Stationary CO2 Tanks in Restaurants

CFC / NFPA / HSC

Presented by

Steve Buscovich (Hayward Fire Department)

Ari Erman (Livermore Pleasanton Fire Department)

Joseph Priestley - First Published Literature - 1772

IMPREGNATING WATER

WITH

FIXED AIR;

In order to communicate to it the peculiar Spirit and Virtues of

Pyrmont Water,

And other Mineral Waters of a similar Nature.

By JOSEPH PRIESTLEY, LL.D. F.R.S.

LONDON:

Printed for J. JOHNSON, No. 72, in St. Paul's Church-Yard. 1772.

[Price ONE SHILLING.]

"If this discovery be of any use to my countrymen, and to mankind at large, I shall have my reward".

He is credited with the discoveries of nitric oxide, anhydrous hydrochloric acid, sulphur dioxide, ammonia, nitrous oxide, and Oxygen. Observed that the plants revitalized in enclosed volumes of air, a discovery that would eventually lead to the discovery of photosynthesis.

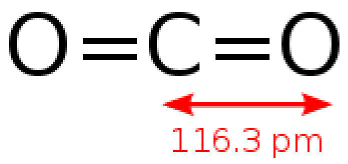
Regards to O2 " five or six times better than common air for the purpose of respiration, inflammation, and, I believe, every other use of common atmospherically air"

Reward: He was forced to flee his hometown in 1791, first to London and then to the United States, after a mob burned down his Birmingham home and church. He spent his last ten years in Northumberland County, Pennsylvania.

LONDON: Printed for J. Johnson, No. 72, in St. Pauls Church-Yard, 1772 [Price ONE SHILLING.]

HISTORY – Fun Facts

Double covalent bond.



$CO_2 + H_2O \rightleftharpoons H_2CO_3$ hydration equilibrium constant of carbonic acid is ~.0017

Therefore the majority of carbon dioxide is not converted into carbonic acid remains as CO2 molecules not affecting the pH creating a weak acid.

This is important to us because we love bubbly beverages that does not burn through our stomach lining.

https://en.wikipedia.org/wiki/Carbon_dioxide

Incidents

- September 27, 2011 a McDonald's restaurant in Phoenix, Arizona, was evacuated because of a leaking soda machine in the basement. A pregnant employee reportedly collapsed while exiting the basement and two firefighters were injured during the incident. The building was equipped with on-site CO_2 monitors, but apparently they failed to alarm.
- In September 2010, a CO_2 leak in a McDonald's restaurant reportedly resulted in the death of a woman in a restroom. 10 additional victims were injured, including three firefighters.
- At a McDonald's restaurant in Sanford, Florida, an 18-year-old employee reportedly died of asphyxiation while refilling CO_2 tanks. The delivery driver also died trying to rescue the first victims.

https://www.firefighterclosecalls.com/co2-close-call-at-phoenix-mc-donalds/

https://www.fireengineering.com/articles/2013/03/carbon-dioxide--a-hidden-danger-for-firefighters.html

Leeb, F. "The Dangers of Carbon Dioxide in Fast Food-Type Occupancies." WNYF-With New York Firefighters. 1st/2012. pp. 26-28

Safety - Concentration levels

Occupational Safety and Health Administration – OSHA, Cal OSHA, NIOSH

- **P**ermissible **E**xposure **L**imit

  TWA 5000 ppm (9000 mg/m^3) total weighted average on a 8h span

  STEL 30,000 ppm (54,000 mg/m^3) short term exposure limit
- **I**mmediately **D**angerous to **L**ife or **H**ealth – 40000 ppm – 4% by volume

CO_2 levels in the atmosphere ~ 410ppm

www.osha.gov

https://www.osha.gov/dsg/annotated-pels/tablez-1.html#niosh_rel

HMBP – Health and Safety Code Ch 6.95

Section 25507

(a) Except as provided in this article, a business shall establish and implement a business plan for emergency response to a release or threatened release of a hazardous material in accordance with the standards prescribed in the regulations adopted pursuant to Section 25503 if the business meets any of the following conditions at any unified program facility:

(5) It handles at any one time during the reporting year cryogenic, refrigerated, or compressed gas in a quantity of 1,000 cubic feet or more at standard temperature and pressure, if the gas is any of the following:

(C) Carbon dioxide

Reminder:

- (a) (1) (A) …physical state and quantity present of mixtures shall be determined by the physical state of the mixture as a whole, not individual components, at standard temperature and pressure.
- (B) …it shall be reported in the physical state at which it is stored.

California Fire Code (2016)

5307.2 Permits. Permits shall be required as set forth in Section 105.6

105.6.4 Carbon dioxide systems used in beverage dispensing applications.

An operational permit is required for carbon dioxide systems used in beverage dispensing applications having more than 100 pounds of carbon dioxide.

Approximately 874 cubic ft.

5307.3 Equipment. The storage, use, and handling of liquid carbon dioxide shall be in accordance with Chapter 53 and the applicable requirements of NFPA 55, Chapter 13. Insulated liquid carbon dioxide systems shall have pressure relief devices vented in accordance with NFPA 55.

CO2 Gas Cylinders

lbs	gallons	cf3
5	.59	44
10	1.18	88
15	1.77	131
20	2.36	175
40	4.72	350
60	7.08	525

CO2 Gas Cylinder

Double chained

50lbs ~ 390 cubic ft

CO2 Liquid Tank- Carbo Mizer Tank Sizes

lbs	gallons	cf3
300	35.4	2622
500	59	4371
750	88.5	6556

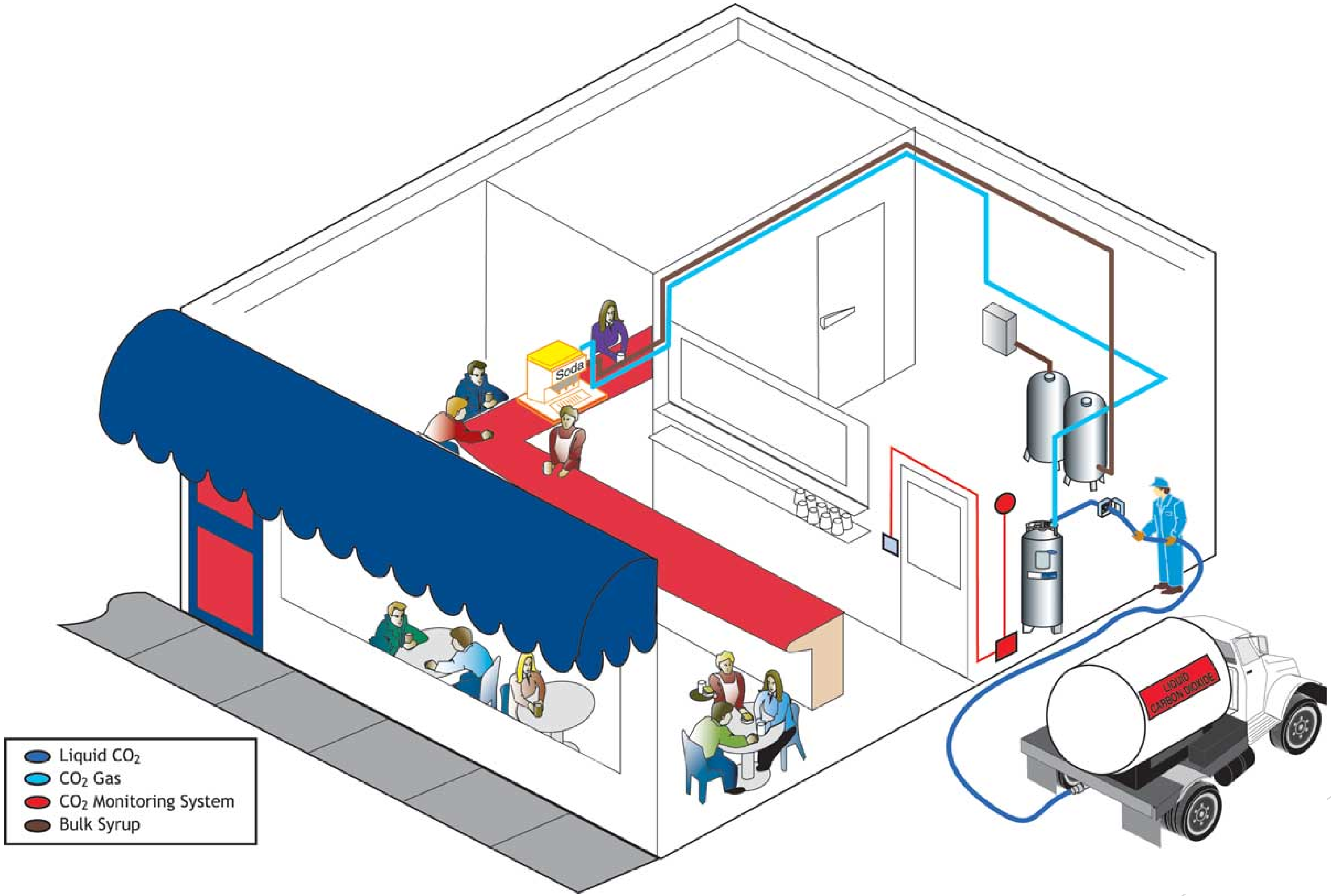
http://www.nuco2.com/products/xactco2.html

