CHAPTER 32
CRYOGENIC FLUIDS

SECTION FC 3201
GENERAL

3201.1 Scope. This chapter shall govern the storage, handling and use of cryogenic fluids.

Exception: Fluids used as refrigerants in refrigerating systems (see FC606).

3201.2 Permits. Permits shall be required as set forth in FC105.6.

3201.3 General. Cryogenic fluids shall be stored, handled and used in accordance with this chapter, except that liquefied natural gas (LNG) shall comply with the requirements of FC3206 only. Containers that contain any amount of cryogenic fluid, including containers that are partially full or have residual gas, shall be considered as full for the purposes of the requirements of this chapter.

3201.3.1 Oxidizing cryogenic fluids. Oxidizing cryogenic fluids, including oxygen, shall additionally comply with the requirements of NFPA 55 and FC Chapter 40, as applicable.

3201.3.2 Flammable cryogenic fluids. Flammable cryogenic fluids, including hydrogen, methane and carbon monoxide, shall additionally comply with the requirements of NFPA 55 and FC Chapter 35, as applicable.

3201.3.3 Inert cryogenic fluids. Inert cryogenic fluids, including argon, helium and nitrogen, shall additionally comply with the requirements of CGA P-18.

3201.4 Supervision. The storage, handling and use of cryogenic fluids shall be supervised as set forth in FC 3201.4.1 through 3201.4.3.

3201.4.1 Handling and use. Handling and use of cryogenic fluid in quantities requiring a permit shall be performed under the personal supervision of a person holding a certificate of fitness.

3201.4.2 Installation and maintenance. The installation and maintenance of cryogenic containers and of systems containing cryogenic fluids, including the repair of such systems, shall be conducted under the personal supervision of a person holding a certificate of fitness.

3201.4.3 Storage. Storage of cryogenic fluids in quantities requiring a permit shall be under the general supervision of a person holding a certificate of fitness.

3201.5 Prohibition. It shall be unlawful to fill a container with a flammable cryogenic fluid except for containers mounted on a hydrogen-powered motor vehicle and used for motive power as authorized by FC2209.1.1(1).

SECTION FC 3202

DEFINITIONS

3202.1 Definitions. The following terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

CRYOGENIC CONTAINER. A pressure container, low-pressure container or atmospheric container of any size designed or used for the transportation, handling or storage of a cryogenic fluid, and which utilizes venting, insulation, refrigeration or a combination thereof to maintain the pressure within design parameters for such container and to keep the contents in a liquid state.

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

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

LOW-PRESSURE CONTAINER. A storage container designed to withstand an internal pressure greater than ½ pound per square inch gauge (psig) (3.4 kPag) but not greater than 15 psig (103.4 kPag).

MAXIMUM ALLOWABLE WORKING PRESSURE (MAWP). The maximum pressure permissible at the top of a container in its operating position for a designated temperature, as established by the container manufacturer.

SECTION FC 3203
GENERAL REQUIREMENTS

3203.1 Cryogenic container. Cryogenic containers shall comply with the requirements of FC 3203.1.1 through 3203.1.3.3 and FC Chapter 27.

3203.1.1 Cryogenic container standards. Cryogenic containers shall be designed, constructed, operated and maintained in accordance with the ASME Boiler and Pressure Vessel Code or United States Department of Transportation regulations, or as otherwise approved.

3203.1.1.1 Pressure gauges. Cryogenic containers shall be provided with pressure gauges. The maximum face reading for dial-type gauges shall not be less than 133 percent nor more than 250 percent of the MAWP of the cryogenic container.

3203.1.1.2 Liquid level-indicating devices. Cryogenic containers shall be provided with a liquid level-indicating device. It shall be unlawful to use cryogenic containers with glass liquid level gauges in direct contact with the contents of such containers.

3203.1.2 Flood hazard. Stationary cryogenic containers located in areas of special flood hazard or on the premises of Group I-2 occupancies that are hospitals located in shaded X-Zones (as defined in Section G201.2 of Appendix G of the Building Code) shall comply with Section G307.5 of the Building Code.

