

CHAPTER 30

COMPRESSED GASES

SECTION 3001 GENERAL

3001.1 Scope. Storage, use and handling of compressed gases in compressed gas containers, cylinders, tanks and systems shall comply with this chapter, 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.

Exceptions:

1. Gases used as refrigerants in refrigeration systems (see Section 606).
2. Compressed air storage and piping systems.

Cutting and welding gases shall also comply with Chapter 27.

Cryogenic fluids shall also comply with Chapter 32. Liquefied natural gas for use as a vehicular fuel shall also comply with NFPA 57 and NFPA 59A.

Compressed gases classified as hazardous materials shall also comply with Chapter 27 for general requirements and chapters addressing specific hazards, including Chapters 35 (Flammable Gases), 37 (Highly Toxic and Toxic Materials), 40 (Oxidizers) and 41 (Pyrophoric).

LP-gas shall also comply with Chapter 38 and the *Arizona State Plumbing Code*.

Compressed natural gas (CNG) for use as a vehicular fuel shall comply with Chapter 22 and NFPA 52.

3001.2 Permits. Permits shall be required as set forth in Section 105.6 and 105.7.

3001.3 Construction documents. Construction documents shall be submitted to the fire code official for approval prior to the installation or modification of compressed gas systems. See Section 105.2.8.

Exception: Compressed air systems.

SECTION 3002 DEFINITIONS

3002.1 Definitions. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

COMPRESSED GAS. A material, or mixture of materials which:

1. Is a gas at 68°F (20°C) or less at 14.7 psia (101 kPa) of pressure; and
2. Has a boiling point of 68°F (20°C) or less at 14.7 psia (101 kPa) which is either liquefied, nonliquefied or in solution, except those gases which have no other health- or physical-hazard properties are not considered to be com-

pressed until the pressure in the packaging exceeds 41 psia (28 kPa) at 68°F (20°C).

The states of a compressed gas are categorized as follows:

1. Nonliquefied compressed gases are gases, other than those in solution, which are in a packaging under the charged pressure and are entirely gaseous at a temperature of 68°F (20°C).
2. Liquefied compressed gases are gases that, in a packaging under the charged pressure, are partially liquid at a temperature of 68°F (20°C).
3. Compressed gases in solution are nonliquefied gases that are dissolved in a solvent.
4. Compressed gas mixtures consist of a mixture of two or more compressed gases contained in a packaging, the hazard properties of which are represented by the properties of the mixture as a whole.

COMPRESSED GAS CONTAINER. A pressure vessel designed to hold compressed gases at pressures greater than one atmosphere at 68°F (20°C) and includes cylinders, containers and tanks.

COMPRESSED GAS SYSTEM. An assembly of equipment designed to contain, distribute or transport compressed gases. It can consist of a compressed gas container or containers, reactors and appurtenances, including pumps, compressors and connecting piping and tubing.

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

SECTION 3003 GENERAL REQUIREMENTS

3003.1 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.

3003.2 Marking. Stationary and portable compressed gas containers, cylinders, tanks and systems shall be marked in accordance with Sections 3003.2.1, 3003.2.2 and 3003.2.3.

3003.2.1 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 2703.5 and 2703.6. Markings shall be visible from any direction of approach.

3003.2.2 Portable containers, cylinders and tanks. Portable compressed gas containers, cylinders and tanks shall be marked in accordance with CGA C-7.

3003.2.3 Piping identification. Piping contents and direction of flow shall be identified in accordance with Chapter 27.

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.

3003.3 Security. Compressed gas containers, cylinders, tanks and systems shall be secured against accidental dislodgement and against access by unauthorized personnel in accordance with Sections 3003.3.1 through 3003.3.3.

3003.3.1 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.

3003.3.2 Physical protection. Compressed gas containers, cylinders, tanks and systems which 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.

3003.3.3 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 accessible to the public. Nesting shall be allowed provided 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.

3003.4 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 3003.4.1 and 3003.4.2.

3003.4.1 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.

3003.4.2 Caps and plugs. Compressed gas containers, cylinders and tanks designed for valve protection caps or other protective devices shall have the caps or devices attached. 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.