CO2 Conversion Factors

Carbon Dioxide	Weight			Gas		Liquid		Solid
	Pounds	Tons	Kilograms	Cubic Feet	Cubic Meters	Gallons	Liters	Cubic Feet
	Lb	Tons	Kg	SCF	Nm3	Gal	L	Cu. Ft.
1 Pound	1	0.0005	0.4536	8.741	0.2294	0.11806	0.4469	0.010246
1 Ton	2000	1	907.2	17483	458.8	236.1	893.9	20.49
1 Kilogram	2.205	0.0011023	1	19253	0.5058	0.2603	0.986	0.226
1 SCF Gas	0.1144	—	0.05189	1	0.02628	0.013506	0.05113	0.0011726
1 Nm3 Gas	4.359	0.00218	1.9772	38.04	1	0.5146	1.948	0.04468
1 Gal Liquid	8.47	0.004235	3.842	74.04	1.9431	1	3.785	0.08678
1 L Liquid	2.238	0.0011185	1.0151	19.562	0.5134	0.2642	1	0.02293
1 Cu Ft Solid	97.56	0.0488	44.25	852.8	22.38	11.518	43.6	1

http://www.libertygases.com/gas-products/carbon-dioxide/

Indoor Installations



http://arc3gases.com/Images/Interior/gases/beverage-co2-diagram-lrg.jpg

300lbs Liquid CO_2 Tank

conversion factors

lbs to ft^3 8.74

typical room 10x30

~ 2610 ft^3 vs 3000 ft^3

750lbs Liquid CO2 Tank

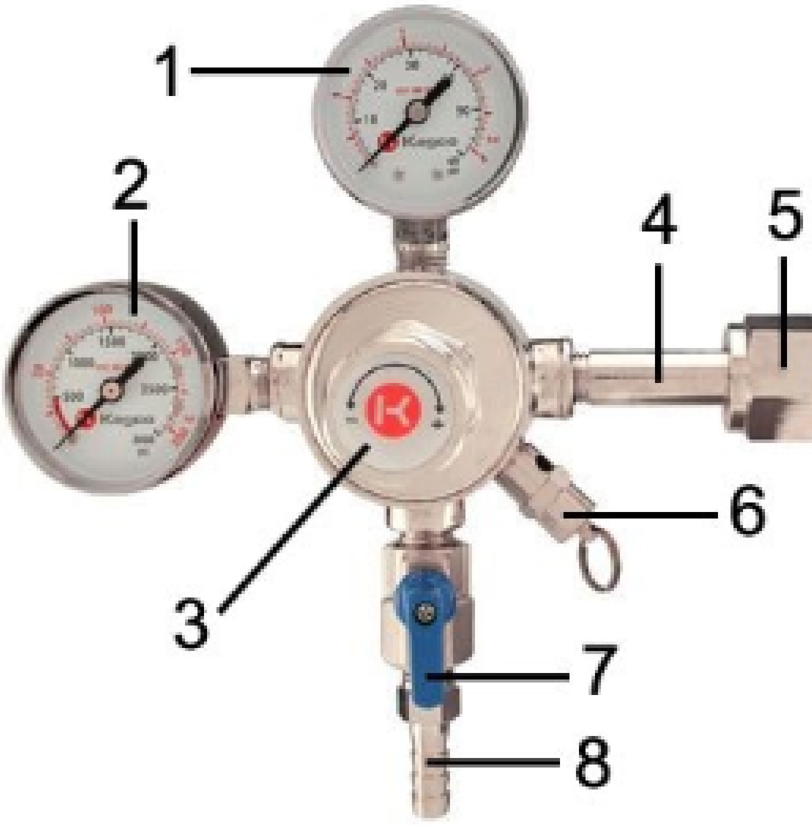
6550 cubic ft

Can fill a 15 x 40 room

Regulator Components

A: The main components of a regulator are:

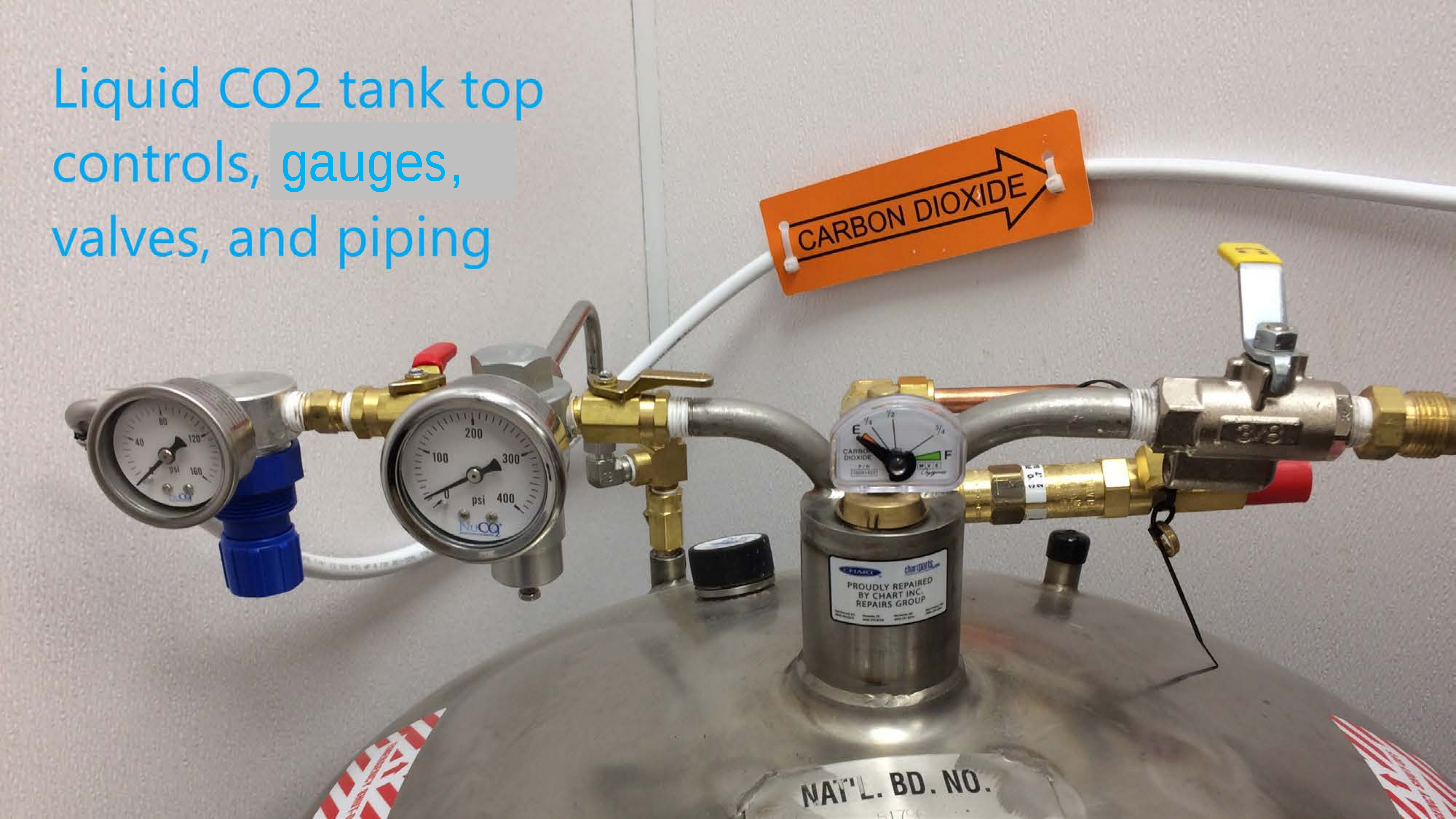
1. Low pressure gauge (reads the amount of internal keg pressure)
2. High pressure gauge (indicates existing pressure in the CO2 cylinder)
3. Pressure adjustment (before tapping the keg, screw clockwise until low pressure gauge indicates the desired pressure)
4. CO2 inlet nipple
5. CO2 inlet nut
6. Pressure relief valve
7. Optional shut-off valve
8. Outlet fittings

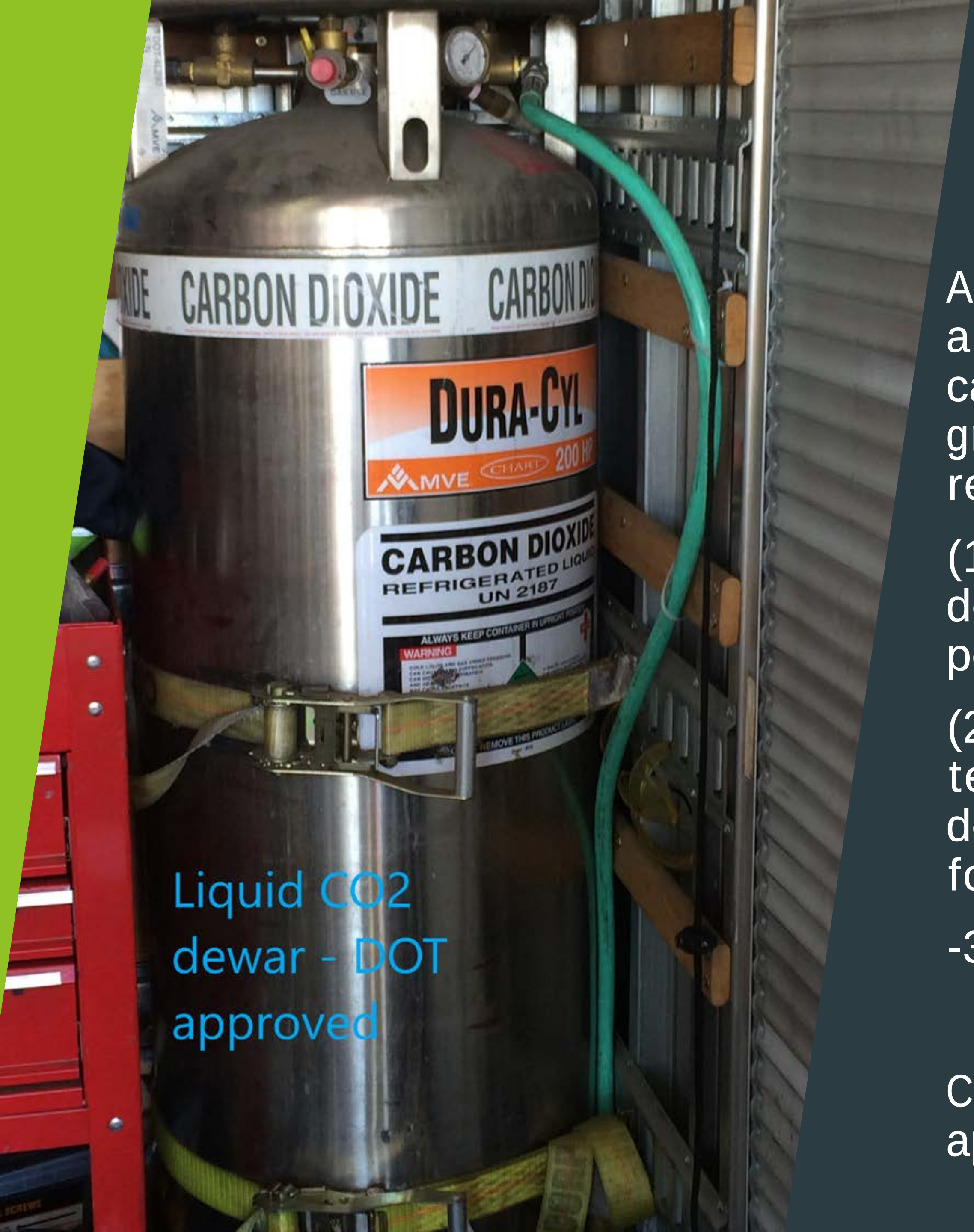


Pressure Relief Devices
NFPA 55 Chapter 13 Insulated CO2 Systems

- **13.3.1 Pressure Relief Devices.** Containers used for liquid carbon dioxide shall be equipped with pressure relief devices piped from the uppermost part of the containers and communicating with the vapor space.
- **13.3.1.2 Vent Pipe Systems.** Pressure relief devices shall be piped to the outdoors where the discharge will not impinge on the structure, personnel, or means of egress and will not create a hazardous concentration of carbon dioxide.
- **13.3.2.1** Pressure relief devices from portable DOT 4L containers that are not part of a stationary system shall not be required to meet the requirements of 13.3.1.2.

Liquid CO_2 tank top controls, gauges, valves, and piping





DOT 4L approved - 49 CFR § 178.57

A DOT 4L cylinder is a fusion welded insulated cylinder with a water capacity (nominal) not over 1,000 pounds water capacity and a service pressure of at least 40 but not greater than 500 psig conforming to the following requirements:

(1) For liquefied hydrogen service, the cylinders must be designed to stand on end, with the axis of the cylindrical portion vertical.

