Exterior Cryogenic Fluid Vessels

PURPOSE

The intent of this guideline is to provide the basic requirements and regulations for storage, use, and handling of exterior cryogenic fluid vessels. The following submittal requirements outline the minimum information required for plan review as set forth by the 2013 California Fire Code (CFC) Chapter 55 and 58, the general requirements of Chapter 50, NFPA 55 and ANSI/CGA P-18. Plans not conforming to these minimum requirements will be returned as incomplete.

SCOPE

This guideline is applicable to the exterior storage, use, and handling of cryogenic fluids in cryogenic vessels and applies to all new installations and/or alterations to existing exterior cryogenic fluid vessels within the jurisdiction of the Orange County Fire Authority (OCFA).

The following definitions are provided to facilitate the consistent application of this guideline:

Cryogenic container – A cryogenic vessel of any size used for the transportation, handling or storage of cryogenic fluids.

Cryogenic fluids – Fluids that have a normal boiling point lower than -130° F at 14.7 pounds per square inch atmosphere.

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 an operating pressure within the design pressure and the contents in a liquid phase.

Design pressure – The maximum gauge pressure that a pressure vessel, device, component, or system is designed to withstand safely under the temperature and conditions of expected use.

Flammable cryogenic fluid – A cryogenic fluid which is flammable in its vapor state.

Inert gas – Nonflammable, non-toxic, non-oxidizing gases such as argon and nitrogen.

Low pressure tank – A storage tank designed to withstand an internal pressure greater than .5 pounds per square inch gauge (psig) but not greater than 15 psig.
**Oxidizer** – A material, other than a blasting agent or explosive that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials.

**System** – An assembly of equipment consisting of a container or containers, appurtenances, pumps, compressors, and connecting piping.

## SUBMITTAL REQUIREMENTS

### 1. General

Plans for all exterior cryogenic fluid vessels shall be submitted to the OCFA for review. All new submittals and revisions will consist of 2 hard copies and 1 electronic copy in .pdf format. All electronic copies may be submitted on CD, DVD, or Memory Stick. Provide a minimum of three copies of the manufacturer’s data sheets for the vessel(s). All data sheets shall be current and complete.  

Note: some building departments within OCFA jurisdiction require additional sets; verify plan submittal requirements with the building department prior to submitting. Plans shall be legible, scaled to nationally recognized standards, and bluelined. Complete an OCFA Service Request form, which can be obtained at the building department or OCFA.

#### A. Required Plan Information

1) Building construction type and occupancy classifications of all buildings within 50 feet of the vessel, as defined by the California Building Code (CBC)

2) Applicable codes and standards used for the system design (e.g., 2013 CFC, 2013 CBC, etc.)

3) Project location, including the full legal address of the facility, and building number, if applicable

4) The contractor’s name, telephone number, address, and California State contractor’s license number

5) A site plan identifying the location of the proposed vessel in relation to the nearest buildings, property lines, and public ways

#### B. Requirements for All Types of Cryogenic Fluids

Provide diagrams and specifications that indicate that the proposed vessel(s) complies with the following CFC requirements, **regardless of cryogen type**:

1) 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.
2) Containers—CFC 5503.1
   a) Concrete containers shall be built in accordance with the CBC.
   b) Containers shall be provided with substantial concrete/masonry foundations or with structural steel supports on firm concrete/masonry foundations. Containers shall be supported to prevent the concentration of excessive loads on the supporting portion of the vessel shell. Foundations for horizontal containers shall be constructed to accommodate expansion and contraction of the container. Foundations shall also support the weight of vaporizers or heat exchangers.
   c) 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.

3) Pressure-relief Devices—CFC 5503.2
   a) Pressure-relief devices shall be provided at every point in the system where liquid can become trapped to protect containers and systems containing cryogenic fluids from rupture in the event of overpressure and must be designed in accordance with nationally recognized standards.
   b) Heat exchangers, vaporizers, insulation casings surrounding containers, vessels, and coaxial piping systems in which liquefied cryogenic fluids could be trapped due to leakage from the primary container shall be provided with a pressure relief device.
   c) 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.
   d) Pressure-relief devices shall be located such that they are readily accessible for inspection and repair. This shall be subject to verification by the OCFA inspector.
   e) Pressure-relief devices shall be arranged to discharge unobstructed to the open air in such a manner as to avoid entering enclosed spaces and to prevent impingement of escaping gas on personnel, containers, equipment, and adjacent structures.
   f) Pressure-relief devices shall not be subjected to cryogenic fluid temperatures except when operating.