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

3203.1.3.1 Temperature effects. When cryogenic container foundations or supports are subject to exposure to temperatures below -130°F (-89.9°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 cryogenic containers in contact with foundations or saddles shall be painted to protect against corrosion. Precautions shall be taken to avoid or minimize corrosion due to galvanic action.

3203.1.3.3 Fill connection supports. Fill connection supports shall be designed and maintained to withstand the repeated application of force required to connect and disconnect hoses of cargo tanks.

3203.2 Pressure relief devices. Pressure relief devices shall be provided in accordance with FC 3203.2.1 through 3203.2.6 to protect cryogenic 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 Cryogenic containers. Cryogenic containers shall be provided with pressure relief devices. Precautions shall be taken to prevent overpressurization of atmospheric tanks. Such pressure relief devices shall communicate with the vapor space of the container, not the cryogenic fluid.

3203.2.2 Equipment other than cryogenic containers. Heat exchangers, vaporizers, insulation casings surrounding cryogenic containers, and sections of coaxial or single wall piping systems in which liquefied cryogenic fluids could be trapped because of leakage from cryogenic containers or isolation by valves shall be provided with pressure relief devices.

3203.2.3 Sizing. Pressure relief devices shall be sized in accordance with the specifications to which the cryogenic container was fabricated. The relief devices shall have sufficient capacity to prevent the MAWP of the cryogenic container or system from being exceeded. It shall be unlawful to use pressure relief devices that are not clearly marked by the manufacturer with their set pressure.

3203.2.4 Accessibility. Pressure relief devices shall be located such that they are readily accessible for inspection, repair and other maintenance.

3203.2.5 Arrangement. Pressure relief devices shall be arranged to discharge unobstructed, at rated capacity, to the outdoors in such a manner as to prevent escaping gas from impinging on personnel, cryogenic containers, equipment and adjacent structures or from entering enclosed spaces.

Exception: United States Department of Transportation specification cryogenic containers with an internal volume of 2 cubic feet (0.057 m^3) or less.

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

Exception: A shutoff valve is allowed on cryogenic containers equipped with multiple pressure-relief device installations where the design and arrangement of the valves provide sufficient relief capacity for the pressure relief devices to prevent the MAWP of the cryogenic container or system from being exceeded at all times.

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 FC 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 outdoors and not impinge on personnel, containers, equipment, foundations 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 or other types of obstruction.

3203.4 Marking. Cryogenic containers and systems shall be marked in accordance with FC 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 areas in which cryogenic fluids are stored, handled or used.

3203.4.2 Identification of contents. Stationary and portable cryogenic containers shall be clearly marked with the name of the cryogenic fluid contained therein. Stationary aboveground cryogenic containers shall be placarded in accordance with FC 2703.5 and 2703.6. Portable cryogenic containers shall be identified in accordance with CGA C-7.

3203.4.3 Identification of cryogenic containers. Stationary cryogenic containers shall be identified with a permanent nameplate indicating the manufacturing specification and MAWP. The nameplate shall be installed on the cryogenic container in an accessible location. The nameplate shall be marked in accordance with the ASME Boiler and Pressure

Vessel Code or the regulations of the United States Department of Transportation, as set forth in 49 CFR Parts 100-180.

3203.4.4 Identification of cryogenic container connections. Cryogenic container inlet and outlet connections, liquid level indicating devices, liquid level limit controls, valves, pressure gauges, regulators, and safety devices shall be marked with a permanent tag or label identifying their function or identified by a schematic drawing designating their function and whether they are connected to the vapor or liquid space of the cryogenic container. Where a schematic drawing is provided, it shall be permanently attached to the cryogenic container and maintained in a legible condition.

3203.4.5 Identification of piping systems. Piping systems shall be identified in accordance with FC3003.2.3.

3203.4.6 Identification of emergency shutoff valves. Emergency shutoff valves shall be identified by posting a durable sign at a conspicuous location at or near the valve.

3203.5 Container protection. Cryogenic containers and systems shall be secured and protected against physical damage and tampering in accordance with FC2703.9.2, and FC 3203.5.2 through 3203.5.4.