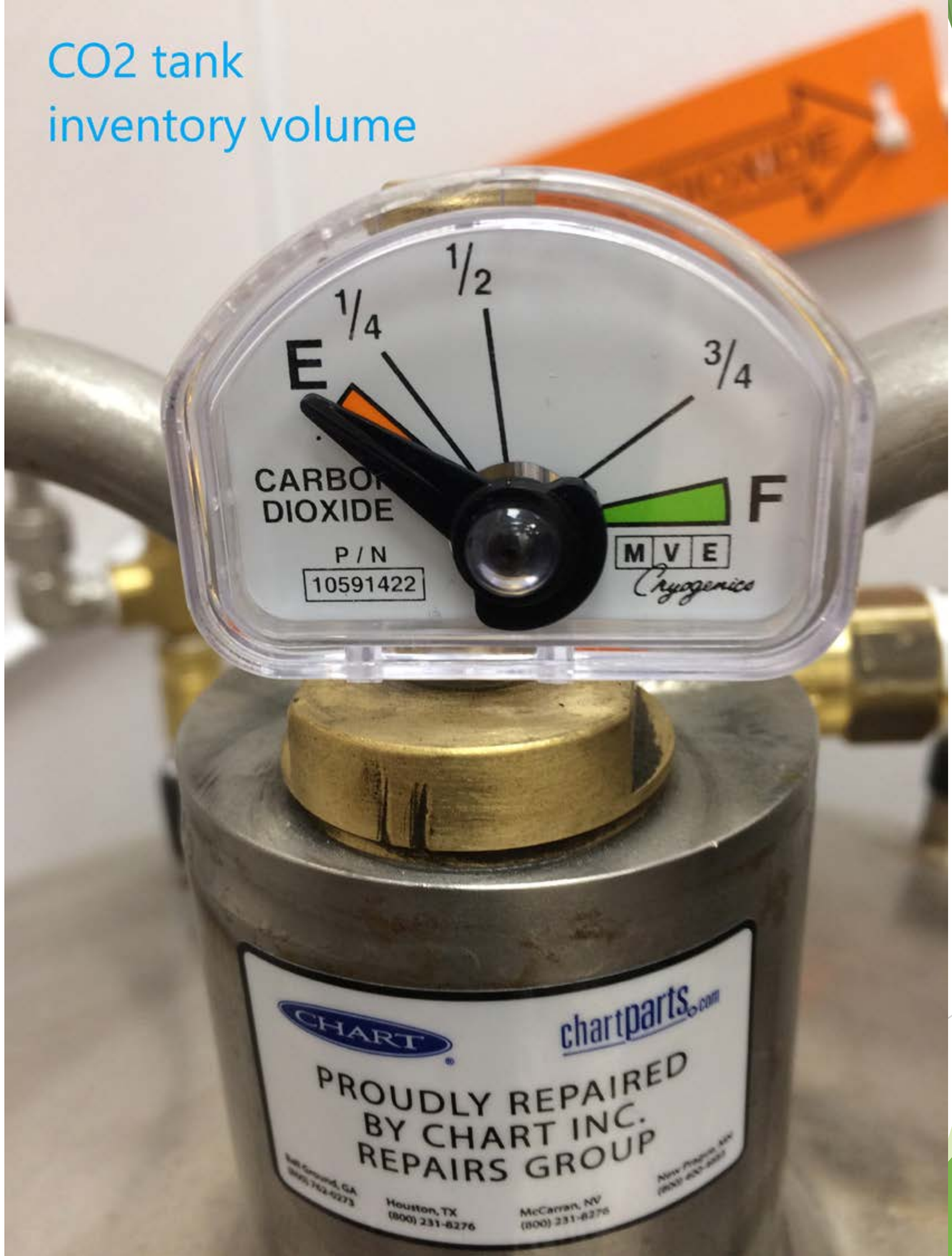
(2) The design service temperature is the coldest temperature for which a cylinder is suitable. The required design service temperatures for each cryogenic liquid is as follows:

-320F for Oxygen

Continued…

Confirmed with NuCo2 that their cylinders are DOT 4L approved.

Tank inventory



CO2 Tank Signage

California Fire Code (2016)

5307.3.2 Gas detection system. *A continuous gas detec*tion system shall be provided in the room or indoor area in which the carbon dioxide enrichment process is located, in the room or indoor area in which the container systems are located, and in areas where the heavier-than-air gas can congregate. Carbon dioxide sensors shall be provided within 12 inches (305 mm) of the floor in the area where the gas is most likely to accumulate or leaks are most likely to occur. The system shall be designed to detect and notify at a low-level alarm and high-level alarm.

The threshold for activation of the low-level alarm shall not exceed a carbon dioxide concentration of 5,000 ppm (9,000 mglm3) Time Weighted Average (TWA) over 8 hours. 0.5%

The threshold for activation of the high-level alarm shall not exceed a carbon dioxide concentration of 30,000 ppm (54,000 mg/m 3). When carbon dioxide is detected at the high-level alarm, the system shall activate an audible and visible alarm in an approved location. 3%

LogiCO2 Mk9 – Gas Monitor Cont.

Certified by UL

Provides continues reading of CO2
Uses non dispersive infrared analysis
No interference from other gases
Supports up to 8 sensors
2min sample size
Customizable alarm levels
Reset button

CO2 controller (close up)

Controller – Not Hardwired!