4) Pressure-relief Vent Piping—CFC 5503.3
   a) 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.
b) 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 to not unduly restrict the flow of escaping gas.

c) Pressure-relief device vent piping and drains in vent lines shall be arranged so that escaping gas will discharge unobstructed to the open air to avoid entering enclosed spaces and not impinge on personnel, containers, equipment, and adjacent structures. 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 due to freezing or ice accumulation.

5) Marking—CFC 5503.4

a) Cryogenic containers and systems shall be marked in accordance with nationally recognized standards.

b) Visible hazard identification signs shall be provided at entrances to buildings or areas in which cryogenic fluids are stored, handled, or used. For inert cryogens, the sign should read “NONFLAMMABLE CRYOGENIC LIQUID”. For flammable cryogens, the sign should read “FLAMMABLE CRYOGENIC LIQUID”. For oxidizing cryogens, the sign should read “OXIDIZER CRYOGENIC LIQUID”. The minimum size of lettering for the signs is three inches and the lettering shall contrast with the background. Refer to OCFA Guideline G-05 for more information.

c) Stationary containers shall be identified with the manufacturing specifications and maximum allowable working pressure with a permanent nameplate. The nameplate shall be installed on the container in an accessible location and be marked in accordance with nationally recognized standards.

d) 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. Schematic drawings shall be attached to the container and maintained in legible condition. State on the plans the method to be used.

e) Piping and tubing shall be labeled per ASME A13.1 to indicate the material conveyed.

f) A sign in a clearly visible location shall identify emergency shut-off valves.

6) Security—CFC 5503.5

a) Cryogenic containers and systems shall be secured against accidental dislodgment and against access by unauthorized personnel.
b) Stationary containers shall be secured to foundations in accordance with the CBC.

c) 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.

d) Containers, piping, valves, pressure-relief devices, regulating equipment and other appurtenances shall be protected against physical damage and against tampering.

7) Electrical Wiring and Equipment—CFC 5503.6

a) Electrical wiring and equipment shall be in accordance with the Electrical Code.

b) Containers and systems shall not be located where they could become part of an electrical circuit or be used for electrical grounding.

8) Separation from Hazardous Conditions—CFC 5504.3.1

a) Cryogenic containers and systems in outdoor storage or use shall be separated from materials and conditions that present exposure hazards.

b) Stationary containers, remote transfer points, and fill-connection points shall be separated from exposure hazards in accordance with the applicable CFC standard for the type of fluid contained and the minimum separation distances required as follows:

<table>
<thead>
<tr>
<th></th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings/wall openings</td>
<td>1 foot</td>
</tr>
<tr>
<td>Property lines</td>
<td>50 feet</td>
</tr>
<tr>
<td>Air intakes</td>
<td>10 feet</td>
</tr>
<tr>
<td>Combustible materials</td>
<td>15 feet</td>
</tr>
<tr>
<td>Places of public assembly</td>
<td>50 feet</td>
</tr>
<tr>
<td>Nonambulatory patient areas</td>
<td>50 feet</td>
</tr>
<tr>
<td>Other hazardous materials</td>
<td>20 feet/noncombustible partition</td>
</tr>
</tbody>
</table>

c) The surface of the area on which stationary containers are placed and where fill connections are made shall be compatible with the fluid in the container.

9) Piping Systems—CFC 5505.1.2

a) Piping, tubing, valves, joints, and fittings conveying cryogenic fluids shall be installed in accordance with material-specific provisions of the code.

b) Piping systems, valves and accessory equipment shall be suitable for the use intended through the full range of pressure and temperature to which they will be
subjected and shall be designed and built to provide adequate allowance for expansion, contraction, settlement, and fire exposure.

c) Accessible shutoff valves shall be provided on all container connections except pressure-relief devices and shall be located as close as practical to the container.

d) Shutoff valves shall be installed in cryogenic fluid piping when needed to limit the volume of liquid discharged in the event of piping or equipment failure, or in the event of an emergency. Pressure-relief valves shall be installed when liquid can be trapped between shutoff valves in the piping system.

e) Piping systems shall be well supported and protected from physical damage. Piping passing through walls shall be protected from mechanical damage.

f) 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. Below-ground piping shall also be protected against corrosion.

10) Filling and Dispensing—CFC 5505.4

a) Piping systems used for filling or dispensing of cryogenic fluids shall be designed and constructed as required for storage (see item 3 above).

