CHAPTER 32
CRYOGENIC FLUIDS

SECTION 3201
GENERAL

3201.1 Scope. Storage, use and handling of cryogenic fluids shall comply with this chapter. Cryogenic fluids classified as hazardous materials shall also comply with Chapter 27 for general requirements. Partially full containers containing residual cryogenic fluids shall be considered as full for the purposes of the controls required.

Exceptions:

1. Fluids used as refrigerants in refrigeration systems (see Section 606).
2. Liquefied natural gas (LNG), which shall comply with NFPA 59A.

Oxidizing cryogenic fluids, including oxygen, shall comply with NFPA 55.

Flammable cryogenic fluids, including hydrogen, methane and carbon monoxide, shall comply with NFPA 55.

Inert cryogenic fluids, including argon, helium and nitrogen, shall comply with CGA P-18.

3201.2 Permits. Permits shall be required as set forth in Section 105.6.

SECTION 3202
DEFINITIONS

3202.1 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.

CRYOGENIC CONTAINER. A cryogenic vessel of any size used for the transportation, handling or storage of cryogenic fluids.

CRYOGENIC FLUID. A fluid having a boiling point lower than -130°F (-89.9°C) at 14.7 pounds per square inch atmosphere (psia) (an absolute pressure of 101.3 kPa).

CRYOGENIC VESSEL. A pressure vessel, low-pressure tank or atmospheric tank designed to contain a cryogenic fluid on which venting, insulation, refrigeration or a combination of these is used in order to maintain the operating pressure within the design pressure and the contents in a liquid phase.

FLAMMABLE CRYOGENIC FLUID. A cryogenic fluid that is flammable in its vapor state.

LOW-PRESSURE TANK. A storage tank designed to withstand an internal pressure greater than 0.5 pounds per square inch gauge (psig) (3.4 kPa) but not greater than 15 psig (103.4 kPa).

SECTION 3203
GENERAL REQUIREMENTS

3203.1 Containers. Containers employed for storage or use of cryogenic fluids shall comply with Sections 3203.1.1 through 3203.1.3.2 and Chapter 27.

3203.1.1 Nonstandard containers. Containers, equipment and devices which are not in compliance with recognized standards for design and construction shall be approved upon presentation of satisfactory evidence that they are designed and constructed for safe operation.

3203.1.1.1 Data submitted for approval. The following data shall be submitted to the fire code official with reference to the deviation from the recognized standard with the application for approval.

1. Type and use of container, equipment or device.
2. Material to be stored, used or transported.
3. Description showing dimensions and materials used in construction.
4. Design pressure, maximum operating pressure and test pressure.
5. Type, size and setting of pressure relief devices.
6. Other data requested by the fire code official.

3203.1.2 Concrete containers. Concrete containers shall be built in accordance with the *International Building Code*. Barrier materials and membranes used in connection with concrete, but not functioning structurally, shall be compatible with the materials contained.

3203.1.3 Foundations and supports. Containers shall be provided with substantial concrete or masonry foundations, or structural steel supports on firm concrete or masonry foundations. Containers shall be supported to prevent the concentration of excessive loads on the supporting portion of the shell. Foundations for horizontal containers shall be constructed to accommodate expansion and contraction of the container. Foundations shall be provided to support the weight of vaporizers or heat exchangers.

3203.1.3.1 Temperature effects. When container foundations or supports are subject to exposure to temperatures below -150°F (-101°C), the foundations or supports shall be constructed of materials to withstand the low-temperature effects of cryogenic fluid spillage.

3203.1.3.2 Corrosion protection. Portions of containers in contact with foundations or saddles shall be painted to protect against corrosion.

3203.2 Pressure relief devices. Pressure relief devices shall be provided in accordance with Sections 3203.2.1 through 3203.2.7 to protect containers and systems containing cryogenic fluids from rupture in the event of overpressure. Pressure

relief devices shall be designed in accordance with CGA S-1.1, CGA S-1.2 and CGA S-1.3.

3203.2.1 Containers. Containers shall be provided with pressure relief devices.

3203.2.2 Vessels or equipment other than containers. Heat exchangers, vaporizers, insulation casings surrounding containers, vessels and coaxial piping systems in which liquefied cryogenic fluids could be trapped because of leakage from the primary container shall be provided with a pressure relief device.

3203.2.3 Sizing. Pressure relief devices shall be sized in accordance with the specifications to which the container was fabricated. The relief device shall have sufficient capacity to prevent the maximum design pressure of the container or system from being exceeded.

3203.2.4 Accessibility. Pressure relief devices shall be located such that they are provided with ready access for inspection and repair.