3203.5.1 Reserved.

3203.5.2 Securing of cryogenic containers. Stationary containers shall be secured to foundations in accordance with the Building Code. Portable cryogenic containers shall be secured to prevent movement from contact, vibration or seismic activity. Nesting shall be an acceptable means of securing cryogenic containers. Cryogenic containers shall not be secured to plumbing pipes or electrical conduits.

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

3203.5.4 Physical protection. Cryogenic containers, piping, valves, pressure relief devices, regulating equipment and other appurtenances which could be exposed to physical damage and tampering shall be protected by posts or other approved means.

3203.6 Electrical wiring and equipment. Electrical wiring and equipment shall comply with the requirements of the Electrical Code and FC 3203.6.1 and 3203.6.2.

3203.6.1 Location. Cryogenic containers and systems shall not be located where they could become part of an electrical circuit.

3203.6.2 Electrical grounding and bonding. Cryogenic containers and systems shall not be used for electrical grounding. When electrical grounding and bonding is required, the grounding and bonding system shall comply with the requirements of the Electrical Code.

The grounding system shall be protected against corrosion, including corrosion caused by stray electric currents or galvanic action.

3203.7 Service and repair. Service, repair, modification or removal of valves, pressure relief devices or other cryogenic container appurtenances, shall comply with the requirements of FC 3203.7.1 and 3203.7.2 and the ASME Boiler and Pressure Vessel Code, Section VIII or the regulations of the United States Department of Transportation, as set forth in 49 CFR Parts 100-180, as applicable.

3203.7.1 Cryogenic containers. Cryogenic containers that have been removed from service shall be repaired or disposed of lawfully.

3203.7.2 System inspection. Cryogenic containers and systems shall be inspected by competent personnel at least once a month.

3203.8 Unauthorized use. Cryogenic containers shall not be used for any purpose other than as a container for the product that it is designed to contain.

3203.9 Leaks, damage and corrosion. Leaking, damaged or corroded cryogenic containers shall be immediately removed from service. Leaking, damaged or corroded systems shall be replaced, repaired or disposed of lawfully in accordance with FC3203.7.

3203.10 Lighting. Lighting shall be provided for equipment such as control valves, gauges, regulators, vaporizers and heat exchangers and operating facilities such as walkways and gates ancillary to stationary cryogenic container installations.

SECTION FC 3204
STORAGE

3204.1 General. Storage of cryogenic containers shall be in accordance with this section.

3204.2 Indoor storage. Indoor storage of cryogenic containers shall be in accordance with FC 3204.2.1 through 3204.2.1.3.

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

3204.2.1.1 Cryogenic containers. Cryogenic containers shall be in accordance with FC3203.1.

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

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

3204.3 Outdoor cryogenic storage. Outdoor storage of cryogenic containers shall be in accordance with FC 3204.3.1 through 3204.3.1.2.5.

3204.3.1 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 FC 3204.3.1.1 through 3204.3.1.1.5.

3204.3.1.1 Stationary cryogenic containers. Stationary cryogenic containers shall be separated from exposure hazards in accordance with the minimum separation distances set forth in FC Table 3204.3.1.1.

FC TABLE 3204.3.1.1
SEPARATION OF STATIONARY CRYOGENIC CONTAINERS FROM EXPOSURE HAZARDS

EXPOSURE	MINIMUM DISTANCE (feet)
Buildings, regardless of construction type	1, or minimum required for service access
Building exit	10
Building openings other than building exits	1
Air intakes	10
Lot lines	5
Group A occupancies and other public gathering places	50
Nonambulatory patient areas	50
Combustible waste or vegetation	15
Other hazardous materials	In accordance with FC Chapter 27

For SI: 1 foot = 304.8 mm.

3204.3.1.1.1 Point-of-fill connections. Fill connections for stationary cryogenic containers shall not be positioned closer to exposure hazards than the minimum distances required for stationary cryogenic containers. Fill connections for stationary cryogenic containers shall be located and maintained to afford cargo tank operator access to valves and indicators on the cryogenic containers and cargo tank.