3003.5 Separation from hazardous conditions. Compressed gas containers, cylinders and tanks and systems in storage or use shall be separated from materials and conditions which 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 3003.5.1 through 3003.5.10.

3003.5.1 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 2703.9.8.

3003.5.2 Combustible waste, vegetation and similar materials. Combustible waste, vegetation and similar materials shall be kept a minimum of 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.

3003.5.3 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.

3003.5.4 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) temperatures unless designed for use under the exposed conditions.

3003.5.5 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.

3003.5.6 Heating. Compressed gas containers, cylinders and tanks, whether full or partially full, shall not be heated by devices which could raise the surface temperature of the container, cylinder or tank to above 125°F (52°C). Heating devices shall comply with the *National Electrical Code*. 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.

3003.5.7 Sources of ignition. Open flames and high-temperature devices shall not be used in a manner which creates a hazardous condition.

3003.5.8 Exposure to chemicals. Compressed gas containers, cylinders, tanks and systems shall not be exposed to corrosive chemicals or fumes which could damage containers, cylinders, tanks, valves or valve-protective caps.

3003.5.9 Exhausted enclosures. When 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 2703.8.5.

3003.5.10 Gas cabinets. When 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 2703.8.6.

3003.6 Wiring and equipment. Electrical wiring and equipment shall comply with the *National Electrical Code*. 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.

3003.7 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.

3003.8 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 which it is designed to contain.

3003.9 Exposure to fire. Compressed gas containers, cylinders and tanks which have been exposed to fire shall be removed from service. Containers, cylinders and tanks so removed shall be handled by approved qualified persons.

3003.10 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 which have been removed from service shall be handled in an approved manner.
2. Compressed gas systems which are determined to be leaking, damaged or corroded shall be repaired to a serviceable condition or removed from service.

3003.11 Surface of unprotected storage or use areas. Unless otherwise specified in Section 3003.12, 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.

3003.12 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. When extreme temperatures prevail, overhead covers shall be provided.

3003.13 Lighting. Approved lighting by natural or artificial means shall be provided.

3003.14 Vaults. Generation, compression, storage and dispensing equipment for compressed gases shall be permitted to be located in either above or below grade vaults complying with Sections 3003.14.1 through 3003.14.14.

3003.14.1 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 the *International Building Code*, Section 1707. 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 ground water or flooding; and to loads imposed from above such as traffic and equipment loading on the vault lid.

3003.14.2 Design and construction. The vault shall completely enclose generation, compression, storage or dispensing equipment located in the vault. There shall be no 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-grade or below-grade vault shall be designed to relieve safely or contain the force of an explosion occurring inside the vault. 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*.

3003.14.3 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.

3003.14.4 Internal clearance. There shall be sufficient clearance with the vault to allow for visual inspection and maintenance of equipment in the vault.

3003.14.5 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 when equipment within the vault is empty.

3003.14.6 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 312.

3003.14.7 Arrangement. Equipment in vaults shall be listed or approved for above-ground use. Where multiple vaults are provided, adjacent vaults shall be permitted 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.

3003.14.8 Connections. Connections shall be provided to permit venting of each vault to dilute, disperse and remove vapors to personnel entering the vault.

3003.14.9 Ventilation. Vaults shall be provided with an exhaust ventilation system installed in accordance with Section 2704.3. 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 of floor area [$0.00508 \text{ m}^3/\text{s}$ per m^2], but not less than 150 cfm [$0.071 \text{ m}^3/\text{s}$ per m^2]. 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 (87 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*.

3003.14.10 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 $1/2$ IDLH for the gas in the vault. Vapor detectors shall be located no higher than 12 inches (305 mm) above the lowest point in the vault for heavier-than-air gases and no 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 manufacturer's 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.

3003.14.11 Liquid removal. Means shall be provided to recover liquid from the vault. Where a pump is used to meet this requirement, the pump 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 the *National Electrical Code*.

3003.14.12 Relief vents. Vent pipes for equipment in the vault shall terminate at least 12 feet (3658 mm) above ground level.

