# Saving Lives:

## Lessons and strategies for managing bulk liquid $CO_2$

## Presenter

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## Objectives:

Learn:
- Familiarity with the code development related to carbon dioxide regulation
- Strategies for protecting firefighters and the community
- Best practices for your community

Understand:
- History of bulk carbon dioxide
- Hazards of carbon dioxide
- Which facilities typically utilize bulk carbon dioxide

## History of Carbon Dioxide

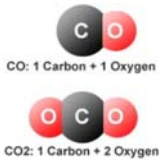
- First used in 1700s
- Steel cylinders
- 20 times volume in liquid form
  - Less labor
  - Fewer deliveries
- 25% storage pressure in liquid form

## Today's Uses of Bulk Liquid $CO_2$

- Beverage dispensing
  - Soda pop
  - Beer
- Slaughterhouses
- Cannabis enrichment / plant growth
- Shield gas in welding
- Fire suppression
- pH balance
- Oil recovery

## $CO_2$ Properties

- Invisible, odorless, 0.04% of our atmospheric breathing air
- Solid, liquid, gas
  - Triple point: 5.1ATM (75psi) < 69˚F
- Non-flammable
- Simple asphyxiant
- Vapor density of 1.53
- BP -109.3˚F : Cryogenic?
- Bulk volume expressed in pounds
- 1 lb liquid $CO_2$ = 8.7719ft$^3$ gaseous $CO_2$
- 1 gal liquid $CO_2$ = 8.47 lb = 74ft$^3$ gaseous $CO_2$

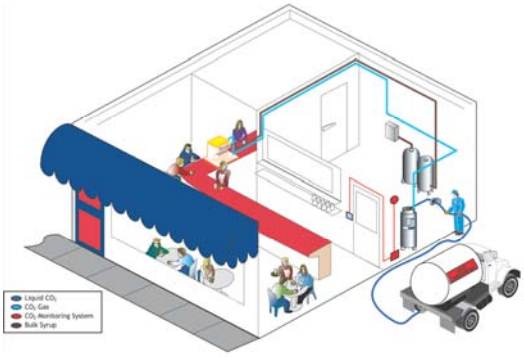



## $CO_2$ Limits

- Atmospheric average = 400ppm
- 1,000ppm limit for offices, classrooms: ASHRAE
- 5,000ppm long-term exposure limit: OSHA TLV-TWA
  - 5,000 /1,000,000 = 0.5% gas molecules per volume=5,000ppmv or ppm
- 10,000ppm drowsiness
- <30,000ppm headaches, dizziness (STEL-TLV 30,000)
- 40,000ppm IDLH
- 80,000ppm death

## $CO_2$ release in a typical small restaurant

- 750lb. x 8.7719 (ft$^3$/lb.) = 6579 ft$^3$ of 100% $CO_2$
  - IDLH is 40,000 PPM or **4%** $CO_2$
  - Just a 2% $CO_2$ concentration can increase RR 50%
- Typical small restaurant ~ 2,500sf
  - 6579ft$^3$ of **100%** $CO_2$ / 3,000sf = $CO_2$ ~ 2.5' up from floor
  - **This tank has the ability to fill store with $CO_2$ above the IDLH.**



## Snohomish 7 CAD Incident Data

Since October 27, 2015 through October 7, 2019 (nearly 4 years)

156 GLI dispatches
- (>5 $CO_2$ incidents) = 3.2% dispatches

229 COA incident dispatches

16 COAM incident dispatches

852 FAC incident dispatches
- (2 Building Fires / 5 cooking fires) = 0.8% dispatches

## Cataloging $CO_2$ Incidents

- Initial Type (Dispatch)
- Final Type (RMS / NFIRS)
- NFIRS Codes
  - 400: hazardous condition, other
  - 420: toxic condition, other
  - 422: chemical spill or leak
- State NFIRS Specialist (Ali Causey) recommends 422: chemical leak
  - Add specific details in the HazMat module

## Bulk Liquid $CO_2$ Code Requirements

- International Fire Code (IFC)
  - Published by the International Code Council (ICC)
- National Board Inspection Code (NBIC)
  - Published by the National Board of Boiler and Pressure Vessel Inspectors (NBBI)
- IFC Interpretation 17-11
  - Published by the Washington State Building Code Council

## IFC Requirements

**SECTION 5307**
**CARBON DIOXIDE ($CO_2$) SYSTEMS USED IN BEVERAGE DISPENSING APPLICATIONS**

**5307.1 General.** Carbon dioxide systems with more than 100 pounds (45.4 kg) of carbon dioxide used in beverage dispensing applications shall comply with Sections 5307.2 through 5307.5.2.