3204.3.1.1.2 Surfaces beneath cryogenic containers. The surface of the area on which stationary cryogenic containers are placed, including the surface of the area located below the point where connections are made for the purpose of filling such cryogenic containers, shall be compatible with the cryogenic fluid in the cryogenic container. The surface shall be capable of withstanding temperatures of cryogenic fluid that may be released during normal filling operations, without cracking, shifting or other impact upon the stability of the installation.

3204.3.1.1.3 Location. Containers of cryogenic fluids shall not be stored or used within diked areas containing other hazardous materials.

3204.3.1.1.3.1 Prohibited locations. It shall be unlawful to install stationary cryogenic containers on the roof of any building or structure.

3204.3.1.1.4 Areas subject to flooding. Stationary cryogenic containers, vaporizers, heat exchangers and connecting piping located in areas subject to flooding shall be securely anchored or elevated to prevent separation of the cryogenic containers and related equipment from foundations or supports.

3204.3.1.1.5 Drainage. The area surrounding stationary cryogenic containers shall be provided with a means to prevent accidental discharge of cryogenic fluid from endangering personnel, cryogenic containers, equipment and adjacent structures or to enter enclosed spaces. The stationary cryogenic container shall not be placed where spilled or discharged fluid will be retained around the cryogenic container.

Exception: These drainage requirements shall not apply when it is determined by the commissioner that the cryogenic container does not constitute a hazard, upon 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 cryogenic containers and character of cryogenic fluid to be stored.

3204.3.1.2 Portable cryogenic containers. Outdoor storage of portable cryogenic containers shall comply with the requirements of FC3203 and this section.

3204.3.1.2.1 Exposure hazard separation. Portable cryogenic containers shall be separated from exposure hazards in accordance with FC Table 3204.3.1.2.1.

FC TABLE 3204.3.1.2.1
SEPARATION OF PORTABLE CRYOGENIC CONTAINERS FROM EXPOSURE HAZARDS

EXPOSURE	MINIMUM DISTANCE (feet)
Building exits	10
Building openings other than building exits	1
Air intakes	10
Lot lines	5
Combustible waste or vegetation	15
Other hazardous materials	In accordance with FC Chapter 27

For SI: 1 foot = 304.8 mm.

3204.3.1.2.2 Surfaces beneath cryogenic containers. Cryogenic containers shall be placed on surfaces that are compatible with the cryogenic fluid in the cryogenic container.

3204.3.1.2.3 Drainage. The area surrounding portable cryogenic containers shall be provided with a means to prevent accidental discharge of fluids from endangering adjacent containers, buildings, equipment or adjoining property.

Exception: These requirements shall not apply when it is determined by the commissioner that the cryogenic container does not constitute a hazard.

3204.3.1.2.4 Areas subject to flooding. Portable cryogenic containers located in areas subject to flooding shall be properly secured to prevent movement.

3204.3.1.2.5 Pressure relief valve discharge. Cryogenic containers shall be positioned such that the pressure relief valve discharge is directed away from any building exit.

SECTION FC 3205

HANDLING AND USE

3205.1 Applicability. Handling and use of cryogenic containers and systems shall be in accordance with this section.

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

3205.1.2 Piping systems. Piping, tubing, valves, joints and fittings used in cryogenic systems shall be designed and installed in accordance with the material-specific provisions of FC 3201.3.1, 3201.3.2, 3201.3.3 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 cryogenic container piping and tubing shall be threaded, welded, silver brazed or flanged.

3205.1.2.3 Valves and piping components. Valves and piping components 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. Valves shall be oriented so that the stem is above the horizontal plane and discharge is directed away from supporting elements.

3205.1.2.3.1 Shutoff valves on cryogenic containers. Shutoff valves shall be provided on all cryogenic container connections except for pressure relief devices. Shutoff valves shall be readily accessible and located as close as practical to the cryogenic container. Manually-operated shutoff valves shall be designed and installed to minimize accidental opening and closing.

Exception: Valves before pressure relief devices shall be installed in accordance with FC3203.2.6.

