Storage of Flammable, Oxidizing and Other Gas Canisters

Fire and Life-Safety Group (FLS)

Based on the 2009 Edition of the International Fire Code (IFC), the 2005 Edition of the Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks (NFPA - 55), the 2008 Edition of the Liquefied Petroleum Gas Code (NFPA-58), and the 2004 Edition of Fire Protection for Laboratories Using Chemicals (NFPA-45)

This document was prepared to list some but not all of the requirements based on the latest edition of adopted codes in 2011. Please ensure that all the requirements of applicable codes at the time of new installations or changes to existing installations are verified and implemented.

Based on the following code review, flammable and oxidizing gases are to be kept a minimum of 20 feet away from each other. Alternatively, there is no requirement for space between flammable and oxidizing gases if a minimum 5ft. high barrier of noncombustible materials with a ½ hour fire-resistance rating is built between the two storage areas. This code review also outlines other important and relevant information about the storage of compressed gases. Please consult FLS for complete code requirements for specific storage facilities.

Incompatibility and General Code Requirements

Section 3503.1.1 of the 2009 edition of the International Fire Code (IFC) states that flammable gases are not to be stored or used in Group A, E, I or R Occupancies or in offices in Group B Occupancies.

Exceptions:

- *Cylinders not exceeding a capacity of 250 cubic feet each at normal temperature and pressure (NTP) used for maintenance purpose, patient care or operation of equipment.*
- *Food service operations in accordance with Section 3803.2.1.7. (Contact FLS for code requirements for LP-gas container use in commercial food operations.)*

Section 3404.2.9.6.3 of the IFC states that the minimum horizontal separation between an LP-gas container and a Class I, II, IIIA liquid storage tank is 20 feet except in the case of Class I, II or IIIA liquid tanks operating at pressures exceeding 2.5 psig or equipped with emergency venting allowing pressures to exceed 2.5 psig, in which case the provisions of Section 3404.2.9.6.2 apply.

Exceptions:

- *Liquefied petroleum gas containers of 125 gallons or less in capacity installed adjacent to fuel-oil supply tanks of 660 gallons or less in capacity.*
- *Horizontal separation is not required between aboveground LP-gas containers and underground flammable and combustible liquid tanks.*

Section 3404.3.3.2 of the IFC states that materials that will react with water or other liquids to produce a hazard are not to be stored in the same room with flammable and combustible liquids in accordance with Section 2703.9.8.

Section 2703.9.8 of the IFC states that incompatible materials in storage and storage of materials that are incompatible with materials in use are to be separated when the stored materials are in containers having a capacity of more than 5 pounds or 0.5 gallons. Separation is to be accomplished by:

1. Segregating incompatible materials in storage by a distance of not less than 20 feet.
2. Isolating incompatible materials in storage by a noncombustible partition extending not less than 18 inches above and to the sides of the stored material.
3. Storing liquid and solid materials in hazardous material storage cabinets.
4. Storing compressed gases in gas cabinets or exhausted enclosures in accordance with Sections 2703.8.5 and 2703.8.6. Materials that are incompatible are not to be stored within the same cabinet or exhausted enclosure.

Section 7.1.6 of NFPA-55 states that gases are to be separated in storage in accordance with Table 7.1.6.2. According to Table 7.1.6.2, oxidizing and flammable gases must be kept a minimum of 20 ft. away from each other.

Exception: The distance can be reduced to 5 feet if one of the gases is enclosed in a gas cabinet or without limit where both gases are enclosed in gas cabinets.

Section 6 of NFPA-55 outlines the following general storage requirements.

- Gases are to be stored in accordance with the quantity thresholds in Table 6.3.1.
- Spill control, drainage, and secondary containment are not required for the storage of compressed gases.
- Floors of storage areas are to be of noncombustible or of limited combustible construction.
- Shelves used for the storage of cylinders are to be of noncombustible materials storage by a minimum distance of 20 feet.

- For separation from incompatible or combustible materials, storage of compressed gases is to be completed in either of the following ways:
- Segregated from any incompatible or combustible materials storage by a minimum distance of 20 feet.
- Isolated from any incompatible or combustible material storage by a barrier of noncombustible material at least 5 feet high and with a minimum fire resistance rating of ½ hour.

