

Liquid Carbon Dioxide Systems

Code and Policy Requirements

Fire Prevention and Hazardous Materials Unit

12/15/2014



This document is intended to provide an overview of the code and policy requirements for installation and maintenance of a small liquid carbon dioxide system in the City of Sunnyvale. It is not intended to be all inclusive of the fire and life safety requirements that the installer and/or building owner may be subject to comply with under local, State and Federal law.

SCOPE

Liquid carbon dioxide (CO₂) is a liquefied compressed gas that can be found in compressed gas cylinders with a gas phase above the liquid phase (Figure 1) or in insulated containers containing refrigerated liquid carbon dioxide (Figure 2). Carbon dioxide gas is an asphyxiant gas that can displace oxygen to dangerous and even fatal levels.

This information bulletin applies to insulated liquefied carbon dioxide systems only.



Figure 1 - Compressed Gas CO₂ Cylinder



Figure 2 - Insulated Liquid CO₂ Container

PERMIT REQUIREMENTS

1. Construction permit required

California Fire Code (CFC) Section 105.7.3 requires a construction permit to install, repair damage to, abandon, remove, place temporarily out of service, close or substantially modify a compressed gas system.

In Sunnyvale, a construction permit must be obtained through the Community Development Department's One-Stop Permit Center located at 456 Olive Way, Sunnyvale, CA prior to conducting any of the above-noted activities.

Information that must be submitted with, or included on, the construction plan set includes, but is not limited to,

- a) Total aggregate quantity of liquid CO₂ in pounds or cubic feet at normal temperature and pressure.
- b) Location and total volume of the room where the liquid CO₂ will be located. Identify whether the room is at grade or below grade.

- c) Location of the container(s) relative to equipment, building openings and means of egress
- d) Manufacturer's specifications and pressure rating, including cut sheets, of all piping and/or tubing to be used.
- e) Include a piping and instrumentation diagram that shows piping support and remote fill connections.
- f) Details of container venting, including, but not limited to vent line size, material and termination location on the roof or side of building.
- g) Alarm and detection system and equipment, if applicable.
- h) Seismic support for container(s).

2. Operating permit required

In accordance with Section 25507(a)(5) of the Health and Safety Code and Sunnyvale Municipal Code Section 20.10.050, the building owner must obtain and maintain an operating permit for any liquid CO₂ system in excess of 1,000 cubic feet at normal temperature and pressure.

The owner of the business using the liquid CO₂ system is also responsible for submitting a Hazardous Materials Business Plan and applicable documents to the California Environmental Reporting System (CERS) on an annual basis, or as otherwise required by state law.

GENERAL REQUIREMENTS

3. General Requirements

3.1 Piping location and support. Carbon dioxide piping shall be located and supported to protect against damage from strain on piping and fittings; the effects of expansion, contraction and vibration; mechanical damage and heat sources. (NFPA 55: 13.1.3.1)

3.2 Piping design. Piping, tubing, hoses and fittings shall be designed to a bursting pressure of at least four times the system design pressure. (NFPA 55: 13.1.3.2)

3.3 Materials of construction. Materials of construction shall be employed for potential exposure to a temperature of -109.3°F (-78.5°C). (NFPA 55: 13.1.4)

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

3.5 Container marking. Portable CO₂ containers shall be marked in accordance with Compressed Gas Association (CGA) C-7. (CFC 5303.4.2)

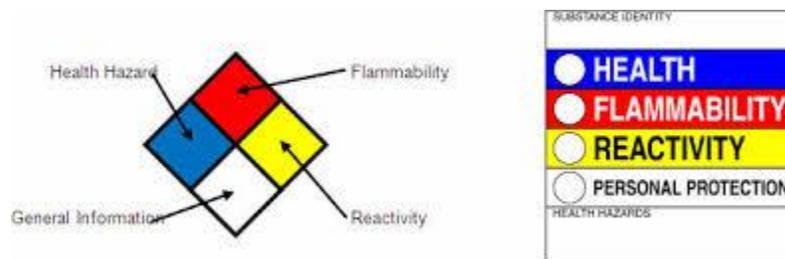
3.6 Marking of piping and tubing. Piping and tubing systems shall be marked in accordance with ASME A13.1. Marking shall consist of the content's name and include a direction of flow arrow. Markings shall be provided at each valve; at wall, floor or ceiling penetrations; at each change of direction; and at a minimum of every 20 feet or fraction thereof throughout the piping run. (CFC 5304.4)