- Employee training
- Ensure yellow tag stays on
- Strapped
- Dedicated Circuit

CO2 Strobe Audio Visual Alarm

NFPA 72 – Applies to fire alarm systems and CO
Use as guidance for CO2 systems

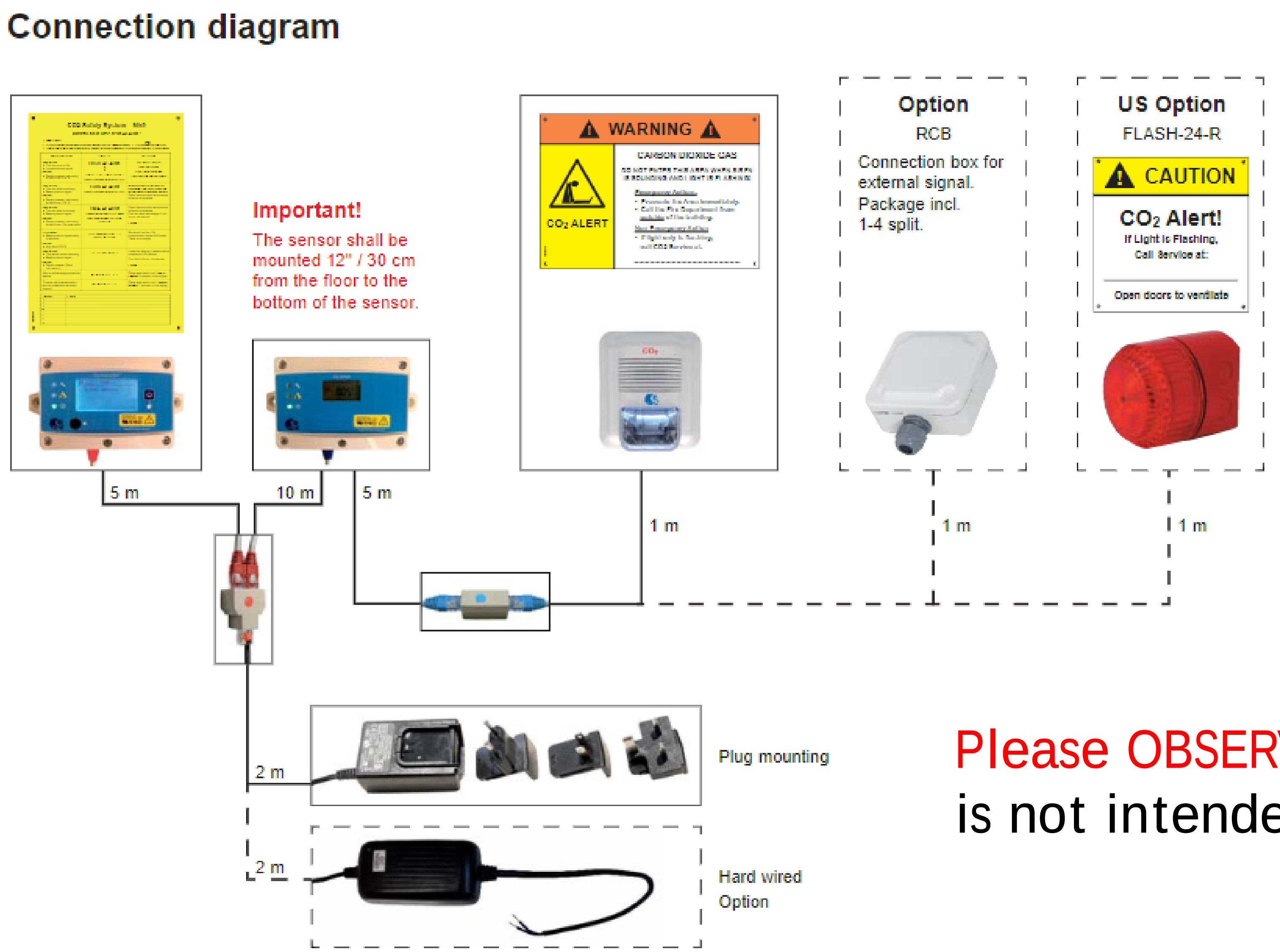
Chapter 18 Notification Appliances

18.4 Audible Characteristics

18.5 Visual Characteristics

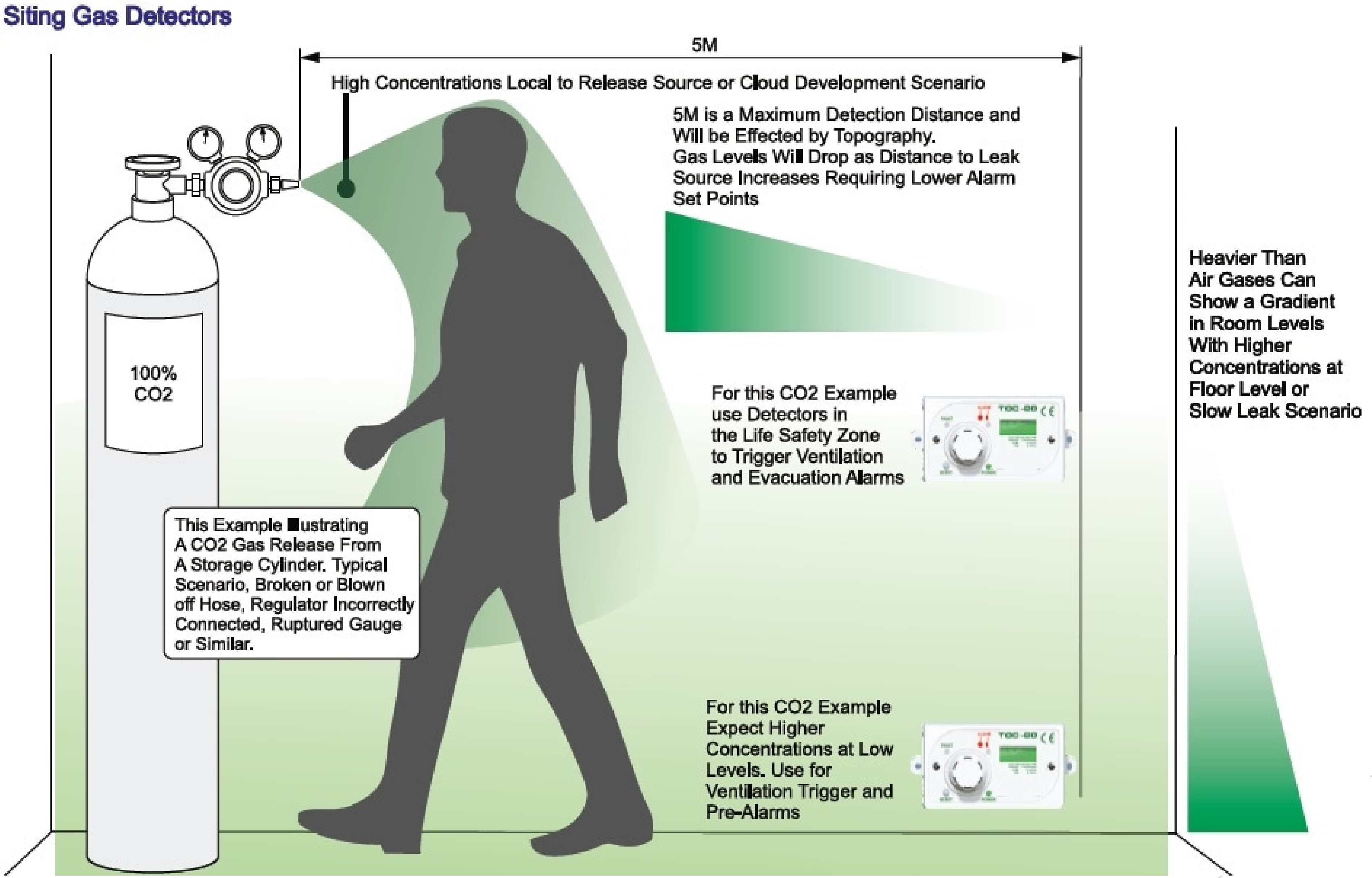
18.5.5.1 Placed at 80 to 96 inches from the floor

Connection Diagram CO2 Sensor



Please OBSERVE! The hard wire option is not intended for the US market.

