



CHAPTER NINE

Carbon Dioxide (CO₂) Systems

Contents:

- Required Permits and Submittal Requirements
- Ventilation and Detection Requirements
- Beverage Dispensing Applications
- Submittal Requirements

Purpose:

Proper installation of CO₂ systems helps to protect the safety of everyone encountering these potentially life-threatening systems.



WHAT IS CO₂?

Carbon dioxide (CO₂) is a colorless, odorless, inert gas with a density that is heavier than air. When compressed and cooled to less than 87.8°F, gaseous CO₂ becomes liquified. CO₂ will remain in liquid form, regardless of the pressure applied, provided that its temperature is maintained below that critical point. Once the temperature rises above 87.8°F, CO₂ will return to a gaseous state.

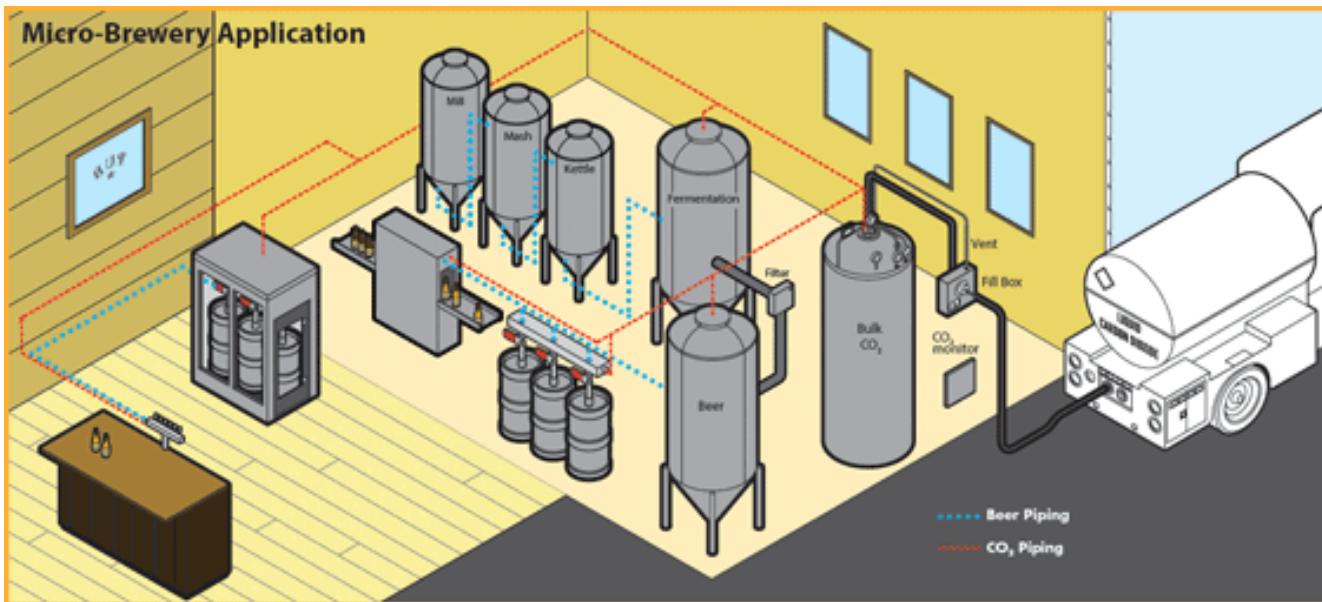
When in a gaseous state, CO₂ can accumulate in hazardous amounts in low lying areas without sufficient ventilation, especially inside confined spaces. High concentrations can displace oxygen in air and cause suffocation.

USE OF LIQUID CO₂ SYSTEMS

Because liquid CO₂ is routinely used to carbonate beverages, liquid CO₂ systems are commonly found in assembly occupancies, especially restaurants and micro-breweries. This is cause for concern because frequently owners, managers, staff, and patrons of these establishments are unaware of the associated risks with these systems. Some vendors have also installed systems without involving the building or fire department, therefore, compliance with applicable codes is called into question. Additionally, it is important for emergency responders to have advance knowledge of where these systems are located in the event of an emergency.

Requirements of this document shall be applied retroactively to existing systems within 12 months of discovery or annexation into Golder Ranch Fire District boundaries.

Requirements of this document do not apply to systems utilizing LESS THAN 100 pounds of carbon dioxide.





REQUIRED PERMITS

CONSTRUCTION PERMITS

A fire construction permit is required to install or modify a compressed gas system utilizing carbon dioxide (CO₂) in excess of 100 pounds or 875 cubic feet at normal temperature and pressure (NTP). Depending on the location of the installation, (Pima/Pinal County or Town of Oro Valley/Marana) submittals shall be routed to the appropriate location as outlined in **Chapter 1-4: Where to Submit Plans** in the Golder Ranch Fire District Fire Code Construction and Development Handbook. See **Chapter 9-11** of this document for permit submittal requirements.

