CHAPTER 53
COMPRESSED GASES

User note:

About this chapter: Chapter 53 regulates the storage, use and handling of all flammable and nonflammable compressed gases, such as those that are used in medical facilities, air separation plants, industrial plants, agricultural equipment and similar occupancies. Also, this chapter regulates inert gases, such as CO₂, used for enrichment and beverage dispensing, that although inert are considered asphyxiants and in larger amounts pose a life safety hazard. Standards for the design, construction and marking of compressed gas cylinders and pressure vessels are referenced. Compressed gases used in welding and cutting, cryogenic liquids and liquefied petroleum gases are also regulated under Chapters 35, 55 and 61, respectively. Compressed gases that are classified as hazardous materials are also regulated in Chapter 50, which includes general requirements.

SECTION 5301
GENERAL

5301.1 Scope. Storage, use and handling of compressed gases in compressed gas containers, cylinders, tanks and systems shall comply with this chapter and NFPA 55, including those gases regulated elsewhere in this code. Partially full compressed gas containers, cylinders or tanks containing residual gases shall be considered as full for the purposes of the controls required.

Liquefied natural gas for use as a vehicular fuel shall also comply with NFPA 52 and NFPA 59A.

Compressed gases classified as hazardous materials shall also comply with Chapter 50 for general requirements and chapters addressing specific hazards, including Chapters 58 (Flammable Gases), 60 (Highly Toxic and Toxic Materials), 63 (Oxidizers, Oxidizing Gases and Oxidizing Cryogenic Fluids) and 64 (Pyrophoric Materials).

Compressed hydrogen (CH₂) shall also comply with the applicable portions of Chapters 23 and 58 of this code, the International Fuel Gas Code.

Cutting and welding gases shall also comply with Chapter 35.

Exceptions:
1. Gases used as refrigerants in refrigeration systems, see Section 606.
2. Compressed natural gas (CNG) for use as a vehicular fuel shall comply with Chapter 23, NFPA 52 and the International Fuel Gas Code.
3. Cryogenic fluids shall comply with Chapter 55.
4. LP-gas shall comply with Chapter 61 and the International Fuel Gas Code.
5. Insulated Liquefied Carbon Dioxide systems shall comply with NFPA 55 and the Phoenix Fire Code.

Compressed gases classified as hazardous materials shall also comply with Chapter 50 for general requirements and chapters addressing specific hazards, including Chapters 58 (Flammable Gases), 60 (Highly Toxic and Toxic Materials), 63 (Oxidizers, Oxidizing Gases and Oxidizing Cryogenic Fluids) and 64 (Pyrophoric Materials).

SECTION 5302
DEFINITIONS

5302.1 Definitions. The following terms are defined in Chapter 2:

COMPRESSED GAS.
COMPRESSED GAS CONTAINER.
COMPRESSED GAS SYSTEM.
NESTING.
TUBE TRAILER.

SECTION 5303
GENERAL REQUIREMENTS

5303.1 Containers, cylinders and tanks. Compressed gas containers, cylinders and tanks shall comply with this section. Compressed gas containers, cylinders or tanks that are not designed for refillable use shall not be refilled after use of the original contents.

5303.2 Design and construction. Compressed gas containers, cylinders and tanks shall be designed, fabricated, tested, marked with the specifications of manufacture and maintained in accordance with the regulations of DOTn 49 CFR Parts 100-185 or the ASME Boiler and Pressure Vessel Code, Section VIII.

5303.3 Pressure relief devices. Pressure relief devices shall be in accordance with Sections 5303.3.1 through 5303.3.5.

5303.3.1 Where required. Pressure relief devices shall be provided to protect containers, cylinders and tanks containing compressed gases from rupture in the event of overpressure.
Exception: Cylinders, containers and tanks when exempt from the requirements for pressure relief devices specified by the standards of design listed in Section 5303.3.2.

5303.3.2 Design. Pressure relief devices to protect containers shall be designed and provided in accordance with CGA S-1.1, CGA S-1.2, CGA S-1.3 or the ASME Boiler and Pressure Vessel Code, Section VIII, as applicable.

5303.3.3 Sizing. Pressure relief devices shall be sized in accordance with the specifications to which the container was fabricated and to material-specific requirements as applicable.

5303.3.4 Arrangement. 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.

Exception: DOTn specification containers having an internal volume of 30 cubic feet (0.855 m³) or less.

5303.3.5 Freeze protection. 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 the operation of the device.

5303.4 Marking. Stationary and portable compressed gas containers, cylinders, tanks and systems shall be marked in accordance with Sections 5303.4.1 through 5303.4.3.

5303.4.1 Stationary compressed gas containers, cylinders and tanks. Stationary compressed gas containers, cylinders and tanks shall be marked with the name of the gas and in accordance with Sections 5003.5 and 5003.6. Markings shall be visible from any direction of approach.

5303.4.2 Portable containers, cylinders and tanks. Portable compressed gas containers, cylinders and tanks shall be marked in accordance with CGA E-7.