3203.2.5 Arrangement. Pressure relief devices shall be arranged to discharge unobstructed to the open air in such a manner as to prevent impingement of escaping gas on personnel, containers, equipment and adjacent structures or to enter enclosed spaces.

Exception: DOTn-specified containers with an internal volume of 2 cubic feet (0.057 m^3) or less.

3203.2.6 Shutoffs between pressure relief devices and containers. Shutoff valves shall not be installed between pressure relief devices and containers.

Exception: A shutoff valve is allowed on containers equipped with multiple pressure-relief device installations where the arrangement of the valves provides the full required flow through the minimum number of required relief devices at all times.

3203.2.7 Temperature limits. Pressure relief devices shall not be subjected to cryogenic fluid temperatures except when operating.

3203.3 Pressure relief vent piping. Pressure relief vent-piping systems shall be constructed and arranged so as to remain functional and direct the flow of gas to a safe location in accordance with Sections 3203.3.1 and 3203.3.2.

3203.3.1 Sizing. Pressure relief device vent piping shall have a cross-sectional area not less than that of the pressure relief device vent opening and shall be arranged so as not to restrict the flow of escaping gas.

3203.3.2 Arrangement. Pressure relief device vent piping and drains in vent lines shall be arranged so that escaping gas will discharge unobstructed to the open air and not impinge on personnel, containers, equipment and adjacent structures or enter enclosed spaces. Pressure relief device vent lines shall be installed in such a manner to exclude or remove moisture and condensation and prevent malfunction of the pressure relief device because of freezing or ice accumulation.

3203.4 Marking. Cryogenic containers and systems shall be marked in accordance with Sections 3203.4.1 through 3203.4.6.

3203.4.1 Identification signs. Visible hazard identification signs in accordance with NFPA 704 shall be provided at entrances to buildings or areas in which cryogenic fluids are stored, handled or used.

3203.4.2 Identification of contents. Stationary and portable containers shall be marked with the name of the gas contained. Stationary above-ground containers shall be placarded in accordance with Sections 2703.5 and 2703.6. Portable containers shall be identified in accordance with CGA C-7.

3203.4.3 Identification of containers. Stationary containers shall be identified with the manufacturing specification and maximum allowable working pressure with a permanent nameplate. The nameplate shall be installed on the container in an accessible location. The nameplate shall be marked in accordance with the ASME *Boiler and Pressure Vessel Code* or DOTn 49 CFR Part 1.

3203.4.4 Identification of container connections. Container inlet and outlet connections, liquid-level limit controls, valves and pressure gauges shall be identified in accordance with one of the following: marked with a permanent tag or label identifying their function, or identified by a schematic drawing which portrays their function and designates whether they are connected to the vapor or liquid space of the container. Where a schematic drawing is provided, it shall be attached to the container and maintained in a legible condition.

3203.4.5 Identification of piping systems. Piping systems shall be identified in accordance with ASME A13.1.

3203.4.6 Identification of emergency shutoff valves. Emergency shutoff valves shall be identified and the location shall be clearly visible and indicated by means of a sign.

3203.5 Security. Cryogenic containers and systems shall be secured against accidental dislodgement and against access by unauthorized personnel in accordance with Sections 3203.5.1 through 3203.5.4.

3203.5.1 Security of areas. Containers and systems shall be secured against unauthorized entry and safeguarded in an approved manner.

3203.5.2 Securing of containers. Stationary containers shall be secured to foundations in accordance with the *International Building Code*. Portable containers subject to shifting or upset shall be secured. Nesting shall be an acceptable means of securing containers.

3203.5.3 Securing of vaporizers. Vaporizers, heat exchangers and similar equipment shall be anchored to a suitable foundation and its connecting piping shall be sufficiently flexible to provide for the effects of expansion and contraction due to temperature changes.

3203.5.4 Physical protection. Containers, piping, valves, pressure relief devices, regulating equipment and other appurtenances shall be protected against physical damage and tampering.

3203.6 Separation from hazardous conditions. Cryogenic containers and systems in storage or use shall be separated from materials and conditions which pose exposure hazards to or from each other in accordance with Sections 3203.6.1 through 3203.6.2.1.

3203.6.1 Stationary containers. Stationary containers shall be separated from exposure hazards in accordance with the provisions applicable to the type of fluid contained and the minimum separation distances indicated in Table 3203.6.1.

