


CITY AND COUNTY OF DENVER	POLICY	DENVER FIRE DEPARTMENT
Subject: CARBON DIOXIDE (CO₂) SYSTEMS USED IN BEVERAGE DISPENSING APPLICATIONS		
References: International Fire Code (IFC), Denver Fire Code Amendments, NFPA 55		
Approved:  Joseph L. Gonzales, Division Chief, Fire Prevention Division		
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This policy is meant to provide basic information for most common conditions and situations related to the use and storage of Carbon Dioxide (CO₂) gases in beverage dispensing applications. Carbon Dioxide (CO₂) gases present an asphyxiation hazard due to oxygen displacement. In any given occupancy, all other Fire Code requirements will be enforced. The Fire Inspector will address these during a premise inspection. Questions can be addressed by contacting the Denver Fire Prevention Division at 720-913-3474. Walk-in hours are Monday-Friday, 6:30 a.m. to 9:00 a.m. ONLY at 745 W. Colfax Ave., 1st Floor.

I. SCOPE

This policy covers the installation, maintenance, operation and permitting requirements as they pertain to the use and storage of Carbon Dioxide (CO₂) compressed gas systems with more than 100 pounds (45.4 kg) of Carbon Dioxide (CO₂) or any system using any amount of Carbon Dioxide (CO₂) below grade used in beverage dispensing applications in new and existing facilities within the City and County of Denver.

Effective immediately, existing Carbon Dioxide (CO₂) compressed gas systems used in beverage dispensing applications that are located within existing buildings need to be retrofitted and modified per this policy. As of January 1, 2018, legal action will be taken for all businesses not in compliance.

II. DEFINITIONS

- Asphyxiation:** to lose consciousness by impairing normal breathing, to suffocate or smother
- Dewar:** a vacuum flask that holds a cryogenic or liquefied gas
- Carbon Dioxide (CO₂) Detector:** a device to measure the concentration of CO₂ in the air
- Liquid Carbon Dioxide (CO₂) Systems:** An assembly of equipment consisting of one or more carbon dioxide containers, interconnecting piping, pressure regulators, and pressure relief devices
- PEL:** Permissible Exposure Limit for CO₂ gas is 5,000 PPM TWA (time-weighted average) @ 8 hours a day, 40 hours per week
- STEL:** Short-Term Exposure Limit for CO₂ is 30,000 PPM for less than 15 minutes
- IDLH:** Immediately Dangerous to Life & Health for CO₂ is 40,000 PPM

III. PERMITS

A. CONSTRUCTION PERMITS

Construction permits are required to install, repair damage to, abandon, remove, place temporarily out of service or close or substantially modify Carbon Dioxide (CO₂) systems with more than 100 pounds (45.4 kg) of Carbon Dioxide (CO₂) or any system using any amount of Carbon Dioxide (CO₂) below grade used in beverage dispensing applications.

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A separate tank installation permit is required for bulk tank installations over 2,000 pounds.

Denver Fire Department, Fire Prevention Division Fire Protection Engineers must review all Carbon Dioxide (CO₂) systems used in beverage dispensing applications including bulk tanks over 2,000 pounds. Upon approval by the Fire Prevention Division Fire Protection Engineers fire construction permits will be issued.

To obtain required fire construction permit(s), the applicant must submit all required documentation at:

Development Services
Wellington Webb Municipal Building
201 W. Colfax Ave., 2nd floor Commercial Login Counter
Denver, Colorado 80204

Provide a Statement of Valuation and Plan Review Contact List that can be obtained in the Commercial Permitting Handbook on the City and County of Denver website:

https://www.denvergov.org/content/dam/denvergov/Portals/696/documents/Guides/Commercial_Permitting_Handbook-12-2014.pdf

Applicable plan review and permit fees shall apply.

Construction permits shall be issued to licensed contractors unless otherwise approved by the Fire Official.