Marking of Containers and Signage

Section 3003.4 of the IFC states that stationary compressed gas containers are to be marked in accordance with this section. Markings are to be visible from any direction of approach and are to be in accordance with CGA C7.

Section 2703.5 of the IFC states that unless otherwise exempted by the fire code official, visible hazard identification signs as specified in NFPA 704 for the specific material contained are to be placed on stationary containers and aboveground tanks and at entrances to locations where hazardous materials are stored, dispensed, used or handled in quantities requiring a permit and at specific entrances and locations designated by the fire code official.

Section 2703.5.1 of the IFC states that individual containers, cartons or packages are to be conspicuously marked or labeled in an approved manner. Rooms or cabinets containing compressed gases are to be conspicuously labeled: COMPRESSED GAS.

Section 2703.6 of the IFC states that signs and markings are required by Sections 2703.5 and 2703.5.1 are not to be obscured or removed, are to be in English as a primary language or in symbols allowed by this code, are to be durable, and the size, color and lettering are to be approved.

Section 2703.7 of the IFC states that stationary containers are to be placarded with hazard identification signs. Signs prohibiting smoking are to be provided in rooms or areas where hazardous materials are stored in open systems in amounts requiring a permit, within 25 ft. of outdoor storage areas and where flammable or combustible hazardous materials are stored, dispensed or used.

Section 4.8.1 of NFPA-55 states that smoking and open flames are not to be permitted in storage areas or within 25 ft. of storage areas.

Container Security and Storage Provisions

Section 3003.5 of the IFC states that compressed gas containers are to be secured against accidental dislodging and access by unauthorized personnel.

Section 3003.5.2 of the IFC states that gas containers, which could be exposed to physical damage, are to be protected by guard posts or other means.

Section 3003.5.3 of the IFC states that compressed gas containers are to be secured to prevent falling due to contact, vibration or seismic activity using one of the following methods:

1. Securing containers to a fixed object with one or more restraints.
2. Securing containers on a cart or other mobile device designed for the movement of compressed gas containers.
3. Nesting containers at filling or service facilities not accessible to the public, provided that containers do not obstruct the means of egress if dislodged.
4. Securing containers to or within a rack, framework, cabinet or similar assembly designed for such use.

    Exception: Compressed gas containers, cylinders and tanks in the process of examination, filling, transport or servicing.

Section 3003.6 of the IFC states that compressed gas containers, cylinder and tank valves are to be protected from physical damage by protective caps, collars or similar devices. These devices are to remain in place except when the containers are in use or being serviced or filled.

Section 3003.7 of the IFC states that compressed gas containers, cylinders and tanks and systems in storage or use are to be separated from materials and conditions which pose exposure hazards to or from each other. Compressed gas containers, cylinders, tanks or systems in storage or use are to be in accordance with the following:

- Separated from each other based on the hazard class of their contents.
- Placed away from exposure to artificially created temperatures exceeding 125 degrees F or sub-ambient (low) temperatures unless designed for such exposure.
- Not placed in areas where they are likely to be damaged by falling objects.
- Placed a minimum of 10 feet away from combustible waste, vegetation and similar materials.
- Placed away from sources of ignition or other heat sources that could raise the surface temperature above 125 degrees F.
- Placed away from chemical exposure that could cause corrosion to the system.

Section 3003.13 of the IFC states that compressed gas containers are to be protected from direct contact with soil or unimproved surfaces. Surfaces are to be graded to prevent accumulation of water.

Section 3004.1 of the IFC states that compressed gas cylinders are to be stored in a “valve end up” upright position, except those designed for use in a horizontal position.

Section 2703.8.6 of the IFC states that gas cabinets are to be constructed of 0.097 in. (12 gage) steel minimum, be provided with self-closing limited access ports or noncombustible windows to give access to equipment controls and be provided with self-closing doors. Additionally, the entire interior is to be treated, coated or constructed of materials that are compatible with the hazardous materials stored.