TABLE 3203.6.1
SEPARATION OF STATIONARY CONTAINERS FROM EXPOSURE HAZARDS

EXPOSURE	MINIMUM DISTANCE (feet)
Buildings, regardless of construction type	1
Wall openings	1
Air intakes	10
Lot lines	5
Places of public assembly	50
Nonambulatory patient areas	50
Combustible materials such as paper, leaves, weeds, dry grass or debris	15
Other hazardous materials	In accordance with Chapter 27

For SI: 1 foot = 304.8 mm.

3203.6.1.1 Point-of-fill connections. Remote transfer points and fill connection points shall not be positioned closer to exposures than the minimum distances required for stationary containers.

3203.6.1.2 Surfaces beneath containers. The surface of the area on which stationary containers are placed, including the surface of the area located below the point where connections are made for the purpose of filling such containers, shall be compatible with the fluid in the container.

3203.6.2 Portable containers. Portable containers shall be separated from exposure hazards in accordance with Table 3203.6.2.

TABLE 3203.6.2
SEPARATION OF PORTABLE CONTAINERS FROM EXPOSURE HAZARDS

EXPOSURE	MINIMUM DISTANCE (feet)
Building exits	10
Wall openings	1
Air intakes	10
Lot lines	5
Room or area exits	3
Combustible materials such as paper, leaves, weeds, dry grass or debris	15
Other hazardous materials	In accordance with Chapter 27

For SI: 1 foot = 304.8 mm.

3203.6.2.1 Surfaces beneath containers. Containers shall be placed on surfaces that are compatible with the fluid in the container.

3203.7 Electrical wiring and equipment. Electrical wiring and equipment shall comply with the *International Code Council Electrical Code—Administrative Provisions* and Sections 3203.7.1 and 3203.7.2.

3203.7.1 Location. Containers and systems shall not be located where they could become part of an electrical circuit.

3203.7.2 Electrical grounding and bonding. Containers and systems shall not be used for electrical grounding. When electrical grounding and bonding is required, the system shall comply with the *International Code Council Electrical Code—Administrative Provisions.* The grounding system shall be protected against corrosion, including corrosion caused by stray electric currents.

3203.8 Service and repair. Service, repair, modification or removal of valves, pressure relief devices or other container appurtenances, shall comply with Sections 3203.8.1 and 3203.8.2 and the ASME *Boiler and Pressure Vessel Code*, Section VIII or DOTn 49 CFR Part 1.

3203.8.1 Containers. Containers that have been removed from service shall be handled in an approved manner.

3203.8.2 Systems. Service and repair of systems shall be performed by trained personnel.

3203.9 Unauthorized use. Containers shall not be used for any purpose other than to serve as a vessel for containing the product which it is designed to contain.

3203.10 Leaks, damage and corrosion. Leaking, damaged or corroded containers shall be removed from service. Leaking, damaged or corroded systems shall be replaced, repaired or removed in accordance with Section 3203.8.

3203.11 Lighting. When required, lighting, including emergency lighting, shall be provided for fire appliances and operating facilities such as walkways, control valves and gates ancillary to stationary containers.

SECTION 3204
STORAGE

3204.1 General. Storage of containers shall comply with this section.

3204.2 Indoor storage. Indoor storage of containers shall be in accordance with Sections 3204.2.1 through 3204.2.2.3.

3204.2.1 Stationary containers. Stationary containers shall be installed in accordance with the provisions applicable to the type of fluid stored and this section.

3204.2.1.1 Containers. Stationary containers shall comply with Section 3203.1.

3204.2.1.2 Construction of indoor areas. Cryogenic fluids in stationary containers stored indoors shall be located in buildings, rooms or areas constructed in accordance with the *International Building Code*.

3204.2.1.3 Ventilation. Storage areas for stationary containers shall be ventilated in accordance with the *International Mechanical Code*.

3204.2.2 Portable containers. Indoor storage of portable containers shall comply with the provisions applicable to the type of fluid stored and Sections 3204.2.2.1 through 32042.2.3.

3204.2.2.1 Containers. Portable containers shall comply with Section 3203.1.

3204.2.2.2 Construction of indoor areas. Cryogenic fluids in portable containers stored indoors shall be stored in buildings, rooms or areas constructed in accordance with the *International Building Code*.

3204.2.2.3 Ventilation. Storage areas shall be ventilated in accordance with the *International Mechanical Code*.

3204.3 Outdoor storage. Outdoor storage of containers shall be in accordance with Sections 3204.3.1 through 3204.3.2.2.

3204.3.1 Stationary containers. The outdoor storage of stationary containers shall comply with Section 3203 and this section.

3204.3.1.1 Location. Stationary containers shall be located in accordance with Section 3203.6. Containers of cryogenic fluids shall not be located within diked areas containing other hazardous materials.