3003.14.13 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.

3003.14.14 Classified area. The interior of the vault containing a flammable gas shall be designated a Class I Division 1 location, as defined in the *National Electrical Code*.

SECTION 3004 STORAGE OF COMPRESSED GASES

3004.1 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, which have been secured to a pallet for transportation purposes.

3004.2 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 31, 35 and 37 through 44.

SECTION 3005 USE AND HANDLING OF COMPRESSED GASES

3005.1 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.

3005.2 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.

3005.3 Piping systems. Piping, including tubing, valves, fittings and pressure regulators, shall comply with this section and Chapter 27. Piping, tubing, pressure regulators, valves and other apparatus shall be kept gas tight to prevent leakage.

3005.4 Valves. Valves utilized on compressed gas systems shall be suitable for the use intended and shall be accessible. Valve handles or operators for required shutoff valves shall not be removed or otherwise altered to prevent access.

3005.5 Venting. Venting of gases shall be directed to an approved location. Venting shall comply with the *International Mechanical Code*.

3005.6 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.

3005.7 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: Fueling of vehicles with compressed natural gas (CNG).

3005.8 Use of compressed gas for inflation. Inflatable equipment, devices or balloons shall only be pressurized or filled with compressed air or inert gases.

3005.9 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 31, 35 and 37 through 44.

3005.10 Handling. The handling of compressed gas containers, cylinders and tanks shall comply with Sections 3005.10.1 and 3005.10.2.

3005.10.1 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 2703.10. 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.

3005.10.2 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 3006 MEDICAL GAS SYSTEMS

3006.1 General. Compressed gases at hospitals and similar facilities intended for inhalation or sedation including, but not limited to, analgesia systems for dentistry, podiatry, veterinary and similar uses shall comply with this section in addition to other requirements of this chapter.

3006.2 Interior supply location. Medical gases shall be stored in areas dedicated to the storage of such gases without other storage or uses. Where containers of medical gases are stored in quantities greater than the maximum allowable quantity inside buildings, they shall be in a 1-hour exterior room, a 1-hour interior room or a gas cabinet in accordance with Section 3006.2.1, 3006.2.2 or 3006.2.3.

3006.2.1 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 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. Rooms shall have at least one exterior wall that is provided with at least two vents. Each vent shall not be less than 36 square inches (0.023 m²) in area. One vent shall be within 6 inches (152 mm) of the floor and one shall be within 6 inches (152 mm) of the ceiling.

3006.2.2 One-hour interior room. When an exterior wall cannot be provided for the room, an interior room shall be provided. The room or enclosure shall be separated from the remainder of the building by fire barriers 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. The room shall be exhausted through a duct to the exterior. Supply and exhaust ducts that penetrate a fire barrier shall be equipped with a listed fire damper or enclosed 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 cubic foot per minute per square foot [0.00508 m³/(s. m²)] of the area of the room.

3006.2.3 Gas cabinets. Gas cabinets shall be constructed in accordance with Section 2703.8.6 and the following:

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

COMPRESSED GASES

3006.3 Exterior supply locations. Oxidizer medical gas systems located on the exterior of a building in quantities greater than the outdoor maximum allowable quantity shall be located in accordance with Section 4004.2.1.

3006.4 Medical gas systems. Medical gas systems including, but not limited to, distribution piping, supply manifolds, connections, pressure regulators, and relief devices and valves, shall comply with NFPA 99 and the general provisions of this chapter.

SECTION 3007 COMPRESSED GASES NOT OTHERWISE REGULATED

3007.1 General. Compressed gases in storage or use not regulated by the material-specific provisions of Chapters 6, 31, 35 and 37 through 45, including asphyxiant, irritant and radioactive gases, shall comply with this section in addition to other requirements of this chapter.

3007.2 Ventilation. Indoor storage and use areas and storage buildings shall be provided with mechanical exhaust ventilation or natural ventilation in accordance with the requirements of Section 2704.3 or 2705.1.9. When mechanical ventilation is provided, the systems shall be operational during such time as the building or space is occupied.