5303.4.3 Piping systems. Piping systems shall be marked in accordance with ASME A13.1. Markings used for piping systems shall consist of the content’s name and include a direction-of-flow arrow. Markings shall be provided at each valve; at wall, floor or ceiling penetrations; at each change of direction; and at not less than every 20 feet (6096 mm) or fraction thereof throughout the piping run.

Exceptions:

1. Piping that is designed or intended to carry more than one 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, refineries and similar occupancies shall be marked in an approved manner.

5303.5 Security. Compressed gas containers, cylinders, tanks and systems shall be secured against accidental dislodgement and against access by unauthorized personnel in accordance with Sections 5303.5.1 through 5303.5.3.

5303.5.1 Security of areas. Areas used for the storage, use and handling of compressed gas containers, cylinders, tanks and systems shall be secured against unauthorized entry and safeguarded in an approved manner.

5303.5.2 Physical protection. Compressed gas containers, cylinders, tanks and systems that could be exposed to physical damage shall be protected. Guard posts or other approved means shall be provided to protect compressed gas containers, cylinders, tanks and systems indoors and outdoors from vehicular damage and shall comply with Section 312.

5303.5.3 Securing compressed gas containers, cylinders and tanks. Compressed gas containers, cylinders and tanks shall be secured to prevent falling caused by contact, vibration or seismic activity. Securing of compressed gas containers, cylinders and tanks shall be by one of the following methods:

1. Securing containers, cylinders and tanks to a fixed object with one or more restraints.

2. Securing containers, cylinders and tanks on a cart or other mobile device designed for the movement of compressed gas containers, cylinders or tanks.

3. Nesting of compressed gas containers, cylinders and tanks at container filling or servicing facilities or in seller’s warehouses not open to the public. Nesting shall be allowed provided that the nested containers, cylinders or tanks, if dislodged, do not obstruct the required means of egress.

4. Securing of compressed gas containers, cylinders and tanks 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.

5303.6 Valve protection. Compressed gas container, cylinder and tank valves shall be protected from physical damage by means of protective caps, collars or similar devices in accordance with Sections 5303.6.1 and 5303.6.2.

5303.6.1 Compressed gas container, cylinder or tank protective caps or collars. Compressed gas containers, cylinders and tanks designed for protective caps, collars or other protective devices shall have the caps or devices in place except when the containers, cylinders or tanks are in use or are being serviced or filled.

5303.6.2 Caps and plugs. Compressed gas containers, cylinders and tanks designed for valve protection caps or other protective devices shall have the caps or devices in place. When outlet caps or plugs are installed, they shall be in place.

Exception: Compressed gas containers, cylinders or tanks in use, being serviced or being filled.

5303.7 Separation from hazardous conditions. Compressed gas containers, cylinders and tanks in storage or use shall be separated from materials and conditions that pose exposure hazards to or from each other. Compressed gas containers, cylinders, tanks and systems in
storage or use shall be separated in accordance with Sections 5303.7.1 through 5303.7.11.2.

5303.7.1 Incompatible materials. Compressed gas containers, cylinders and tanks shall be separated from each other based on the hazard class of their contents. Compressed gas containers, cylinders and tanks shall be separated from incompatible materials in accordance with Section 5003.9.8.

5303.7.2 Combustible waste, vegetation and similar materials. Combustible waste, vegetation and similar materials shall be kept not less than 10 feet (3048 mm) from compressed gas containers, cylinders, tanks and systems. A noncombustible partition, without openings or penetrations and extending not less than 18 inches (457 mm) above and 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.

5303.7.3 Ledges, platforms and elevators. Compressed gas containers, cylinders and tanks shall not be placed near elevators, unprotected platform ledges or other areas where falling would result in compressed gas containers, cylinders or tanks being allowed to drop distances exceeding one-half the height of the container, cylinder or tank.

5303.7.4 Temperature extremes. Compressed gas containers, cylinders and tanks, whether full or partially full, shall not be exposed to artificially created high temperatures exceeding 125°F (52°C) or subambient (low) temperatures unless designed for use under the exposed conditions.

5303.7.5 Falling objects. Compressed gas containers, cylinders, tanks and systems shall not be placed in areas where they are capable of being damaged by falling objects.

5303.7.6 Heating. Compressed gas containers, cylinders and tanks, whether full or partially full, shall not be heated by devices that could raise the surface temperature of the container, cylinder or tank to above 125°F (52°C). Heating devices shall comply with the International Mechanical Code and NFPA 70. Approved heating methods involving temperatures of less than 125°F (52°C) are allowed to be used by trained personnel. Devices designed to maintain individual compressed gas containers, cylinders or tanks at constant temperature shall be approved and shall be designed to be fail-safe.

5303.7.7 Sources of ignition. Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition.

5303.7.8 Exposure to chemicals. Compressed gas containers, cylinders, tanks and systems shall not be exposed to corrosive chemicals or fumes that could damage containers, cylinders, tanks, valves or valve-protective caps.

5303.7.9 Exhausted enclosures. Where exhausted enclosures are provided as a means to segregate compressed gas containers, cylinders and tanks from exposure hazards, such enclosures shall comply with the requirements of Section 5003.8.5.