Section 2703.2.5 of the IFC states that empty containers are to be free from residual material and vapor as defined by DOTn, the Resource Conservation and Recovery Act (RCRA) or other regulating authority or maintained as specified for the storage of hazardous material.

Section 3504.1.1 of the IFC states that buildings or portions thereof containing flammable gases are to be provided with explosion control in accordance with section 911.

Section11.1.5.1 of NFPA-45 states that cylinders are to be secured from tipping over by holders designed for such service.

Section 7.2.1.2 of NFPA-55 states that liquefied flammable gas cylinders are to be positioned in the upright position.

Section 8.2.1.1 of NFPA-58 states that stored cylinders are to be located to minimize exposure to excessive temperatures, physical damage, or tampering.

Section 8.2.1.3 of NFPA-58 states that cylinders stored in accordance with section 8.3 are not to be located near exits, stairways, or in areas normally used for safe egress of occupants.

Section 8.3.2.1 of NFPA-58 states that for storage within buildings, the quantity of LP-Gas shall not exceed 200 lbs.

Section 8.4.1.1 of NFPA-58 states that outdoor storage of cylinders are to be at least 5 feet from any doorway or opening in a building that has two means of egress, at least 10 feet from any doorway or opening for any building that has only one means of egress and at least 20 feet from any automotive service station fuel dispenser.

Section 8.4.2.1 of NFPA-58 states that cylinders at a location open to the public are to be protected by either of the following:

- An enclosure in accordance with 6.18.4.2
- A lockable ventilated metal locker or rack that prevents tampering with valves and pilferage of the cylinders.

Section 8.4.2.2 of NFPA-58 states that protection against vehicle impact is to be provided where vehicle traffic is normally expected.

Heat and Exposure

Section 3003.7.4 of the IFC states that compressed gas containers are not to be exposed to artificially created high temperatures exceeding 125 degrees F or sub-ambient (low) temperatures unless designed for use under the exposed conditions.

Section 3003.7.6 of the IFC states that compressed gas containers are not to be heated by devices that could raise the surface temperature of the container above 125 degrees F. Trained personnel are to allow approved heating methods. Devices used to keep containers at a constant temperature are to be designed to be failsafe.

Section 3003.7.7 of the IFC states that open flames and high temperature devices are not to be used in a manner that creates a hazardous condition.

Section 3003.14 of the IFC states that compressed gas containers may be stored or used in the sun. In extreme temperatures overhead covers are to be provided.

Section 7.1.6.7 of NFPA-55 states that compressed gas containers, cylinders, and tanks, whether full or partially full, are not to be heated by devices that could raise the surface temperature of the container, cylinder, or tank to above 125 ^{0}F.

Container Construction

Section 2703.2.1 of the IFC states that containers are to be designed and constructed in accordance with approved standards.

Section 2703.2.6 of the IFC states that defective containers are to be removed from service, repaired or disposed of in an approved manner.

Section11.1.5.3 of NFPA-45 states that cylinders are to have a manual shutoff valve. Additionally, a quick connect is not be used in place of a shutoff valve.

Ventilation and Exhaust

Section 2703.8.4.2 of the IFC states that ventilation systems for gas rooms are to be designed to operate at a negative pressure in relation to the surrounding area.

Section 6.16 of NFPA-55 states that indoor storage and use areas and storage buildings for compressed gases and cryogenic fluids are to be provided with mechanical exhaust ventilation or natural ventilation, where natural ventilation can be shown to be acceptable for the material as stored.

Section 6.16.3 of NFPA-55 states that mechanical ventilation is to be at a rate of not less than 1 $ft^3/min/ft^2$ of floor area over the area of storage or use.

Section 3005.5 of the IFC states that venting of gases is to be directed to an approved location and is to comply with the International Mechanical Code.

Permits and Documentation

Section 105.6.20 of the IFC states that an operational permit is required to store, transport on site, dispense, use or handle hazardous material in excess of quantities specified in Table 105.6.20.