Construction drawings and specifications shall be complete and of sufficient clarity to indicate the entire work proposed and show in detail that the Carbon Dioxide (CO₂) system conforms to the provisions of the Fire and Building Codes and relevant laws, ordinances, rules and regulations. Each set of drawings and specifications shall, at a minimum, contain the following information, architectural, structural, mechanical, electrical drawings, specifications and analysis:

1. Exact address, legal description and location of the work performed.
2. Name and address of the owner.
3. Name and address of the person or firm responsible for the preparation of the drawings and specifications. If after review of the construction drawings and specifications, the Fire Official determines that the proposed Carbon Dioxide (CO₂) system is inadequately designed, the Fire Official may require that the construction drawings and specifications bear the seal of a licensed Colorado professional engineer.
4. Two complete sets of construction documents showing the construction of architectural, structural, mechanical, plumbing and electrical arrangements.
5. One copy of specifications or notes that clearly describe the type, quality and finish of materials and the method of assembly, erection and installation of equipment to be installed with proper reference to accepted standards.

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6. Except for entirely interior installations, a plot plan showing the location of the proposed construction (i.e., tanks) and the location of every adjacent existing building on the property, roads, walks, utilities and other site improvements, all property lines, streets, alleys, easements and other public areas.
7. Bulk tank installations over 2,000 pounds will require an engineered structural foundation with a separate tank installation permit. Two complete sets of structural drawings, specifications and analysis (calculations) shall be provided and shall bear the seal of a licensed Colorado professional engineer.

B. OPERATIONAL PERMITS

Operational permits shall be issued upon approval, issuance, and final inspections of required construction fire permits.

An annual operational permit shall be obtained from the Denver Fire Department’s Fire Prevention Division for Carbon Dioxide (CO₂) systems used in beverage dispensing applications as defined in the scope.

A separate annual compressed gas storage/use permit will be required for 6,000 cubic feet or more of Carbon Dioxide (CO₂) as an “Inert Gas.” (1 pound of CO₂ = 8.74 cu/ft)

Operational permits shall be posted on site.

To obtain required operational permit(s), the Business owner or Company Representative must complete and sign the Carbon Dioxide (CO₂) Systems Used in Beverage Dispensing Applications Permit application.

Make check payable to: **Denver Manager of Finance**

Mail-in to: Denver Fire Department
 Fire Prevention Division - Permits
 745 W. Colfax Avenue
 Denver, CO 80204

Walk-in permits: Monday – Friday, **6:30 a.m. to 9:00 a.m. ONLY** at 745 W. Colfax Ave., 1st floor

PERMIT COST - See Permit Fee Table at www.denvergov.org/Fire for current fees.

IV. CARBON DIOXIDE (CO₂) SYSTEMS USED IN BEVERAGE DISPENSING APPLICATIONS REQUIREMENTS

Specifics and Conditions:

- A. Equipment.** The storage, use, and handling of carbon dioxide shall be in accordance with the Compressed Gases Chapter in the IFC and the applicable requirements of NFPA 55, Chapter 13. All equipment utilized in compressed gas systems shall be compatible with

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the intended gas and use.

1. **Containers, cylinders and tanks.** Gas storage containers, cylinders and tanks shall be designed, fabricated, tested, labeled and installed per manufacturers' specifications and shall be maintained in accordance with the regulations of DOTn 49 CFR, Parts 100-185 or the ASME Boiler and Pressure Vessel Code, Section VIII.
 - a. **Location.** Location of gas storage containers, cylinders and tanks, inside or outside the building, shall be at an approved location.
 - b. **Security.** Gas storage containers, cylinders and tanks shall be secured in an approved manner to prevent overturning. Containers, cylinders and tanks located outside shall be secured and safeguarded against tampering and protected from physical damage if exposed to vehicle traffic.
 - c. **Design and construction.** Bulk tank installations over 2,000 pounds will require an engineered foundation and construction permit per the Denver Building Code.