5303.7.10 Gas cabinets. Where gas cabinets are provided as a means to separate compressed gas containers, cylinders and tanks from exposure hazards, such gas cabinets shall comply with the requirements of Section 5003.8.6.

5303.7.11 Tube trailers. Tube trailers, including those containing compatible compressed gases, shall be surrounded by a clear space of not less than 3 feet (914 mm) to allow for maintenance, access and inspection.

5303.7.11.1 Individual tube trailers containing incompatible materials. Increased separation distances between individual tube trailers containing incompatible gases shall be provided where required by Section 5303.7.1.

5303.7.11.2 Connections. Piping systems used to connect tube trailers to a user piping system shall not be viewed as an encroachment into the 3-foot (914 mm) clear space.

5303.8 Wiring and equipment. Electrical wiring and equipment shall comply with NFPA 70. Compressed gas containers, cylinders, tanks and systems shall not be located where they could become part of an electrical circuit. Compressed gas containers, cylinders, tanks and systems shall not be used for electrical grounding.

5303.9 Service and repair. Service, repair, modification or removal of valves, pressure-relief devices or other compressed gas container, cylinder or tank appurtenances shall be performed by trained personnel.

5303.10 Unauthorized use. Compressed gas containers, cylinders, tanks and systems shall not be used for any purpose other than to serve as a vessel for containing the product that it is designed to contain.

5303.11 Exposure to fire. Compressed gas containers, cylinders and tanks that have been exposed to fire shall be removed from service. Containers, cylinders and tanks so removed shall be handled by approved, qualified persons.

5303.12 Leaks, damage or corrosion. Leaking, damaged or corroded compressed gas containers, cylinders and tanks shall be removed from service. Leaking, damaged or corroded compressed gas systems shall be replaced or repaired in accordance with the following:

1. Compressed gas containers, cylinders and tanks that have been removed from service shall be handled in an approved manner.

2. Compressed gas systems that are determined to be leaking, damaged or corroded shall be repaired to a serviceable condition or removed from service.

5303.13 Surface of unprotected storage or use areas. Unless otherwise specified in Section 5303.14, compressed gas containers, cylinders and tanks are allowed to be stored or used without being placed under overhead cover. To prevent bottom corrosion, containers, cylinders and tanks shall be protected from direct contact with soil or unimproved surfaces. The surface of the area on which the
containers are placed shall be graded to prevent accumulation of water.

5303.14 Overhead cover. Compressed gas containers, cylinders and tanks are allowed to be stored or used in the sun except in locations where extreme temperatures prevail. Where extreme temperatures prevail, overhead covers shall be provided.

5303.15 Lighting. Approved lighting by natural or artificial means shall be provided.

5303.16 Vaults. Generation, compression, storage and dispensing equipment for compressed gases shall be allowed to be located in either above- or below-grade vaults complying with Sections 5303.16.1 through 5303.16.14.

5303.16.1 Listing required. Vaults shall be listed by a nationally recognized testing laboratory.

Exception: Where approved by the fire code official, below-grade vaults are allowed to be constructed on site, provided that the design is in accordance with the International Building Code and that special inspections are conducted to verify structural strength and compliance of the installation with the approved design in accordance with Section 1707 of the International Building Code. Installation plans for below-grade vaults that are constructed on site shall be prepared by, and the design shall bear the stamp of, a professional engineer. Consideration shall be given to soil and hydrostatic loading on the floors, walls and lid; anticipated seismic forces; uplifting by groundwater or flooding; and to loads imposed from above, such as traffic and equipment loading on the vault lid.

5303.16.2 Design and construction. The vault shall completely enclose generation, compression, storage or dispensing equipment located in the vault. There shall not be openings in the vault enclosure except those necessary for vault ventilation and access, inspection, filling, emptying or venting of equipment in the vault. The walls and floor of the vault shall be constructed of reinforced concrete at least 6 inches (152 mm) thick. The top of an above-grade vault shall be constructed of noncombustible material and shall be designed to be weaker than the walls of the vault to ensure that the thrust of any explosion occurring inside the vault is directed upward.

The top of an at- or below-grade vault shall be designed to relieve safely or contain the force of an explosion occurring inside the vault in accordance with NFPA 68 Guide for Venting Deflagrations. The top and floor of the vault and the tank foundation shall be designed to withstand the anticipated loading, including loading from vehicular traffic, where applicable. The walls and floor of a vault installed below grade shall be designed to withstand anticipated soil and hydrostatic loading. Vaults shall be designed to be wind and earthquake resistant, in accordance with the International Building Code.

5303.16.3 Secondary containment. Vaults shall be substantially liquid-tight and there shall be no backfill within the vault. The vault floor shall drain to a sump.

For premanufactured vaults, liquid tightness shall be certified as part of the listing provided by a nationally recognized testing laboratory. For field-erected vaults, liquid tightness shall be certified in an approved manner.

5303.16.4 Internal clearance. There shall be sufficient clearance within the vault to allow for visual inspection and maintenance of equipment in the vault.