3.7 Securing containers. Liquid CO₂ containers shall be secured to prevent falling caused by contact, vibration or seismic activity by one of the following methods:

1. Securing containers to a fixed object with one or more noncombustible restraints.
2. Securing containers on a cart or other mobile device designed for the movement of compressed gas containers.
3. Securing container to or within a rack, framework, cabinet or similar assembly designed for such use. (CFC 5303.5.3)

3.8 Operating instructions. Operating instructions shall account for potential exposure to extremely low temperatures. (NFPA 55: 13.1.5)

3.9 Hazardous identification signs. Where liquid CO₂ containers are located in buildings, visible NFPA 704 hazardous identification signs displaying the following hazard ratings (**Health-3; Flammability-0; Reactivity-0; General Information-SA**) shall be posted at each building entrance. (CFC 5003.5)



3.10 Remote fill signage. Where liquid CO₂ is located in buildings and a remote fill location is located on the exterior of the building, a visible weather-resistant sign displaying the following message shall be posted at the remote fill location. (CFC 5003.5)

**Liquid Carbon Dioxide
Remote Fill**

3.11 Security. Containers shall be secured against accidental dislodgement and against access by unauthorized personnel. (CFC 5303.5)

4. Additional requirements if PEL can be exceeded based on room volume

4.1 Gas detection and alarm system.

4.1.1. Rooms or areas where container systems are filled and used indoors or in enclosed outdoor locations shall be provided with a gas detection and alarm system that is capable of detecting and notifying the building occupants of a gas release that creates carbon dioxide vapors in excess of its permissible exposure level (PEL). (NFPA 55: 13.2.2)

Point of information

The gas detector must be a carbon dioxide detector and not an oxygen detector.

4.1.2. The carbon dioxide gas detector shall be mounted in a location near the gas supply distribution point in accordance with the gas detector manufacturer's recommendations.

4.1.3. Activation of the gas detection system shall initiate an audible alarm within the room or area in which the system is installed. (NFPA 55: 13.2.2.1)

4.1.4 Activation of the gas detection system shall sound a local alarm to notify persons responsible for the system operation of a hazardous condition in the area in which the system is installed. (NFPA 55: 13.2.2.3)

4.2 Warning sign. A warning sign at least 8 inches wide and 6 inches high shall be posted at the entrance to the building, room, enclosure or confined area where the container is located that reads: (NFPA 55: 13.2.3)

CAUTION – CARBON DIOXIDE GAS
Ventilate the area before entering.
A high carbon dioxide (CO₂) gas concentration in
this area can cause suffocation.

How to determine whether the Permissible Exposure Limit (PEL) can be exceeded.

The information provided in this section is informational only and intended to assist the user in determining how to calculate whether the PEL can be exceeded given the container size and location.

The PEL for carbon dioxide is 5,000 ppm, so only systems containing more than 5 standard cubic feet (scf) of carbon dioxide for every 1,000 cubic feet (or 0.5%) of room volume are required to be in compliance with SMC Section 5308.

Physical properties of liquid CO₂:

1 gal = 74.04 scf

1 lb = 8.74 scf

1 gal = 8.47 pounds

Point of Information:

1,000 scf CO₂ = 13.508 gal = 114.4 lbs CO₂

Sample Calculation:**Given:**

A single container holding 100 pounds of liquid carbon dioxide is connected for use in a room 12 feet by 24 feet and 10 feet high. Is this system required to comply with SMC Section 5308 and this document?

Step 1. Calculate Total Room Volume = (l)(w)(h) = (12 ft)(24 ft)(10 ft) = 2,880 ft³

Step 2. Calculate Volume of CO₂ gas at normal temperature and pressure represented by 100 lbs of liquid CO₂.

$$\text{CO}_2 \text{ Volume (scf)} = (100 \text{ lb})(8.74 \text{ scf/lb}) = 874 \text{ scf}$$

Step 3. Determine whether 874 scf of CO₂ gas equals or exceeds 0.5% of the room volume.

$$(2,880 \text{ ft}^3 \text{ total room volume})(.005) = 14.4 \text{ ft}^3$$

$$874 \text{ scf CO}_2 > 14.4 \text{ ft}^3 \text{ (} 0.5 \times 2,880 = 0.5\% \text{ of room volume)}$$

Therefore, this example system **IS** required to comply.