Storage of flammable cryogenic fluids in stationary containers outside of buildings is prohibited within the limits established by law as the limits of districts in which such storage is prohibited (see Section 3 of the Sample Ordinance for Adoption of the *International Fire Code* on page v).

3204.3.1.2 Areas subject to flooding. Stationary containers located in areas subject to flooding shall be securely anchored or elevated to prevent the containers from separating from foundations or supports.

3204.3.1.3 Drainage. The area surrounding stationary containers shall be provided with a means to prevent accidental discharge of fluids from endangering personnel, containers, equipment and adjacent structures or to enter enclosed spaces. The stationary container shall not be placed where spilled or discharged fluids will be retained around the container.

Exception: These provisions shall not apply when it is determined by the fire code official that the container does not constitute a hazard, after consideration of special features such as crushed rock utilized as a heat sink, topographical conditions, nature of occupancy, proximity to structures on the same or adjacent property, and the capacity and construction of containers and character of fluids to be stored.

3204.3.2 Portable containers. Outdoor storage of portable containers shall comply with Section 3203 and this section.

3204.3.2.1 Location. Portable containers shall be located in accordance with Section 3203.6.

3204.3.2.2 Drainage. The area surrounding portable containers shall be provided with a means to prevent accidental discharge of fluids from endangering adjacent containers, buildings, equipment or adjoining property.

Exception: These provisions shall not apply when it is determined by the fire code official that the container does not constitute a hazard.

3204.4 Underground tanks. Underground tanks for the storage of liquid hydrogen shall be in accordance with Sections 3204.4.1 through 3204.5.3.

3204.4.1 Construction. Storage tanks for liquid hydrogen shall be designed and constructed in accordance with ASME *Boiler and Pressure Vessel Code* (Section VIII, Division 1) and shall be vacuum jacketed in accordance with Section 3204.5.

3204.4.2 Location. Storage tanks shall be located outside in accordance with the following:

1. Tanks and associated equipment shall be located with respect to foundations and supports of other structures such that the loads carried by the latter cannot be transmitted to the tank.
2. The distance from any part of the tank to the nearest wall of a basement, pit, cellar or lot line shall not be less than 3 feet (914 mm).
3. A minimum distance of 1 foot (1525 mm), shell to shell, shall be maintained between underground tanks.

3204.4.3 Depth, cover and fill. The tank shall be buried such that the top of the vacuum jacket is covered with a minimum of 1 foot (305 mm) of earth and with concrete a minimum of 4 inches (102 mm) thick placed over the earthen cover. The concrete shall extend a minimum of 1 foot (305 mm) horizontally beyond the footprint of the tank in all directions. Underground tanks shall be set on firm foundations constructed in accordance with the *International Building Code* and surrounded with at least 6 inches (152 mm) of noncorrosive inert material, such as sand.

Exception: The vertical extension of the vacuum jacket as required for service connections.

3204.4.4 Anchorage and security. Tanks and systems shall be secured against accidental dislodgement in accordance with this chapter.

3204.4.5 Venting of underground tanks. Vent pipes for underground storage tanks shall be in accordance with Sections 2209.5.4 and 3203.3.

3204.4.6 Underground liquid hydrogen piping. Underground liquid hydrogen piping shall be vacuum jacketed or protected by approved means and designed in accordance with this chapter.

3204.4.7 Overfill protection and prevention systems. An approved means or method shall be provided to prevent the overfill of all storage tanks.

3204.5 Vacuum jacket construction. The vacuum jacket shall be designed and constructed in accordance with Section VIII of ASME *Boiler and Pressure Vessel Code* and shall be designed

to withstand the anticipated loading, including loading from vehicular traffic, where applicable. Portions of the vacuum jacket installed below grade shall be designed to withstand anticipated soil, seismic and hydrostatic loading.

3204.5.1 Material. The vacuum jacket shall be constructed of stainless steel or other approved corrosion-resistant material.

3204.5.2 Corrosion protection. The vacuum jacket shall be protected by approved or listed corrosion-resistant materials or an engineered cathodic protection system. Where cathodic protection is utilized, an approved maintenance schedule shall be established. Exposed components shall be inspected at least twice a year. Maintenance and inspection events shall be recorded and those records shall be maintained on the premises for a minimum of three years and made available to the fire code official upon request.

3204.5.3 Vacuum level monitoring. An approved method shall be provided to indicate loss of vacuum within the vacuum jacket(s).

SECTION 3205
USE AND HANDLING

3205.1 General. Use and handling of cryogenic fluid containers and systems shall comply with Sections 3205.1.1 through 3205.5.2.