5303.16.5 Anchoring. Vaults and equipment contained therein shall be suitably anchored to withstand uplifting by groundwater or flooding. The design shall verify that uplifting is prevented even where equipment within the vault is empty.

5303.16.6 Vehicle impact protection. Vaults shall be resistant to damage from the impact of a motor vehicle, or vehicle impact protection shall be provided in accordance with Section 512.

5303.16.7 Arrangement. Equipment in vaults shall be listed or approved for above-ground use. Where multiple vaults are provided, adjacent vaults shall be allowed to share a common wall. The common wall shall be liquid and vapor tight and shall be designed to withstand the load imposed when the vault on either side of the wall is filled with water.

5303.16.8 Connections. Connections shall be provided to permit the venting of each vault to dilute, disperse and remove vapors prior to personnel entering the vault.

5303.16.9 Ventilation. Vaults shall be provided with an exhaust ventilation system installed in accordance with Section 5004.3. The ventilation system shall operate continuously or be designed to operate upon activation of the vapor or liquid detection system. The system shall provide ventilation at a rate of not less than 1 cubic foot per minute (cfm) per square foot [0.00508 m²/(s • m²)] of floor area, but not less than 150 cfm (4.3 m³/min). The exhaust system shall be designed to provide air movement across all parts of the vault floor for gases having a density greater than air and across all parts of the vault ceiling for gases having a density less than air. Supply ducts shall extend to within 3 inches (76 mm), but not more than 12 inches (305 mm), of the floor. Exhaust ducts shall extend to within 3 inches (76 mm), but not more than 12 inches (305 mm) of the floor or ceiling, for heavier-than-air or lighter-than-air gases, respectively. The exhaust system shall be installed in accordance with the International Mechanical Code.

5303.16.10 Monitoring and detection. Vaults shall be provided with approved vapor and liquid detection systems and equipped with on-site audible and visual warning devices with battery backup. Vapor detection systems shall sound an alarm when the system detects vapors that reach or exceed 25 percent of the lower explosive limit (LEL) or one-half the immediately dangerous to life and health (IDLH) concentration for the gas in the vault. Vapor detectors shall not be located higher than 12 inches (305 mm) above the lowest point in the vault for heavier-than-air gases and not lower than 12 inches (305 mm) below the highest point in the vault for lighter-than-air gases. Liquid detection
systems shall sound an alarm upon detection of any liquid, including water. Liquid detectors shall be located in accordance with the manufacturers’ instructions. Activation of either vapor or liquid detection systems shall cause a signal to be sounded at an approved, constantly attended location within the facility served by the tanks or at an approved location. Activation of vapor detection systems shall also shut off gas-handling equipment in the vault and dispensers.

5303.16.11 Liquid removal. Means shall be provided to recover liquid from the vault. Where a pump is used to meet this requirement, it shall not be permanently installed in the vault. Electric-powered portable pumps shall be suitable for use in Class I, Division 1 locations, as defined in NFPA 70.

5303.16.12 Relief vents. Vent pipes for equipment in the vault shall terminate not less than 12 feet (3658 mm) above ground level.

5303.16.13 Accessway. Vaults shall be provided with an approved personnel accessway with a minimum dimension of 30 inches (762 mm) and with a permanently affixed, nonferrous ladder. Accessways shall be designed to be nonsparking. Travel distance from any point inside a vault to an accessway shall not exceed 20 feet (6096 mm). At each entry point, a warning sign indicating the need for procedures for safe entry into confined spaces shall be posted. Entry points shall be secured against unauthorized entry and vandalism.

5303.16.14 Classified area. The interior of a vault containing a flammable gas shall be designated a Class I, Division 1 location, as defined in NFPA 70.

SECTION 5304
STORAGE OF COMPRESSED GASES

5304.1 Upright storage. Compressed gas containers, cylinders and tanks, except those designed for use in a horizontal position, and all compressed gas containers, cylinders and tanks containing nonliquefied gases, shall be stored in an upright position with the valve end up. An upright position shall include conditions where the container, cylinder or tank axis is inclined as much as 45 degrees (0.80 rad) from the vertical.

Exceptions:
1. Compressed gas containers with a water volume less than 1.3 gallons (5 L) are allowed to be stored in a horizontal position.
2. Cylinders, containers and tanks containing nonflammable gases or cylinders, containers and tanks containing nonliquefied flammable gases, that have been secured to a pallet for transportation purposes.

5304.2 Material-specific regulations. In addition to the requirements of this section, indoor and outdoor storage of compressed gases shall comply with the material-specific provisions of Chapters 54, 58 and 60 through 67.

SECTION 5305
USE AND HANDLING OF COMPRESSED GASES

5305.1 Compressed gas systems. Compressed gas systems shall be suitable for the use intended and shall be designed by persons competent in such design. Compressed gas equipment, machinery and processes shall be listed or approved.

5305.2 Controls. 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.

5305.3 Piping systems. Piping, including tubing, valves, fittings and pressure regulators, shall comply with this section and Chapter 50. Piping, tubing, pressure regulators, valves and other apparatus shall be kept gas tight to prevent leakage.

