm will transmit a signal to the fire department via a central monitoring station. The certificate of fitness holder must answer any questions asked by the fire fighters 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 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.

## **Fire**

When a fire occurs, the certificate of fitness holder must notify the fire department immediately. Then actions must be taken to control the fire. When possible, the gas supply should be shut off. Large quantities of water should be sprayed on materials surrounding the fire to cool them down. This will reduce the likelihood of heat radiating from the heated materials re-igniting the flame after the fire has been extinguished. Combination fog and solid stream nozzles are preferable to permit widest adaptability in fire control. Small gas flames can be extinguished using dry chemical, halogenated or carbon dioxide fire extinguishers. However, these methods may not be effective when attempting to extinguish large fires. If a compressed gas leak or a liquified gas spill has not ignited, use water spray to direct gas-air mixture away from sources of ignition. If it is desirable to evaporate a spill quickly, water spray may be used to increase the rate of evaporation, if the increased vapor evolution can be controlled. Do not discharge solid streams into liquid.

## **Inspections**

### **Fire Department inspections**

Fire department inspectors will conduct periodic inspections of the premises under the supervision of the certificate of fitness holder to make sure that all fire department regulations are obeyed. Enforcement actions may be taken against the certificate of fitness holder and the building owner when fire department regulations are not obeyed. These actions may include fines and the revocation of the certificate of fitness.

### **Fire Extinguisher Inspections**

The extinguishers must be inspected by a qualified technician at least once every six months. Generally, the inspections are conducted by a representative of the company who holds the maintenance contract for the fire extinguishers. The certificate of fitness holder should record the testing date and the technician's name in the inspection log. All inspections must also be recorded on a tag attached to the extinguisher.

In addition, the certificate of fitness holder should visually inspect the fire extinguishers monthly. He or she should make sure that they are positioned in the correct locations and are clearly visible. When a damaged extinguisher is discovered, it should be repaired or replaced immediately. The certificate of fitness holder should check to make sure that all fire extinguishers are fully charged at all times. The condition of the extinguisher is checked by looking at the gauge connected to the top of the extinguisher. A needle that indicates the extinguisher's condition is positioned inside the gauge. When the needle points to the green area, the extinguisher is fully charged. When the needle points to the red area, the extinguisher needs to be recharged. When extinguishers need to be recharged, repaired or replaced the certificate of fitness holder must make the necessary arrangements.

### **Recommended Inspection Procedures**

The certificate of fitness holder is required to make regular inspections and patrols of the assigned area of responsibility to make sure that fire protection systems, storage containers, and related equipment are in good condition. Defective components (e.g., faulty regulators) should be replaced promptly. The certificate of fitness holder must notify the fire department and his or her supervisor when major defects are discovered (e.g., when the sprinkler system is inoperative). Violations may be issued and enforcement action taken against the certificate of fitness holder when major defects are not reported. Although the inspections will vary depending on the location, the following general guidelines will apply for all locations.

- The entire premises must be checked daily for potential ignition sources. Any potential Ignition sources that are discovered must be corrected or removed immediately. For example, frayed electrical wires and defective electronic components must be either repaired or removed.
- Trash and garbage must not to be allowed to accumulate anywhere inside the storage areas. Accumulated trash is a fire hazard because it may be easily ignited by a stray spark. All trash and garbage must be removed from the premises.
- Interior fire alarm systems, when installed, must be tested daily by a certificate of fitness holder. It is not necessary to test all fire alarm boxes. Instead, one fire alarm box of each type should be tested daily.

All required Fire Department permits and certificates must be secured and posted. These permits are valid for a period of one year from the date they were issued. The results of all tests and inspections must be recorded in

the inspection log and kept on file for at least 6 months. The log, permits, and certificates must be made available to fire department representatives upon request.

All fire extinguishers must be clearly visible. Signs must be posted indicating the locations of the extinguishers. Signs describing how to use the fire extinguishing devices must also be posted. The certificate of fitness holder must make sure that the extinguishers are inspected every six months. The fire extinguishers must be recharged after each time they are used or when required according to the type of extinguisher.

## **Maintenance**

Regular inspections should be conducted to make sure that the entire distribution gas system and related equipment are working correctly. The certificate of fitness holder must visually inspect and record the settings and conditions of all gauges to the gas distribution system. For example, when a bulk hydrogen system is installed, the pressure and the liquid hydrogen level in the storage tank must be recorded. Defective components in the system should be replaced immediately. The certificate of fitness holder must notify the fire department and his or her supervisor when major defects are discovered in the system. He or she must also make sure that prompt corrective action is taken to repair the defect. For example, the fire department must be notified when a major leak is discovered in the distribution system. Violations may be issued to and enforcement action taken against the certificate of fitness holder when major defects are not reported.

Sometimes the certificate of fitness holder will have to identify and correct a leak in the system. Typically, leaks are easily identified and are repaired by tightening valve connections. However, slow leaks may be difficult to identify. In such cases, the certificate of fitness holder should perform a soap and water solution test to identify the leak.

## **Testing**

Bulk, liquefied gas receivers and storage tanks must be pneumatically pressure tested every five years and this test must be conducted by the system maintenance company and observed by a fire department representative.

## **Permits**

The certificate of fitness holder is responsible for ensuring that all required permits are secured and posted in visible locations. Permits are valid for 12 months only. Enforcement action may be taken against the certificate of fitness holder when the required permits are not secured and posted. The enforcement actions may include fines and/or the revocation of the certificate of fitness.

It shall be unlawful to store for sale any gas compressed to a pressure greater than six pounds to the square inch, without a permit, except under certain conditions that include the following:

- Combustible, non-liquefied, non-absorbed gases, such as hydrogen or illuminating gas, compressed to a pressure not exceeding three hundred pounds to the square inch, and in quantities not exceeding a total container capacity of thirty cubic feet, and in containers none of which shall have a capacity exceeding a total container capacity of thirty cubic feet, and in containers none of which shall have a capacity exceeding six cubic feet;
- Combustible, non-liquefied, non-absorbed gases, such as hydrogen or illuminating gas, compressed to a pressure exceeding three hundred pounds to the square inch and in quantities not exceeding a total container capacity of ten cubic feet, and in containers none of which shall have a capacity exceeding two and one-half cubic feet;

- Absorbed acetylene, under pressure not exceeding two hundred fifty pounds to the square inch, and in quantities not exceeding a total container capacity of ten cubic feet, and in containers none of which shall have a capacity exceeding two and one-half cubic feet.