2. **Piping systems.** Piping, tubing, fittings, valves and pressure regulating devices shall be designed and installed in accordance with approved standards and manufacturers' recommendations.
 - a. **Piping, tubing and hoses.** Piping, tubing and hose materials shall be compatible with carbon dioxide and rated for the temperatures and pressures encountered in the system. All hoses and tubing used in carbon dioxide service shall be designed for a bursting pressure of at least four times their design pressure. PVC/ABS and other types of rigid plastic piping are not approved materials. Acceptable piping for carbon dioxide shall be the following:
 - i. Stainless steel A269 grade, which is either seamless or welded drawn over mandrel
 - ii. Copper K grade, hard drawn seamless
 - iii. Copper ACR grade (1/2 inch outside diameter or less) annealed seamless
 - iv. Plastic/polymer materials rated for use with carbon dioxide and compliant with Code of Federal Regulations Title 21 FDA Part 177 Indirect Food Additives Polymers
 - v. Additional approved piping, tubing and hoses found in the Compressed Gas Association (CGA) standards for carbon dioxide
 - b. **Fittings, joints and connections.** Fittings, joints and connections shall be subject to the approval of the fire and building departments.
 - i. **Fittings and joints between gas supply containers and automatic shutoff valve.** Joints and fittings on the supply piping or tubing between the CO₂ supply source and the automatic system shutoff valve shall be threaded, compression or welded.
 - ii. **Unused connections.** Unused piping or tubing connected to the supply system shall be capped or plugged. A closed valve will not be allowed in lieu of a cap or plug.

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c. **Valves.** Piping systems shall be provided with valves as follows:

- i. **Pressure relief valves.** Pressure relief valves shall be provided and piped to the outdoors.
- ii. **System shutoff valve.** An automatic system shutoff valve shall be provided as near to the supply pressure regulator as possible and shall be designed to fail to a closed condition or close on loss of electrical power. Additional automatic shutoff valves may be provided at each point of use.
- iii. **Appliance shutoff valves.** Each appliance shall be provided with a shutoff valve within 3 feet of the appliance. All shutoff valves shall be capable of being locked or tagged in the closed position for servicing.
- iv. **Check valves.** One-way flow check valves shall be installed at the most downstream end of copper runs that are used for beverage consumption.
- v. **Accessibility and identification.** Valves and controls shall be readily accessible at all times. Normal and emergency system shut-off valves shall be clearly identified. All valves shall be designed or marked to indicate clearly whether it is open or closed.

d. **Venting.** Venting of gases shall be directed to an approved location outside the building. Insulated liquid carbon dioxide systems shall have pressure relief devices vented in accordance with NFPA 55.

B. Protection from damage. Carbon dioxide systems shall be installed so the storage tanks, cylinders, piping and fittings are protected from damage by occupants or equipment during normal facility operations.

C. Required protection. Where carbon dioxide storage tanks, cylinders, piping and equipment are located indoors, rooms or areas containing carbon dioxide storage tanks, cylinders, piping and fittings and other areas where a leak of a carbon dioxide system can collect shall be provided with either ventilation or an emergency alarm system as follows:

1. **Ventilation.** Mechanical ventilation shall be in accordance with the *International Mechanical Code* and shall comply with all of the following:
 - a. Mechanical ventilation in the room or area shall be at a rate of not less than 1 cubic foot per minute per square foot [0.00508 m³/(s • m²)].
 - b. Exhaust shall be taken from a point within 12 inches (305 mm) of the floor.
 - c. The ventilation system shall be designed to operate at a negative pressure in relation to the surrounding area.
 - d. Ventilation shall run continuously or be activated by a sensor or detector to

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maintain an atmosphere of less than 5,000 ppm.

- e. A mechanical permit is required per the Denver Building Code.