3205.1.1 Cryogenic fluid systems. Cryogenic fluid systems shall be suitable for the use intended and designed by persons competent in such design. Equipment, machinery and processes shall be listed or approved.

3205.1.2 Piping systems. Piping, tubing, valves and joints and fittings conveying cryogenic fluids shall be installed in accordance with the material-specific provisions of Sections 3201.1 and 3205.1.2.1 through 3205.1.2.6.

3205.1.2.1 Design and construction. Piping systems shall be suitable for the use intended through the full range of pressure and temperature to which they will be subjected. Piping systems shall be designed and constructed to provide adequate allowance for expansion, contraction, vibration, settlement and fire exposure.

3205.1.2.2 Joints. Joints on container piping and tubing shall be threaded, welded, silver brazed or flanged.

3205.1.2.3 Valves and accessory equipment. Valves and accessory equipment shall be suitable for the intended use at the temperatures of the application and shall be designed and constructed to withstand the maximum pressure at the minimum temperature to which they will be subjected.

3205.1.2.3.1 Shutoff valves on containers. Shutoff valves shall be provided on all container connections except for pressure relief devices. Shutoff valves shall be provided with access thereto and located as close as practical to the container.

3205.1.2.3.2 Shutoff valves on piping. Shutoff valves shall be installed in piping containing cryogenic fluids where needed to limit the volume of liquid discharged in the event of piping or equipment failure. Pressure relief valves shall be installed where liquid is capable of being trapped between shutoff-valves in the piping system (see Section 3203.2).

3205.1.2.4 Physical protection and support. Piping systems shall be supported and protected from physical damage. Piping passing through walls shall be protected from mechanical damage.

3205.1.2.5 Corrosion protection. Above-ground piping that is subject to corrosion because of exposure to corrosive atmospheres, shall be constructed of materials to resist the corrosive environment or otherwise protected against corrosion. Below-ground piping shall be protected against corrosion.

3205.1.2.6 Testing. Piping systems shall be tested and proven free of leaks after installation as required by the standards to which they were designed and constructed. Test pressures shall not be less than 150 percent of the maximum allowable working pressure when hydraulic testing is conducted or 110 percent when testing is conducted pneumatically.

3205.2 Indoor use. Indoor use of cryogenic fluids shall comply with the material-specific provisions of Section 3201.1.

3205.3 Outdoor use. Outdoor use of cryogenic fluids shall comply with the material specific provisions of Sections 3201.1, 3205.3.1 and 3205.3.2.

3205.3.1 Separation. Distances from property lines, buildings and exposure hazards shall comply with Section 3203.6 and the material specific provisions of Section 3201.1.

3205.3.2 Emergency shutoff valves. Manual or automatic emergency shutoff valves shall be provided to shut off the cryogenic fluid supply in case of emergency. An emergency shutoff valve shall be located at the source of supply and at the point where the system enters the building.

3205.4 Filling and dispensing. Filling and dispensing of cryogenic fluids shall comply with Sections 3205.4.1 through 3205.4.3.

3205.4.1 Dispensing areas. Dispensing of cryogenic fluids with physical or health hazards shall be conducted in approved locations. Dispensing indoors shall be conducted in areas constructed in accordance with the *International Building Code*.

3205.4.1.1 Ventilation. Indoor areas where cryogenic fluids are dispensed shall be ventilated in accordance with the requirements of the *International Mechanical Code* in a manner that captures any vapor at the point of generation.

Exception: Cryogenic fluids that can be demonstrated not to create harmful vapors.

3205.4.1.2 Piping systems. Piping systems utilized for filling or dispensing of cryogenic fluids shall be designed and constructed in accordance with Section 3205.1.2.

3205.4.2 Vehicle loading and unloading areas. Loading or unloading areas shall be conducted in an approved manner in accordance with the standards referenced in Section 3201.1.

3205.4.3 Limit controls. Limit controls shall be provided to prevent overfilling of stationary containers during filling operations.

3205.5 Handling. Handling of cryogenic containers shall comply with Sections 3205.5.1 and 3205.5.2.

3205.5.1 Carts and trucks. Cryogenic containers shall be moved using an approved method. Where cryogenic containers are moved by hand cart, hand truck or other mobile device, such carts, trucks or devices shall be designed for the secure movement of the container.

Carts and trucks used to transport cryogenic containers shall be designed to provide a stable base for the commodities to be transported and shall have a means of restraining containers to prevent accidental dislodgement.

3205.5.2 Closed containers. Pressurized containers shall be transported in a closed condition. Containers designed for use at atmospheric conditions shall be transported with appropriate loose fitting covers in place to prevent spillage.