CODES and STANDARDS

Design and installation shall comply with the applicable provisions of the following codes and standards:

- 2018 International Fire Code (IFC) Sections 916 and 5307
- Golder Ranch Fire District IFC Amendments
- 2016 NFPA 72: National Fire Alarm and Signaling Code

GENERAL CARBON DIOXIDE SYSTEM REQUIREMENTS

The following requirements apply to all compressed gas systems utilizing CO₂:

1. The fill port is to be piped to the outside atmosphere.
2. All venting (normal and emergency) is to be piped to the outside atmosphere.
3. When used, insulated liquid CO₂ containers are to be anchored to the slab.
4. When used, CO₂ compressed gas cylinders are to be properly secured from tipping or movement.
5. All hoses and fittings used within the systems are to be manufacturer approved.
6. Warning signs are required to be posted in accordance with this chapter.
7. A backup power source is required for all systems. Batteries are an acceptable option. Exception: backup power is not required when the system is monitored for loss of power and a trouble signal is initiated by the building's fire alarm control panel.
8. Battery backup is required for CO₂ sensors/detectors that reset to an alarm condition upon loss of primary power.
9. Inspection and testing of the gas detection system shall be conducted annually, at a minimum. Sensor calibration shall be confirmed upon installation and performed at the frequency specified by the sensor manufacturer.
10. **Any CO₂ system found to be not in good working order shall be shut down and taken out of service immediately until appropriate corrective actions are made by professional service personnel.**



BEVERAGE DISPENSING APPLICATIONS

Mechanical Ventilation

Mechanical ventilation is required to be installed in rooms or areas indoors where insulated liquid carbon dioxide storage tanks, cylinders, piping and equipment are located and other areas where a CO₂ leak is expected to accumulate.

Mechanical ventilation systems shall be installed in compliance with the International Mechanical Code and must meet the following requirements:

1. Rooms containing CO₂ shall be maintained at a negative pressure in relation to the surrounding area.
2. Mechanical ventilation shall be at a rate of not less than 1 cubic foot per minute per square foot.
3. Systems shall operate continuously unless alternative designs are approved and system shall be operational during all times the building or space is occupied.
4. A manual shutoff control shall be provided adjacent to the access door or in another approved location. The switch shall be a break-glass type labeled VENTILATION SYSTEM EMERGENCY SHUTOFF.
5. Exhaust ventilation shall be taken from a point within 12 inches of the floor.
6. Exhaust and inlet air openings shall provide air movement across all portions of the floor or room.
7. Exhaust air shall not be recirculated.



A gas detection system installed in compliance with the International Fire Code may be installed in lieu of mechanical ventilation.



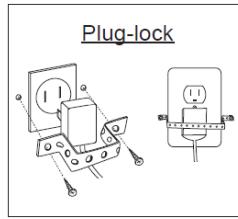
BEVERAGE DISPENSING APPLICATIONS

Gas Detection Systems

When mechanical ventilation requirements are not met, a gas detection system shall be provided.

Gas detection systems shall meet with following requirements:

1. Detection shall be provided in rooms, indoor areas and below-grade outdoor areas with insulated carbon dioxide systems.
2. CO₂ sensors shall be installed within 12 inches of the floor at all points of use areas where the gas is expected to accumulate or where leaks are most likely to occur. These areas include, but may not be limited to:
 - All storage and/or supply areas with CO₂ containers, tanks or cylinders
 - Areas where pure CO₂ is piped into the building
 - All mixing areas
 - Other approved locations
3. Gas sampling shall be continuous.
4. A local alarm and strobe are to be provided in each room or area where sensors are located to provide audible and visible notification of an alarm condition. An additional notification appliance is required in an area occupied by members of the public (i.e. dining room).
 - Strobes shall have a minimum candela rating of 110 with an **amber** lens installed.
 - Alarm devices shall provide a minimum of 75 decibels at 10 feet.
5. A Central Unit or CO₂ system annunciator shall be installed in a normally attended location where all alerts and tones can be heard, and all installed sensors must report to one central unit or annunciator.
6. Gas detection systems shall be permanently connected to the building's power supply with the electrical circuit for the CO₂ detection system labeled and locked or power cords shall be connected to unswitched receptacles using approved, fixed restraints to secure the plug from tampering or accidental disruption of power.





BEVERAGE DISPENSING APPLICATIONS

Alarm Conditions and Monitoring

1. CO₂ concentration of **5,000 ppm or .5%** shall activate an audible and visible **supervisory alarm** in a normally attended location (CO₂ system annunciator).
2. CO₂ concentration of **30,000 ppm or 3%** shall activate audible and visible alarms **initiating evacuation** of the building (CO₂ alarm with amber strobe).