2. Emergency alarm system. An emergency alarm system shall comply with all of the following:

- a. Continuous gas detection shall be provided to monitor areas where carbon dioxide (CO₂) can accumulate. Detection equipment shall be provided to indicate carbon dioxide (CO₂) levels at each point of use and in each storage area/room.
- b. Detectors shall be:
 - i. listed or approved devices
 - ii. permanently mounted
 - iii. installed at a height of between 12 - 24 inches above the floor or as approved by the fire code official
 - iv. directly connected to building electrical and fire alarm systems and protected from accidental disconnection or damage
 - v. auto calibrating and self “zeroing” devices are not permitted unless they can be zeroed and spanned
 - vi. located within manufacturers specified detection range for each point of use and storage location
- c. Alarm set points shall be set at:
 - i. 5,000 PPM (TWA) Time Weighted Average – Self re-setting (non-latching) alarm
 - Notification for employees only in approved locations
 - Supervisory Signal*
 - ii. 15,000 PPM – Latching Alarm
 - Notification for employees only in approved locations
 - Requires a service company to investigate, repair and reset
 - Supervisory Signal*
 - iii. 30,000 PPM – Latching Alarm
 - Initiate amber strobes and audible horns provided in the vicinity of each interior storage container, cylinder or tank and at each point of use. The notification devices shall be rated a minimum of 80cd for a visible effect and 75 dBA for an audible effect and shall be mounted per NFPA 72 requirements.
 - Activation of automatic system shutoff valve
 - Evacuate room/area and call 911
 - Alarm Signal*

*In buildings with a monitored sprinkler or fire alarm/detection system, the carbon dioxide (CO₂) emergency alarm system shall be connected to the building fire alarm control panel. A fire alarm permit is required per the Denver Building Code.

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- d. Signage shall be required adjacent to each horn/strobe within 4 inches as follows:

“FLASHING LIGHT MEANS CARBON DIOXIDE LEAK DETECTED – EVACUATE IMMEDIATELY AND CALL 911”

The sign shall have a minimum 2-inch block lettering with a minimum ½-inch stroke. The sign shall be on a contrasting surface of black on yellow and shall be of durable construction.

Warning signs shall be posted at the entrances to a room or confined area where the container is located. The warning sign shall be at least 8 inches (200 mm) wide and 6 inches (150 mm) high and state the following:

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

NFPA 704 placards for Simple Asphyxiants shall also be provided at the main entrance to storage rooms, areas or confined spaces.

- D. Transfilling.** Filling and transfilling of gases between storage containers, cylinders and tanks and delivery vehicles shall be performed by qualified personnel using equipment and operating procedures in accordance with CGA P-1. Interior storage containers, cylinders and tanks shall be filled via remote fill ports on the exterior of the building at grade level. Exterior remote fill ports shall be fitted with a vent line to the outside. Delivery personnel shall have access to interior storage areas to inspect valves and piping prior to initiating filling operations.

- E. Inspection and testing.** All piping installations shall be visually inspected, calibrated, and pressure tested to determine that the materials, design, fabrication and installation practices comply with the requirements of the IFC.

- 1. Records.** A written record of all required inspections, testing, calibration, and maintenance shall be maintained in a log book on the premises containing the three (3) most current years of records and be available for review by fire inspection personnel.

- a. Required inspections and testing.** All piping installations shall be tested and inspected as follows:

- i. Acceptance testing.** Appliances and equipment shall not be placed in operation until after the piping system has been checked for leakage and detectors have been tested by a qualified service company. All piping installations shall be visually inspected and pressure tested prior to initial operation. The test pressure downstream of the pressure regulator shall

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be not less than 110% of the operating pressure. Joints shall be checked with a bubble-forming solution. Acceptance testing is required to be witnessed by Fire and Building Code Officials.