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 on all sections of piping systems where liquid is capable of being trapped (see FC3203.2). Shutoff valves shall be installed so that piping components can be isolated for maintenance. Check valves shall be installed on discharge lines where pumps or other pressure-increasing equipment operate in parallel.

3205.1.2.4 Physical protection and support. Piping systems shall be supported and protected from physical damage. Piping passing through floors or walls shall be protected from damage caused by movement of the floors or walls.

3205.1.2.5 Corrosion protection. Aboveground 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. Underground 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 MAWP 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 requirements of FC 3201.3.1 through 3201.3.3.

3205.3 Outdoor use. Outdoor use of cryogenic fluids shall comply with the material specific requirements of FC 3201.3.1, 3201.3.2, 3201.3.3, 3205.3.1 and 3205.3.2.

3205.3.1 Separation. Distances from property lines, buildings and exposure hazards shall comply with the requirements of FC3204.3 and the material specific requirements of FC 3201.3.1 through 3201.3.3.

3205.3.2 Emergency shutoff valves. Approved 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 the requirements of FC 3205.4.1 through 3205.4.4.

3205.4.1 Dispensing areas. Dispensing of cryogenic fluids shall be conducted in approved locations. Dispensing indoors shall be conducted in areas constructed in accordance with the construction codes, including the Building Code.

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

3205.4.1.1.1 Alarms. Oxygen sensors equipped with an audible alarm shall be provided in dispensing areas to continuously monitor the level of oxygen in the area. The alarm shall actuate when oxygen concentration drops below 19.5 percent.

3205.4.1.2 Piping systems. Piping systems utilized for filling or dispensing of cryogenic fluids shall be designed and constructed in accordance with FC3205.1.2.

3205.4.2 Vehicle loading and unloading areas. Loading or unloading areas shall be designed and maintained in accordance with the standards referenced in FC 3201.3.1 through 3201.3.3. Loading and unloading areas shall additionally comply with the requirements of

FC 3204.3.1 through 3204.3.1.2.5 and shall be capable of withstanding the weight of the fully loaded cargo tank.

3205.4.2.1 Vehicle loading and unloading operations. Vehicle loading and unloading operations shall be conducted in an approved manner in accordance with the standards referenced in FC 3201.3.1 through 3201.3.3.

3205.4.3 Limit procedures. Limit procedures shall be established to prevent overfilling of stationary cryogenic containers during filling operations.

3205.4.4 Prohibited filling of flammable cryogenic fluid. It shall be unlawful to fill cryogenic containers with flammable cryogenic fluid.

3205.5 Handling. Handling of cryogenic containers shall be in accordance with this section.

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

3205.5.2 Closed cryogenic containers. Pressurized portable cryogenic containers shall be moved with all operable valves in a closed position. Cryogenic containers designed for use at atmospheric conditions shall be moved with appropriate loose fitting covers in place to prevent spillage.

3205.5.3 Stationary cryogenic containers. Stationary cryogenic containers shall not be moved while containing cryogenic fluid. Handling of cryogenic containers shall be in accordance with the manufacturer's instructions.

SECTION FC 3206
LNG INSTALLATIONS AND FACILITIES

3206.1 New LNG installations and facilities. It shall be unlawful to construct any new LNG installation or facility. It shall be unlawful to operate any LNG installation or facility that was not lawfully existing on the effective date of this code.

3206.2 Existing LNG installations and facilities. LNG installations and facilities lawfully existing on the effective date of this code shall be designed, installed, operated and maintained in accordance with this code, the rules and the regulations of the United States Department of Transportation, as set forth in 49 CFR Part 193, except as otherwise provided in FC 102.3, 102.4 and 102.5.

3206.2.1 Out-of-service LNG storage tanks. Notwithstanding any other provision of law, rule or regulation, any storage tank erected prior to the effective date of this code which has not been used for the storage of liquefied natural gas for a period in excess of 2 years from the date of completion of the construction of the tank structure shall be recertified by the various city

agencies in the same manner as if filing design and installation documents of a new tank before a certificate of occupancy be issued if the tank is to be placed in service.