5305.4 Valves. Valves utilized on compressed gas systems shall be suitable for the use intended. Access to such valves shall be provided and maintained. Valve handles or operators for required shut-off valves shall not be removed or otherwise altered to prevent access.

5305.5 Venting. Venting of gases shall be directed to an approved location. Venting shall comply with the International Mechanical Code.

5305.6 Upright use. Compressed gas containers, cylinders and tanks, except those designed for use in a horizontal position, and all compressed gas containers, cylinders and tanks containing nonliquefied gases, shall be used in an upright position with the valve end up. An upright position shall include conditions where the container, cylinder or tank axis is inclined as much as 45 degrees (0.80 rad) from the vertical. Use of nonflammable liquefied gases in the inverted position when the liquid phase is used shall not be prohibited provided that the container, cylinder or tank is properly secured and the dispensing apparatus is designed for liquefied gas use.

Exception: Compressed gas containers, cylinders and tanks with a water volume less than 1.3 gallons (5 L) are allowed to be used in a horizontal position.

5305.7 Transfer. Transfer of gases between containers, cylinders and tanks shall be performed by qualified personnel using equipment and operating procedures in accordance with CGA P-1.

Exception: The fueling of vehicles with CNG or CH₂ conducted in accordance with Chapter 23.

5305.8 Use of compressed gas for inflation. Inflatable equipment, devices or balloons shall only be pressurized or filled with compressed air or inert gases.

5305.9 Material-specific regulations. In addition to the requirements of this section, indoor and outdoor use of compressed gases shall comply with the material-specific provisions of Chapters 54, 58 and 60 through 67.

5305.10 Handling. The handling of compressed gas containers, cylinders and tanks shall comply with Sections 5305.10.1 and 5305.10.2.
5305.10.1 Carts and trucks. Containers, cylinders and tanks shall be moved using an approved method. Where containers, cylinders or tanks 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, cylinders or tanks. Carts and trucks utilized for transport of compressed gas containers, cylinders and tanks within buildings shall comply with Section 5003.10. Carts and trucks utilized for transport of compressed gas containers, cylinders and tanks exterior to buildings shall be designed so that the containers, cylinders and tanks will be secured against dropping or otherwise striking against each other or other surfaces.

5305.10.2 Lifting devices. Ropes, chains or slings shall not be used to suspend compressed gas containers, cylinders and tanks unless provisions at time of manufacture have been made on the container, cylinder or tank for appropriate lifting attachments, such as lugs.

SECTION 5306
MEDICAL GASES

5306.1 General. General. Medical gases at health care-related facilities intended for patient or veterinary care shall comply with Sections 5306.2 through 5306.5 in addition to other requirements of this chapter and Section 427 of the International Building Code.

5306.2 Interior supply location. Medical gases shall be located in areas dedicated to the storage of such gases without other storage or uses. Where containers of medical gases in quantities greater than the permit amount are located inside buildings, they shall be in a 1-hour exterior room, a 1-hour interior room or a gas cabinet in accordance with Section 5306.2.1, 5306.2.2 or 5306.2.3, respectively. Rooms or areas where medical gases are stored or used in quantities exceeding the maximum allowable quantity per control area as set forth in Section 5003.1 shall be in accordance with the International Building Code for high-hazard Group H occupancies.

5306.2.1 One-hour exterior rooms. A 1-hour exterior room shall be a room or enclosure separated from the remainder of the building by fire barriers constructed in accordance with Section 707 of the International Building Code or horizontal assemblies constructed in accordance with Section 711 of the International Building Code, or both, with a fire-resistance rating of not less than 1 hour. Openings between the room or enclosure and interior spaces shall be self-closing smoke- and draft-control assemblies having a fire protection rating of not less than 1 hour. An automatic sprinkler system shall be installed within the room. The room shall be exhausted through a duct to the exterior. Supply and exhaust ducts shall be located in a 1-hour-rated shaft enclosure from the room to the exterior. Approved mechanical ventilation shall comply with the International Mechanical Code and be provided at a minimum rate of 1 cfm per square foot [0.00508 m³/(s • m²)] of the area of the room.

5306.2.2 Gas cabinets. Gas cabinets shall be constructed in accordance with Section 5003.8.6 and shall comply with the following:

1. Exhausted to the exterior through dedicated exhaust duct system installed in accordance with Chapter 5 of the International Mechanical Code.

2. Supply and exhaust ducts shall be located in a 1-hour fire-resistance-rated shaft enclosure from the cabinet to the exterior. The average velocity of ventilation at the face of access ports or windows shall be not less than 200 feet per minute (1.02 m/s) with not less than 150 feet per minute (0.76 m/s) at any point of the access port or window.

3. Provided with an automatic sprinkler system internal to the cabinet.

5306.2.3 Exterior supply locations. Oxidizer medical gas systems located on the exterior of a building with quantities greater than the permit amount shall be located in accordance with Section 6304.2.1.

5306.4 Transfilling. Transfilling areas and operations including, but not limited to, ventilation and separation, shall comply with NFPA 99.