ALARM SYSTEM COMPONENTS



Strobe with Amber Lens



CO₂ Sensor/Detector



Central Unit or Annunciator



SENSOR INSTALLATION LOCATIONS

Points of Use/Mixing Areas





SENSOR AND ALARM LOCATIONS

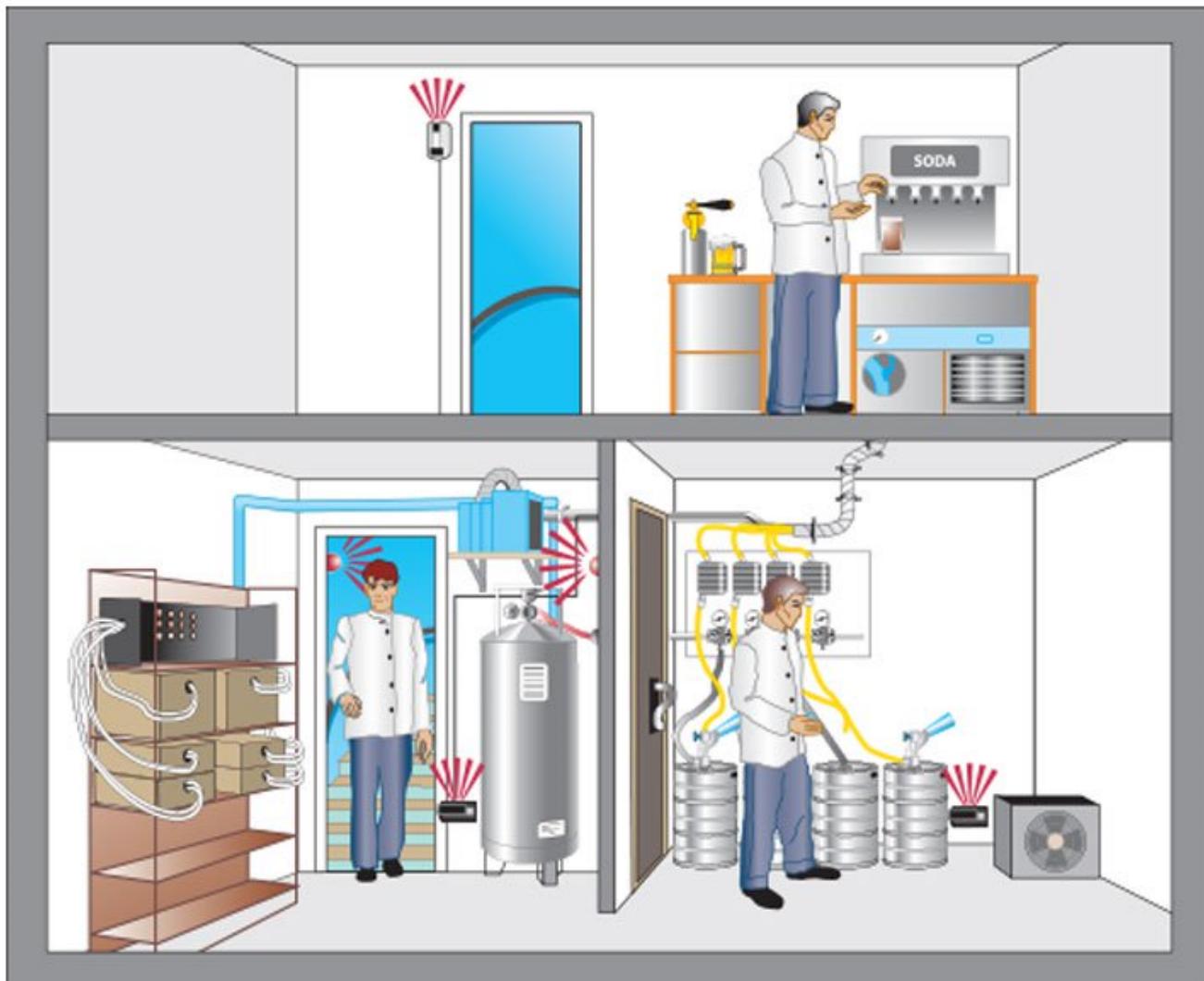


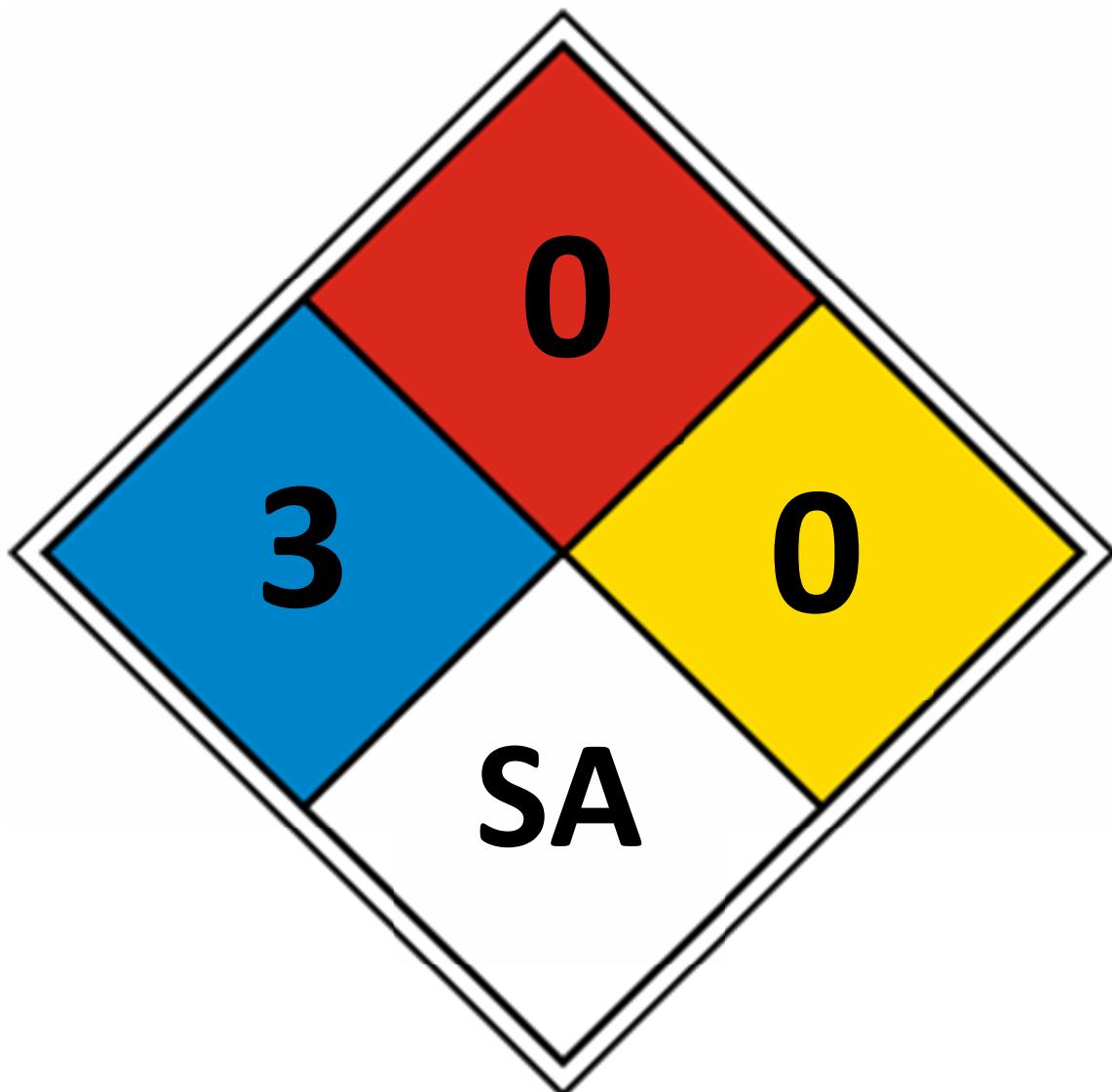
Image used with permission from Chart Industries, Inc.



HAZARD IDENTIFICATION SIGNAGE

Where liquid CO₂ containers are located in buildings, NFPA 704 placards displaying the hazard ratings shown below shall be posted at specific entrances (e.g. exterior doors closest to tanks, storage rooms doors) as determined by the fire code official.

See **Chapter 8: Hazardous Material Identification** for sign specifications.





WARNING SIGNS

A warning sign shall be placed next to each audible/visual notification appliance.



A warning sign shall also be placed at the entrance to the room where CO₂ tanks are located.
Signs shall be a minimum of 7" H by 10" W.





PERMIT SUBMITTAL REQUIREMENTS

The following items are required to be provided when submitting plans for a Construction Permit. Incomplete submittals will not be accepted.

1. Floor plan of the building showing the following components:
 - a. When CO₂ is supplied from a bulk CO₂ system for use inside of a building, provide one of the following with the submittal:
 - i. Plans for the mechanical ventilation system including calculations and electrical connections OR
 - ii. Plans for the CO₂ Gas Detection System showing the following items:
 1. Locations of CO₂ Alarm Components:
 - a. CO₂ sensor/detectors
 - b. CO₂ audible/visible alarms
 - c. Central unit or annunciator
 - b. Location of CO₂ tanks or cylinders
 - c. Mixing station location(s) and valves
 - d. Fill port location
 - e. Locations of required warning signage
 2. Data sheets for all major components
 3. Completed permit applications for each contractor:
 - a. CO₂ System Installer