CO2 Sensor Placement – **12 inches**



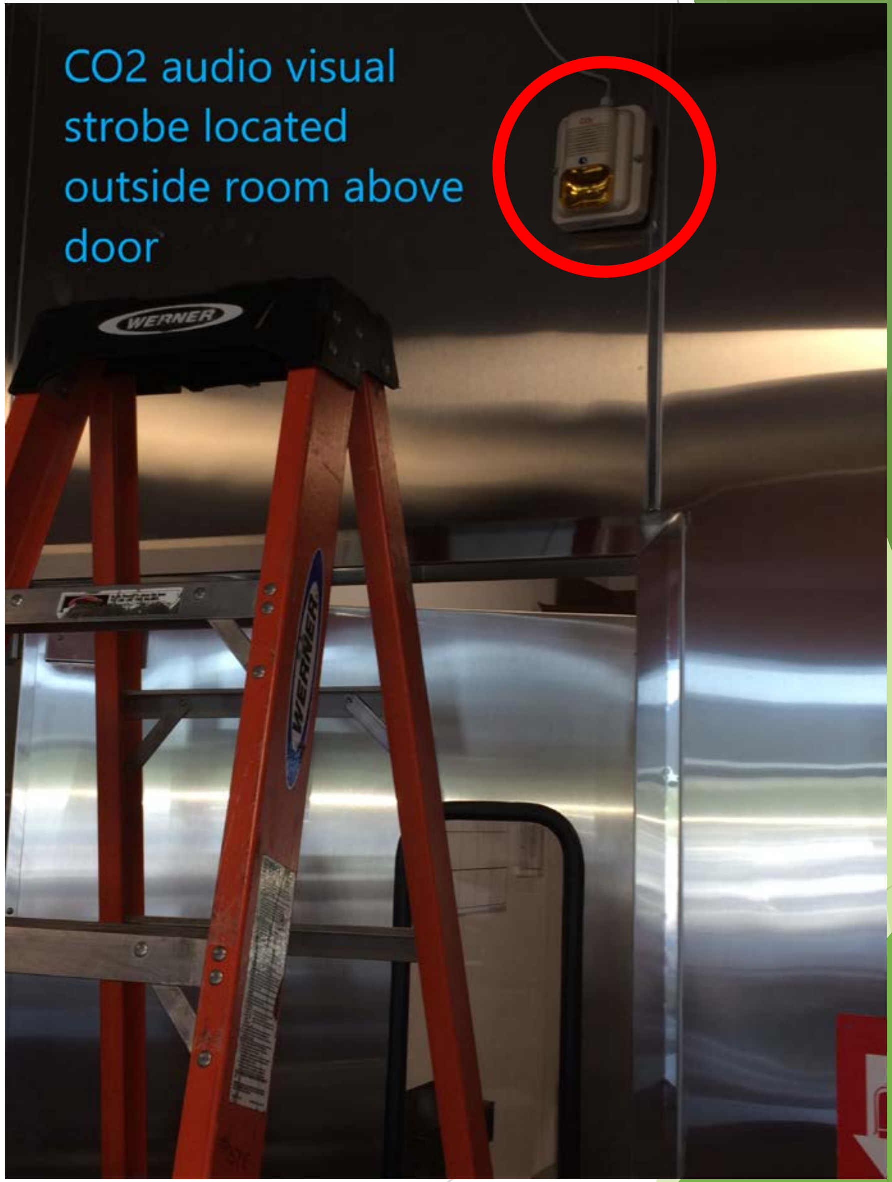
https://www.internationalgasdetectors.com/placement-gas-detector-guidelines/

Audio Visual Alarm

Location

Clear Line of Sight

More than One?



Information Sign

Level 1 – Awareness

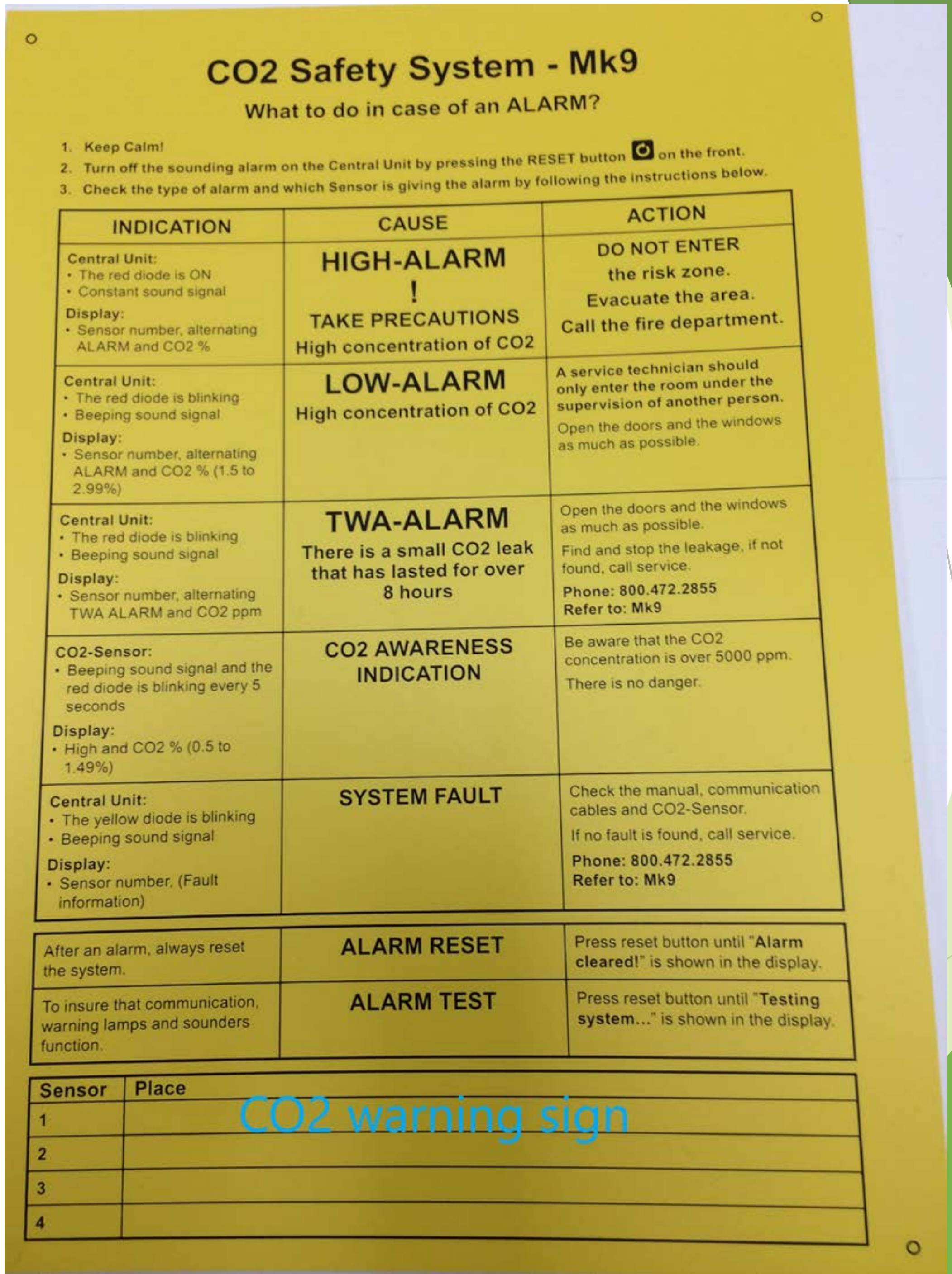
CO2% .5 to 1.49%
Red diode – 5sec
Beeping Sound

Level 2 – Low Alarm

CO2% 1.5 to 2.99%
Red diode – rapid blinking
Beeping Sound

Level 3 – High Alarm
Red diode – On
Constant Sound

ACTION



CO2 warning sign

NFPA 704

RATING NUMBER	HEALTH HAZARD	FLAMMABILITY HAZARD	INSTABILITY HAZARD
4	Can be lethal	Will vaporize and readily burn at normal temperatures	May explode at normal temperatures and pressures
3	Can cause serious or permanent injury	Can be ignited under almost all ambient temperatures	May explode at high temperature or shock
2	Can cause temporary incapacitation or residual injury	Must be heated or high ambient temperature to burn	Violent chemical change at high temperatures or pressures
1	Can cause significant irritation	Must be preheated before ignition can occur	Normally stable. High temperatures make unstable
0	No hazard	Will not burn	Stable

RATING SYMBOL	SPECIAL HAZARD
OX	Oxidizing
SA	Simple asphyxiants
~~W~~	Reacts violently or explosively with water

NFPA Placard Locations

- Front entrance
- Back entrance
- Room entrance ?