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

11) Lighting, including emergency lighting, may be required to illuminate fire appliances and operating facilities, such as walkways, control valves, and gates ancillary to stationary containers.

12) The area surrounding stationary containers shall be provided with a means to prevent an accidental discharge of fluids from entering enclosed spaces or endangering personnel, containers, equipment, and adjacent structures.

2. Requirements for Specific Cryogen Types

Provide diagrams and specifications that indicate that the proposed vessel complies with the following CFC requirements.

A. Oxidizer Cryogenic Fluid/Bulk Oxygen Systems—NFPA 55

The following requirements apply to bulk oxygen systems exceeding 20,000 cubic feet:

1) Bulk oxygen storage systems shall be located aboveground and outdoors (with exceptions), the location of which shall be such that containers and associated equipment shall not be beneath or exposed to the failure of electric power lines,
2) Bulk oxygen systems shall be located not less than one foot from buildings of noncombustible construction, not less than 50 feet from buildings of combustible construction, and not less than 50 feet from property lines.

3) Bulk oxygen storage containers shall be equipped with a safety-relief valve meeting the provisions of nationally recognized standards for safety-relief devices for compressed gas storage containers.

B. Flammable Cryogenic Fluid—NFPA 55

The following requirements apply to delivery or storage systems that discharge cryogenic fluid in the liquid or gaseous form:

1) Storage containers shall be designed, constructed, and tested in accordance with nationally recognized standards.

2) Permanently installed containers shall be provided with substantial supports of noncombustible material securely anchored on firm foundations likewise constructed of noncombustible materials. Supports in excess of 18 inches in height supporting flammable cryogenic fluid containers shall have a minimum two-hour fire-resistive rating in accordance with nationally recognized standards.

3) Each container shall be legibly marked to indicate “Liquefied (name of gas)—Flammable Gas”.

4) Uninsulated piping and equipment operating at cryogenic fluid temperatures below -280°F shall be installed so as to prevent contact of liquid air with combustible materials and combustible surfaces located beneath such piping and equipment. Drip pans installed under uninsulated piping and equipment shall retain and vaporize condensed liquid air.

5) After installation, all field-erected piping shall be tested and proved gas tight at operating pressure and temperature. Testing shall be performed in accordance with nationally recognized standards.

6) Electrical wiring and equipment shall comply with the Electrical Code.

7) Flammable cryogenic fluid containers and associated piping shall be electrically bonded and grounded.

8) Storage of flammable cryogens in stationary containers is prohibited within the limits established by law within districts in which such storage is prohibited.

9) If walls, roofs, weather shelters, or canopies are provided, they shall be constructed of non-combustible or limited combustible material.
10) The minimum distance in feet from flammable cryogenic fluid systems shall be in accordance with NFPA 55. The following are examples only, for quantities up to 3,500 gallons:

<table>
<thead>
<tr>
<th>Description</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall of Type I or II construction adjacent to system</td>
<td>5 feet</td>
</tr>
<tr>
<td>Wall of Type III, IV, or V construction adjacent to system</td>
<td>25 feet</td>
</tr>
<tr>
<td>Between stationary flammable cryogenic fluid containers</td>
<td>5 feet</td>
</tr>
<tr>
<td>Flammable gas storage other than flammable cryogenic fluids</td>
<td>50 feet</td>
</tr>
<tr>
<td>Public ways, railroads, and property lines</td>
<td>25 feet</td>
</tr>
<tr>
<td>Places of public assembly</td>
<td>75 feet</td>
</tr>
</tbody>
</table>

C. Inert Cryogenic Fluid Systems—ANSI/CGA P-18

The following requirements apply to the installation, maintenance, and use of inert cryogenic fluid systems:

1) Inert cryogenic fluid tanks shall not be diked, and the location shall not expose the system to electric power lines, crane-ways, or utility or process piping in any manner which creates a hazard condition.

2) Bulk inert gas systems installed outdoors shall be installed so that liquid leakage and fire-protection water from stored flammable and combustible liquids cannot flow to the bulk inert gas system. When necessary to locate a bulk inert gas system at a lower ground level than adjacent flammable or combustible liquid storage, the flammable or combustible liquids shall be diked or other means provided to divert any leaking flammable or combustible liquid away from the bulk inert gas system.