5306.5 Medical gas systems. Medical gas systems including, but not limited to, distribution piping, supply manifolds, connections, pressure regulators and relief devices and valves, shall be installed in accordance with NFPA 99 and the general provisions of this chapter. Existing medical gas systems shall be maintained in accordance with the maintenance, inspection and testing provisions of NFPA 99 for medical gas systems.

SECTION 5307
COMPRESSED GASES
NOT OTHERWISE REGULATED
5307.1 General. Compressed gases in storage or use not regulated by the material-specific provisions of Chapters 6, 54, 55, and 60 through 67, including asphyxiant, irritant and radioactive gases, shall comply with this section in addition to other requirements of this chapter.

5307.2 Reserved.

Ventilation. Indoor storage and use areas and storage buildings shall be provided with ventilation in accordance with Section 5004.3. Where mechanical ventilation is provided, the systems shall be operational during such time as the building or space is occupied.

Exceptions:
1. A gas detection system complying with Section 5307.2.1 shall be permitted in lieu of mechanical ventilation.
2. Areas containing insulated liquid carbon dioxide systems used in beverage dispensing applications shall comply with Section 5307.3.

5307.2.1 Reserved.

Gas detection system. In rooms or areas not provided with ventilation in accordance with Section 5307.2, a gas detection system complying with Section 916 or, where approved, an oxygen depletion alarm system, either of which initiates audible and visible alarm signals in the room or area where sensors are installed, shall be provided.

5307.3 Reserved.

Insulated liquid carbon dioxide systems used in beverage dispensing applications. Insulated liquid carbon dioxide systems used in beverage dispensing applications shall comply with Section 5307.3.1.

5307.3.1 Reserved.

Ventilation. Where insulated liquid carbon dioxide storage tanks, cylinders, piping and equipment are located indoors, rooms or areas containing storage tanks, cylinders, piping and equipment, and other areas where a leak of carbon dioxide is expected to accumulate, shall be provided with mechanical ventilation in accordance with Section 5004.3 and designed to maintain the room containing carbon dioxide at a negative pressure in relation to the surrounding area.

Exception: A gas detection system complying with Section 5307.3.2 shall be permitted in lieu of mechanical ventilation.

5307.3.2 Reserved.

Gas detection system. Where ventilation is not provided in accordance with Section 5307.3.1, a gas detection system shall be provided in rooms or indoor areas and in below-grade outdoor locations with insulated carbon dioxide systems. Carbon dioxide sensors shall be provided within 12 inches (305 mm) of the floor in the area where the gas is expected to accumulate or other approved locations. The system shall be designed as follows:
1. Activates an audible and visible supervisory alarm at a normally attended location upon detection of a carbon dioxide concentration of 5,000 ppm (9000 mg/m3).
2. Activates an audible and visible alarm within the room or immediate area where the system is installed upon detection of a carbon dioxide concentration of 30,000 ppm (54,000 mg/m3).

5307.2 General. Carbon dioxide and other simple asphyxiant gas systems with more than 50 pounds (22.7 kg) in use, per system, shall comply with this section.

Exception: One (1) additional 50lb DOT 3AA cylinder of carbon dioxide may be connect to the same system provided an isolation valve is in place, and only one cylinder can be in use at a time.

5307.2.1 Permits. Permits shall be required as set forth in Section 105.6 through 105.12.

5307.2.1.1 Equipment. The storage, use, and handling of liquid carbon dioxide shall be in accordance with Chapter 53 and the applicable requirements of NFPA 55, Chapter 13. Insulated liquid carbon dioxide systems shall have pressure relief devices vented in accordance with NFPA 55.

5307.2.1.2 Protection from damage. Carbon dioxide and other simple asphyxiant gas systems shall be installed so the storage tanks, cylinders, piping fittings, detection and notification devices are protected from damage by occupants or equipment during normal facility operations, in accordance with Sections 5303.5 and 5303.6.

5307.2.2 Gas Ventilation Requirements. When any ASME vessels containing liquefied carbon dioxide and other simple asphyxiant gas or more than two 50lb DOT AA3 gaseous carbon dioxide cylinders and other simple asphyxiant gas per system, are connected to a piping system and located within the structure, a mechanical exhaust ventilation system shall be provided in accordance with the International Mechanical Code. A separate plan submittal for the installation of this mechanical exhaust ventilation system is required by the Planning and Development Department.

5307.2.2.1 Exhaust. The mechanical exhaust ventilation system shall be designed at a rate not less than one cubic foot per minute, per square foot of floor area, within the area inside the structure where the ASME vessel or DOT cylinders are located. The ventilation system shall be designed to operate at a negative pressure in relation to the surrounding area.

5307.2.2.2 Exhaust intake. The exhaust intake shall be taken from a point within 12 inches (305 mm) of the floor. The exhaust system intake shall be located a minimum of 2 feet away from any gas detector or located on the opposite wall of any gas detector.
5307.2.2.2.3 Exhaust termination. The termination point of exhaust outlets and ducts discharging to the outdoors shall be located a minimum of 10 feet from property lines, a minimum of 3 feet above the roof line and a minimum of 10 feet from operable openings into the building and a minimum of 10 feet above adjoining grade.