Sir you will need to rotate this NFPA placard 45 degrees
Which way, clockwise or counter-clock wise?
Clockwise
Can I rotate the numbers and the letters instead?

California Fire Code - Continued

5307.4.5 Signage. Hazard Identification signs shall be posted at the entrance to the room and indoor areas where the carbon dioxide enrichment process is located, and at the entrance to the room or indoor where the carbon dioxide containers are located. The sign shall be a minimum 8 inches wide and 6 inches high and indicate:

CAUTION: CARBON DIOXIDE GAS

Ventilate the area before entering.

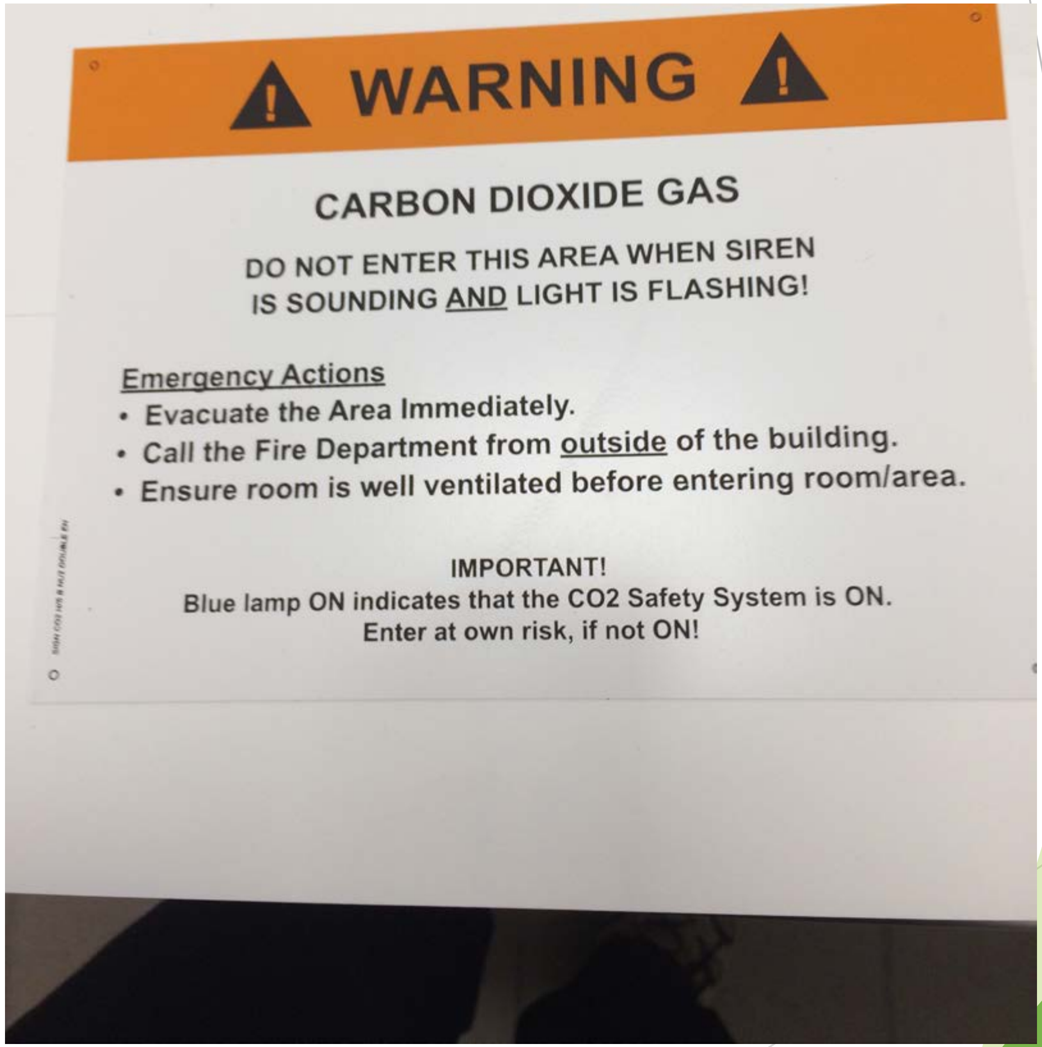
A high carbon dioxide (CO2) gas concentration

In this area can cause asphyxiation

5307.4.6 Seismic and structural design. Carbon dioxide system containers and piping shall comply with the seismic design requirements in Chapter 16 of the California Building Code and shall not exceed the floor loading limitation of the building.

5307.4.7 Container refilling. Carbon dioxide containers located indoors shall not be refilled unless filled from a remote connection located outdoors.

Warning sign provided by the manufacturer of the CO2 detection system. Placed at the entrance to the CO2 tank area.