3) Connections used for filling tanks and liquid level limit controls shall be installed at an approved location at the exterior of the building and in accordance with the following:

   a) Filling controls shall be accessible to the delivery vehicle.

   b) Liquid level limit controls and pressure gauges on the storage vessel shall either be visible, readable, and operable at the delivery point or duplicate controls shall be provided.

   c) Filling controls shall be protected from the elements.

   d) Filling controls shall be secured against unauthorized access.
4) Warning signs shall be posted at each entrance to an enclosure or confined space where a bulk inert gas system is installed. Wording for such signs shall include, at a minimum, the following:

**WARNING—*(Name of Gas)*
HIGH CONCENTRATION OF GAS MAY OCCUR IN THIS AREA AND MAY CAUSE ASPHYXIATION. VERIFY THAT OXYGEN CONCENTRATION IS ABOVE 19.5% BEFORE ENTERING AND DURING ACTIVITY IN THIS AREA**

5) Adequate ventilation is to be provided when bulk inert gas systems are installed in courtyards and similar enclosed areas and such areas shall be clearly posted with a warning.

6) Gas piping may be placed above or below ground. All piping shall run as directly as practicable, carefully protected against physical damage, and with allowance for expansion, contraction, and vibration. Underground piping shall be adequately protected against corrosion and other physical damage and shall be in ducts or casings when it passes under roads, railroad tracks, or parking lots.

7) Valves for shutting off the gas supply in case of an emergency shall be provided for all buildings at readily accessible outside locations. A shutoff valve at the gas supply vessel shall also be provided.

3. Notes

Provide the following notes, verbatim, on the plan under the heading "FIRE AUTHORITY NOTES":

A. OCFA inspection required. Please schedule all field inspections at least 48 hours in advance. Inspections canceled after 1 p.m. on the day before the scheduled date will be subject to a reinspection fee. Call OCFA Inspection Scheduling at 714-573-6150.

B. When addition of a cryogen tank modifies the existing fire department access, plans for fire department access and fire lane markings shall be submitted to and approved by the OCFA prior to approval of the cryogen tank plans.

C. 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.

D. The area within 15 feet of any cryogen tank shall be kept free of paper, leaves, weeds, or other combustible debris.
E. Full face shields, gloves, and aprons shall be worn when handling cryogenic liquids.

F. A CFC permit is required for cryogenic liquids. This permit will be issued by an OCFA inspector.

G. Locations and classifications of extinguishers shall be in accordance with CFC 906.2 and Chapter 3, Title 19 California Code of Regulations and placement is subject to the approval of the fire inspector.

H. Storage, dispensing, or use of any additional hazardous materials shall comply with CFC regulations.

I. Cryogenic fluid systems shall be suitable for the use intended and designed by persons competent in such design. Where nationally recognized good practices or standards have been established for the process employed, such practices and standards shall be followed.

J. Concrete containers shall be built in accordance with the CBC. Barrier materials and membranes used in connection with concrete, but not functioning structurally, shall be compatible with the materials contained.

K. Piping systems, valves and accessory equipment shall be suitable for the use intended through the full range of pressure and temperature to which they will be subjected and shall be designed and built to provide adequate allowance for expansion, contraction, settlement, and fire exposure.

L. Aboveground piping systems shall be well supported and protected from physical damage. Piping passing through walls shall be protected from mechanical damage.

M. Pressure-relief devices shall be located such that they are readily accessible for inspection and repair. This shall be subject to verification by the OCFA inspector.

N. Pressure-relief devices shall not be subjected to cryogenic fluid temperatures except when operating.

O. Stationary containers shall be identified with the manufacturing specifications and maximum allowable working pressure with a permanent nameplate. The nameplate shall be installed on the container in an accessible location and be marked in accordance with nationally recognized standards.

P. 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. Schematic drawings shall be attached to the container and maintained in legible condition.

Q. Stationary containers shall be secured to foundations in accordance with the CBC.
R. Electrical wiring and equipment shall be in accordance with the Electrical Code.

S. Containers and systems shall not be located where they could become part of an electrical circuit or be used for electrical grounding.

T. Storage containers shall be designed, constructed, and tested in accordance with nationally recognized standards.

U. After installation, all field-erected piping shall be tested and proved gas tight at operating pressure and temperature. Testing shall be performed in accordance with nationally recognized standards.

V. Electrical wiring and equipment shall comply with the Electrical Code requirements for Class I locations.

W. Flammable cryogenic fluid containers and associated piping shall be electrically bonded and grounded.