- ii. **Daily inspections.** All detectors and alarms shall be visibly inspected daily. These inspections are permitted to be conducted by trained employees.
 - iii. **Monthly inspections.** All storage vessels, piping, and appurtenances shall be visibly inspected monthly. These inspections are permitted to be conducted by trained employees.
 - iv. **Semi-annual inspections.** Systems shall be visually inspected, gas detectors calibrated per manufacturer specification, alarms tested, and tested for leaks semi-annually by a qualified service company.
 - v. **Alterations and repair.** In the event alterations, repairs or additions are made, the affected piping shall be retested.
- b. **Calibration.** Detectors shall be checked for accuracy, calibrated to a reference gas concentration, and span reset.
- c. **Pressure testing.** Pipe joints shall be exposed for examination during the test.
- i. **Test medium.** The test medium shall be air, nitrogen, carbon dioxide, or an inert gas.
 - ii. **Section testing.** Piping systems shall be permitted to be tested as a complete unit or in sections. A valve shall not be subjected to the test pressure unless it can be determined that the valve, including the valve-closing mechanism, is designed to safely withstand the test pressure.
 - iii. **Regulators and valve assemblies.** Regulator and valve assemblies fabricated independently of the piping systems in which they are to be installed shall be permitted to be tested with inert gas or air at the time of fabrication. Test records shall be maintained.
 - iv. **Test preparation.** All joints and fittings shall be exposed for examination during and after the test.
 - a) **Pipe clearing.** Prior to testing, the interior of the pipe shall be cleared of all foreign material.
 - b) **Appliance and equipment isolation.** Appliances and equipment that are not to be included in the test shall be isolated from the piping by closing the appliance shutoff valve.
 - c) **Test pressure measurement.** Test pressure shall be measured

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with a pressure-measuring device designed and calibrated to read, record or indicate a pressure loss caused by leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made. Mechanical gauges used to measure test pressures shall have a range such that the highest end of the scale is not greater than five times the test pressure.

d) Test pressure. The test pressure downstream of the pressure regulator shall be not less than 110% of the operating pressure. Where the test pressure exceeds 125 psig (862 kPa gauge), the test pressure shall not exceed a value that produces a hoop stress in the piping greater than 50 percent of the specified minimum yield strength of the pipe or tubing. Pressures shall be adjusted smoothly and slowly to avoid pressure spikes.

v. Test duration. The test duration shall be not less than 10 minutes.

vi. Visual inspection and cleaning. After testing is complete and the pressure is reduced to at or below operating pressure, all joints shall be cleaned of bubble forming solution and visually inspected.

vii. Detection of leaks and defects. The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects. Any reduction of test pressures as indicated by pressure gauges shall be deemed to indicate the presence of a leak.

viii. Corrections. Where leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and retested.

F. 5307.8 Training. All employees shall receive annual training in hazard identification, physical properties, inspection, and emergency procedures. Training records shall be maintained on site and be available to fire inspectors upon request.

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CARBON DIOXIDE (CO₂) SYSTEMS USED IN BEVERAGE DISPENSING APPLICATIONS PERMIT APPLICATION

THIS FORM SHALL BE COMPLETED AND SIGNED BY BUSINESS OWNER OR A REPRESENTATIVE OF THE PROPERTY OWNER APPLYING FOR THE PERMIT(S).

PLEASE MAKE CHECKS PAYABLE TO MANAGER OF FINANCE

NAME OF BUSINESS: _____

MAILING ADDRESS: _____ CITY, STATE, ZIP _____

PERMIT SITE ADDRESS: _____ DENVER, CO. ZIP _____

CONTACT NAME: _____

CONTACT PHONE NUMBER: _____ E-MAIL: _____

GAS SUPPLY COMPANY NAME: _____

COMPANY PHONE NUMBER: _____ E-MAIL: _____

TYPE OF CO₂ STORAGE CONTAINER(S): _____

TOTAL QUANTITY OF CO₂ GAS ON SITE: _____

LOCATION OF CO₂ GAS STORAGE (PROVIDE DIAGRAM): # OF AREAS _____

(CHECK ALL THAT APPLY)

INDOOR _____ OUTDOOR _____ ENCLOSED ROOM _____ ABOVE GRADE _____ BELOW GRADE _____

NUMBER AND DESCRIPTION OF POINTS OF USE (PROVIDE FLOOR PLAN): _____

I UNDERSTAND THAT DENVER FIRE PREVENTION DIVISION PERSONNEL WILL CONDUCT A SITE INSPECTION, AND IF THE INSTALLATION DOES NOT COMPLY WITH THE DENVER FIRE CODE, THE PERMIT MAY BE REVOKED WITHOUT A REFUND.

SIGNATURE: _____ DATE: _____

END OF DOCUMENT