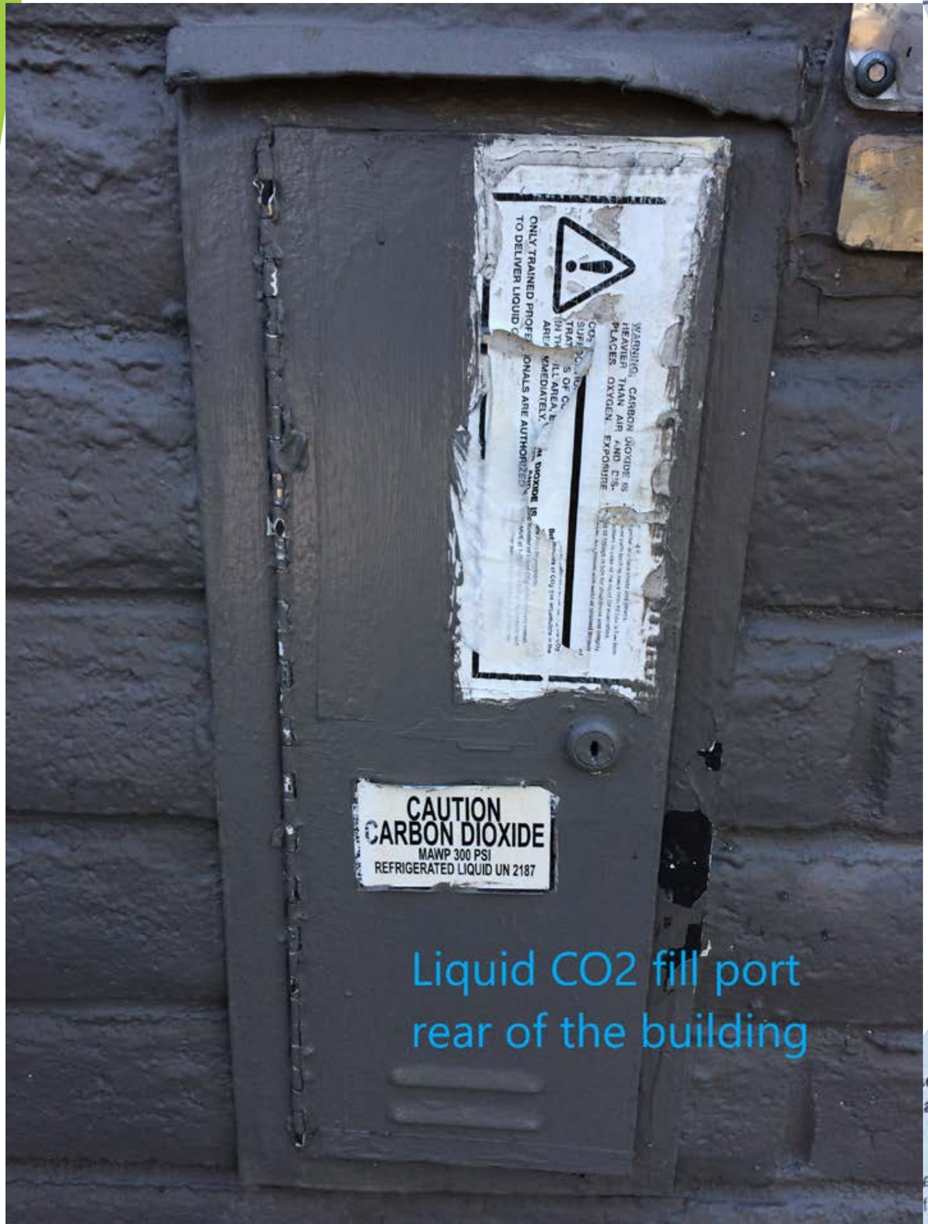
Liquid CO_2 flex piping

NFPA 55 Section 8.14.2.1 – Piping systems shall be designed for the use intended through the full range of pressure and temperature to which they will be subjected.

NFPA 55 Chapter 13 Insulated Liquid Carbon Dioxide Systems
Section 13.4* ~ T rated to -109.3F
Section 13.3.3.2 ~ P rated to 4 times system design pressure

This particular hose is designed to stand 2000psi max pressure

Fill Port



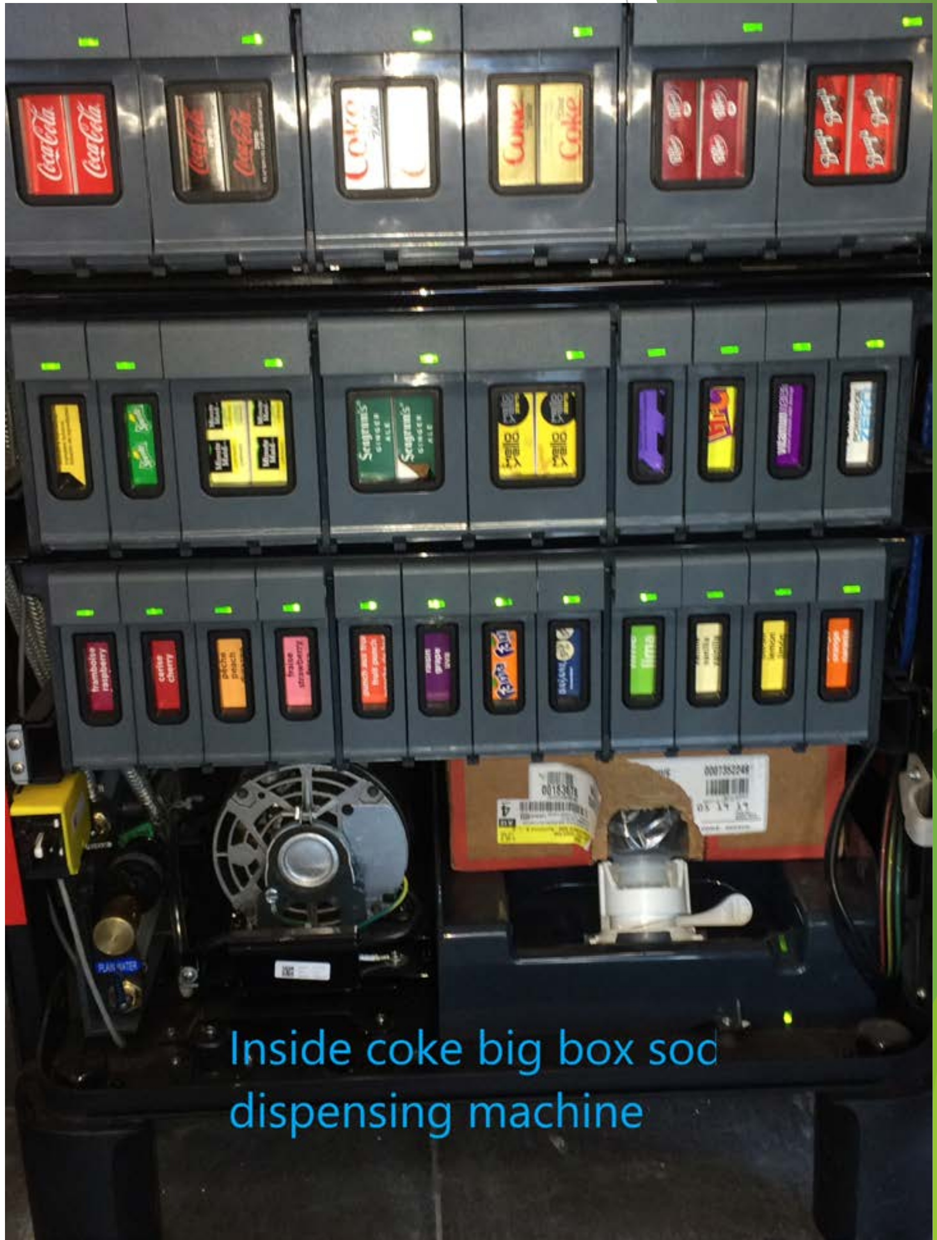
Liquid CO2 fill port
rear of the building

Liquid CO2 Delivery Truck

Tank Syrup Rack and Polisher

Water Polisher Syrup Rack

Soda Machine



NFPA Chapter 53

NFPA 55 Continued – Outdoor install

- **13.7.1.1** Aboveground outdoor locations shall not be provided with a gas detection and alarm system in accordance with 13.6.2 where they system is **unenclosed**
- **13.7.1.1.1** To be considered unenclosed, enclosures constructed to limit access or otherwise provide a visual or architectural barrier for the installation shall be constructed in accordance with the requirements in Section 6.6 for weather protection or with the following.

1) The enclosure shall be constructed without a roof or overhead cover.
2) Supports and walls shall not obstruct more than three sides no more than 75 percent of the perimeter of the storage or use area, with 25 percent of the perimeter being open to the atmosphere.

- **13.7.1.1.2** Enclosures that do not meet the requirements of 13.7.1.1.1 shall be permitted when constructed in accordance with the following:

1. The enclosure shall be constructed without a roof or overhead cover.
2. Continuous mechanical exhaust ventilation shall be provided.

NFPA 55 Continued – Protection & Ventilation

- **13.10.3 Protection from damage.** Carbon dioxide storage tanks, cylinders, piping, and fittings shall be installed so that they are protected from damage by occupants or equipment during normal facility operations
- **13.10.4 Required protection.** Carbon dioxide storage tanks, cylinders, piping, and equipment located indoors, in rooms, and other areas where a leak of carbon dioxide can collect shall be provided with either ventilation in accordance with 13.10.4.1 an emergency ventilation in accordance with 13.10.4.1 OR * (typo) an emergency alarm system in accordance with 13.101.4.2
- **13.10.4.1 Ventilation.** Mechanical ventilation shall be in accordance with the Uniform Mechanical Code and shall comply with all of the following:

1. Mechanical ventilation in a room or area shall be at a rate of not less than 1 cubic ft per min per square foot.
2. Exhaust shall be taken from a point within 12 inches of the floor.
3. The ventilation system shall be designed to operate with a negative pressure in relation to the surrounding area.

Thank You

Alameda County Environmental Task Force