5307.2.2.4 Automatic activation. The exhaust system shall automatically activate when:

1. The concentration of carbon dioxide reaches 3% (30,000 ppm), or
2. The concentration of oxygen reaches 19.5% in an oxygen deficient environment, or

Exception: Continuous ventilation.

5307.2.2.5 Manual activation. A manual activation switch shall be provided at the entrance of the area where the ASME vessel or DOT cylinders are located. This manual activation switch shall be clearly marked with its function.

5307.2.3 Equipment venting. On all new and existing installations, emergency relief vents, burst disks and pump vents shall be terminated outside the building and at least 10 feet from openings into the building or property lines.

5307.2.4 Gas detection. Compressed gases such as Carbon Dioxide, Helium, Argon, Nitrogen and other compressed gases that are classified as an asphyxiant shall be provided with a gas detection and alarm systems. The gas detection and alarm systems shall be installed, inspected, tested, calibrated and maintained per the manufacturer's instructions or at a minimum annually.

5307.2.4.1 Gas detectors. Gas detectors shall be field tested at the time of final inspection and annually, or as required by the manufacturer. Testing, inspection, and maintenance of detection devices shall be performed with an approved test gas. All test gas shall have a recognized certification that documents the type and percentage of gas.

5307.2.4.2 Records. Records of inspections and maintenance shall be available for review upon request by the Phoenix Fire Department.

5307.2.4.3 Specific gas detection. Where the gas is carbon dioxide, the gas detection systems shall be designed to detect carbon dioxide. All other simple asphyxiants shall use an oxygen sensor.

5307.2.4.4 Location. Gas detection shall be provided at each point of use and at vessels or cylinders inside structures. Basements and or subterranean spaces that could be physically entered and that have product lines shall have gas detection.

5307.2.4.5 Carbon dioxide two tier detection. The detection system shall be capable of two tier detection. Tier one shall be set at 0.5% carbon dioxide or 5,000 ppm. Two tier shall be set at 3% carbon dioxide or 30,000 ppm.

5307.2.4.6 Simple asphyxiant two tier detection. The detection system shall be capable of two tier detection. Tier one shall be set at 19.5% oxygen in an oxygen deficient environment. Two tier shall be set at 18% in an oxygen deficient environment.

5307.2.4.7 Installation. Asphyxiant gas detection systems or appropriate gas detection for the gas, shall be installed per the manufacture manual.

5307.2.4.8 Power. The power supply to the gas detection system shall be circuit locked and labeled. Approved backup power shall be provided.

5307.2.5 Supervisory signal. At 0.5% (5,000 ppm) carbon dioxide or 19.5% oxygen, a local warning/supervisory signal with visible and audible indication shall occur at a constantly manned location and shall be transmitted off-site to a UL approved third party monitoring station as a supervisory signal alarm when the facility has a system monitoring signals off site.

5307.2.6 Evacuation alarm. At 3% (30,000 ppm) carbon dioxide or 18% oxygen, an evacuation alarm shall sound for the occupancy and shall transmitted off-site to a UL approved third party monitoring station as a gas specific alarm.

Exception: When the facility does not have a system capable of transmitting signals off site then established approved protocols shall be in place to call 911.

5307.2.6.1 Monitoring. Connection to fire alarm panel or monitoring panel shall be completed by a fire protection company holding a Phoenix Fire Department Business Certificate. A separate permit obtained by an approved fire alarm contractor from the Fire Department is required.

5307.2.7 Notification. Evacuation notification devices with audible and visible notification shall be provided:

1. Near every point-of-use,
2. In the area or room where the asphyxiant gas cylinders are located,
3. In the common area where public gathers,
4. At the entrance to the room with required detection,
5. It shall be clear to the responders upon approach to the hazard that asphyxiant gas is present.
6. Or as required by the fire code official.

5307.2.7.1 Notification devices. Notification devices shall comply with the following:

1. The notification device shall be rated a minimum of 100 candela rating for a visual effect and 75 decibels for an audible effect.
2. The notification devices shall be identified and labeled for the gas being detected. Use of the building fire alarm notification devices for evacuation is acceptable, provided the asphyxiant gas detection has visible and audible clear
indicators in the hazard area upon both the warning level and alarm level of the gas.

5307.3 Tank and Piping Requirements. Piping systems shall be designed and constructed and tested in accordance with ASME/ANSI B31.3 Process Piping Code.

5307.3.1 Piping and marking. Piping and tubing shall be identified in accordance with ASME A13.1 to indicate the material conveyed. Markings used for piping systems shall consist of the content’s name and include a direction-of-flow arrow. Markings shall be provided at each valve; at wall, floor or ceiling penetrations; at each change of direction; and repeated at not less than every 20 feet (6096 mm) or fraction thereof throughout the piping run.

5307.3.2 Piping design. Gas piping systems shall be designed as follows:

1. Piping systems shall be designed to a bursting pressure of at least four times the system design pressure.

All fittings used in the piping system shall be designed for a working pressure not to exceed 125% of designed pressure of the hose.