Section 2701.5.1 of the IFC states that a Hazardous Materials Management Plan is necessary when required by the fire code official. Each application for a permit is to include a Hazardous Materials Management Plan (HMMP) and is to include the following: storage and use areas, the maximum amount of each material stored or used in each area, range of container sizes, locations of emergency isolation and mitigation valves, piping other than utility-owned fuel gas lines, on and off positions of valves, a storage plan showing intended storage arrangement and the location and type of emergency equipment. Additionally, the plans are to be legible and drawn approximately to scale.

Section 2703.4 of the IFC states that Material Safety Data Sheets (MSDS) are to be readily available on the premises for hazardous materials. Additionally, when hazardous substance is developed in a laboratory, available information is to be documented.

Section 4.2.1 of NFPA-55 states that an emergency response plan is to be prepared and updated wherever liquefied or compressed gases are produced, handled, stored or used. The plan is to be available for inspection by the authority having jurisdiction upon reasonable notice. The following information is to be included in the emergency plan.

- The type of emergency equipment available and its location
- A brief description of any testing or maintenance programs for the available emergency equipment.
- An indication that hazard identification labeling is provided for each storage area
- Location of posted emergency response procedures
- Material safety data sheets (MSDS) are to be available for all gases stored on the site.
- A list of responsible personnel who are designated and trained to be liaison personnel for the fire department.
- A list of the types and quantities of compressed and liquefied gases normally at the facility.

Storage Quantities

Section 7.6.1.1 of NFPA-55 states that storage or use of flammable gases exceeding the quantity thresholds for gases requiring special provisions according to Table 6.3.1 are to be in accordance with Chapters 1-6 and Section 7.1 to 7.3 and 7.6.

Section 6.3.1.3.1 of NFPA-55 states that flammable and oxidizing gases are not to be stored or used in other than industrial occupancies.

Section 7.7.1 of NFPA-55 states that storage or use of oxidizing compressed gases exceeding the quantity thresholds for gases requiring special provisions according to Table 6.3.1 are to be in accordance with Chapters 1-6 and Section 7.1 to 7.3 and 7.7.

Section 7.5.2 of NFPA-55 states that outdoor storage of corrosive compressed gas is not to be within 20 feet of buildings, not associated with the manufacture or distribution of corrosive gases, lot lines, streets, alleys, public ways, or means of egress.

Exception: The separation distance can be permitted to be reduced to 0 ft. when separated by a 2-hour fire barrier located at least 1.5 meters from any exposure.

Electrical Precautions

Section 6.6 of NFPA 55 states that electrical wiring and equipment is to conform to the provisions of the Section 6.6 of the National Electrical Code (NFPA-70), including Article 505.

Section 8.7.2 of NFPA 55 states that containers and systems are not to be located where they could become part of an electrical circuit.

Section 8.7.3 of NFPA 55 states that containers and systems are not to be used for electrical grounding.

Section 3003.8 of the IFC states that compressed gas containers, cylinders, tanks and systems are not to be located where they could become part of an electrical circuit, and are not to be used for electrical grounding.

Storage Room Requirements

Section 3003.15 of the IFC states that adequate lighting by natural or artificial means is to be provided.

Section 2703.8.3.1 of the IFC states that control areas are to be separated from each other in accordance with the International Building Code (IBC).

Section 2703.8.3.3 of the IFC states that the number of control areas is not to exceed three on the first floor level and is to comply with the requirements of Table 2703.8.3.2.

Section 2703.8.3.4 of the IFC states that gas rooms are to be separated by not less than a two-hour fire-resistive barrier for the floor of the control area. Additionally, walls are to have a one-hour fire resistive rating for the first three floors and a two-hour fire resistive rating for all floors above the 3rd floor.

Section 2703.8.5.1 of the IFC states that exhausted enclosures are to be noncombustible.

Section 6.11 of NFPA-55 states that buildings or portions thereof required to comply with Protection Levels 1 through 5 are to be protected by an approved automatic fire sprinkler system complying with NFPA 13, Standard for the Installation of Sprinkler Systems.

Exception: Rooms or areas that are of noncombustible construction with wholly noncombustible contents are not required to be protected by an automatic fire sprinkler system.