5307.3.3 Piping materials. Carbon dioxide Gas piping systems shall be of listed and approved materials for each specific gas in use. Rigid plastic piping shall not be allowed.

Exception: Non-listed materials requires a special report by an Arizona registered engineer on the piping material shall be submitted to the fire code official for approval.

A special report on the piping material shall not be required if the piping material has been listed by a third-party testing group such as UL or FM for the intended use.

5307.3.4 Leak tests. All piping systems shall be leak tested in accordance with the following:

1. Piping systems shall be tested by a pneumatic pattern at a pressure equal to the working pressure for 15 minutes or as long as it takes to check each joint; the test medium shall be carbon dioxide, and,

2. Soap testing of all fittings shall be witnessed at time of inspection.

5307.4 Carbon dioxide enrichment systems. The design, installation and maintenance of carbon dioxide enrichment systems with more than 100 pounds (45.4 kg) of carbon dioxide, and carbon dioxide enrichment systems with any quantity of carbon dioxide having a remote fill connection, shall comply with Sections 5307.4.1 through 5307.4.7.

5307.4.1 Documentation. The following information shall be provided with the application for permit:

1. Total aggregate quantity of liquid carbon dioxide in pounds or cubic feet at normal temperature and pressure.

2. Location and total volume of the room where the carbon dioxide enrichment operation will be conducted. Identify whether the room is at grade or below grade.

3. Location of containers relative to equipment, building openings and means of egress.

4. Manufacturer’s specifications and pressure rating, including cut sheets, of all piping and tubing to be used.

5. A piping and instrumentation diagram that shows piping support and remote fill connections.

6. Details of container venting, including but not limited to vent line size, material and termination location.

7. Alarm and detection system and equipment, if applicable.

8. Seismic support for containers.

5307.4.2 Equipment. Pressure relief, vent piping, fill indicators, fill connections, vent terminations, piping systems and the storage, use and handling of the carbon dioxide shall be in accordance with Chapter 53 and NFPA 55.

5307.4.3 Gas detection system. A gas detection system complying with Section 916 shall be provided in rooms or indoor areas in which the carbon dioxide enrichment process is located, in rooms or indoor areas in which container systems are located, and in other areas where carbon dioxide is expected to accumulate. Carbon dioxide sensors shall be provided within 12 inches (305 mm) of the floor in the area where the gas is expected to accumulate or leaks are most likely to occur. The system shall be designed as follows: in accordance with Sections 5307.2 through 5307.12.2.

1. Activates a low-level alarm upon detection of a carbon dioxide concentration of 5,000 ppm (9000 mg/m3).

2. Activates a high-level alarm upon detection of a carbon dioxide concentration of 30,000 ppm (54 000 mg/m).

5307.4.3.1 System activation. System activation shall be in accordance with Sections 5307.2 through 5307.12.2 and this section.

Activation of the low level gas detection system alarm shall automatically:

1. Stop the flow of carbon dioxide to the piping system.

2. Activate the mechanical exhaust ventilation system.

3. Activate an audible and visible supervisory alarm signal at an approved location within the building.

Activation of the high-level gas detection system alarm shall automatically:
1. Stop the flow of carbon dioxide to the piping system.
2. Activate the mechanical exhaust ventilation system.
3. Activate an audible and visible evacuation alarm both inside and outside of the carbon dioxide enrichment area, and the area in which the carbon dioxide containers are located.

5307.4.4 Pressurization and ventilation. Rooms or indoor areas in which carbon dioxide enrichment is provided shall be maintained at a negative pressure in relation to the surrounding areas in the building. A mechanical ventilation system shall be provided in accordance with the *International Mechanical Code* that complies with all of the following:

1. Mechanical ventilation in the room or area shall be at a rate of not less than 1 cfm per square foot [0.00508 m³/(s • m²)].
2. When activated by the gas detection system, the mechanical ventilation system shall remain on until manually reset.
3. The exhaust system intakes shall be taken from points within 12 inches (305 mm) of the floor.
4. The ventilation system shall discharge to the outdoors in an approved location.

5307.4.5 Signage. Hazard identification signs shall be posted at the entrance to the room and indoor areas where the carbon dioxide enrichment process is located, and at the entrance to the room or indoor area where the carbon dioxide containers are located. The sign shall be not less than 8 inches (200 mm) in width and 6 inches (150 mm) in height and indicate:

   CAUTION – CARBON DIOXIDE GAS
   VENTILATE THE AREA BEFORE ENTERING.
   A HIGH CARBON DIOXIDE (CO₂) GAS
   CONCENTRATION
   IN THIS AREA CAN CAUSE ASPHYXIATION.

5307.4.6 Seismic and structural design. Carbon dioxide system containers and piping shall comply with the seismic design requirements in Chapter 16 of the *International Building Code* and shall not exceed the floor loading limitation of the building.

5307.4.7 Container refilling. Carbon dioxide containers located indoors shall not be refilled unless filled from a remote connection located outdoors.