Washington State Building Code Council

STATE BUILDING CODE INTERPRETATION 17-11

## 2015 IFC Requirements

- Operational Fire Permit for > 100lb $CO_2$
  - 105.6.4
- Comply with NFPA 55, Chapter 13 (Compressed Gases and Cryogenic Fluids Code), 2013ed.
  - Pressure relief – piped to outdoors (13.1.1 / 13.1.1.2)
  - Physical protection (13.1.1.1)
  - Pressure and level gauges (13.1.2)
  - Piping system protection (13.1.3)
  - Operating instructions (13.1.5)

## NFPA 55, Chapter 13

- Pressure relief – piped to outdoors (13.1.1 / 13.1.1.2)
- Physical protection (13.1.1.1)
- Pressure and level gauges (13.1.2)
- Piping system protection (13.1.3)
- Operating instructions (13.1.5)
- Indoor areas where filled or used: gas detection and alarm system (13.2.2)
- Initiate audible alarm where system installed (13.2.2.1)
- Initiate local alarm to notify operators (13.2.2.3)
- Warning sign (13.2.3) 8” wide / 6” high

## NFPA 55, Chapter 13, continued

**CAUTION — CARBON DIOXIDE GAS.**
**Ventilate the area before entering.**
**A high carbon dioxide ($CO_2$) gas concentration in this area can cause suffocation.**

## Gas Detection System

IFC (2015) 5307.5:

- Indoor locations where $CO_2$ can accumulate:
  - Ventilation OR emergency alarm system

NFPA (2013) 13.2.2:

- Indoor areas where filled or used: gas detection and alarm system

## Discussion

Scenario:
Carbon dioxide gas piping running through a walk-in cooler.

Question 1:
Is a gas detection system required in the walk-in cooler?

Question 2:
If yes (or no), is an alarm required in cooler?

## Common Findings in Bulk $CO_2$ Occupancies

- Employees not aware of dangers
- Low points not protected with gas detection
- Gas detection not provided in all areas
- Disconnected $CO_2$ alarms
- Disconnected sampling tubes
- Alarms not installed where warranted

Recommend Best Practice on Bulk Liquid Carbon Dioxide Management

Presented by Washington State Pressure Vessel Inspectors and Washington State Association of Fire Marshals $CO_2$ Taskforce

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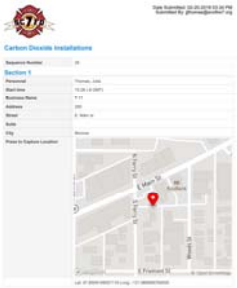
Partnering with Pressure Vessel Inspectors




Inspection captures data for FIRE and for PRESSURE VESSEL INSPECTOR


Automatically sends to local PV inspector upon completion

## Always provide Education to business


## Community Risk Reduction "5 Es"


## Fire Service Best Practices Recommendations

1. Accept that bulk liquid $CO_2$ is a potential hazard
2. Recognize SBCC Interpretation 17-11
3. Adhere to NFPA 55
4. Consider IFC 2018 provisions
5. Partner with Pressure Vessel Inspectors
6. Train firefighters about (b.l.) $CO_2$
7. Us NFIRS incident type 422 (chemical spill or leak) in RMS
8. Train business members about hazards of $CO_2$
9. Train business members about their $CO_2$ alarms
10. Provide inspection personnel with wearable $CO_2$ alarm

## Resources for learning more about liquid $CO_2$

- https://www.youtube.com/watch?v=N_cHcOLcAvE
- https://www.youtube.com/watch?v=93pPQWtCltQ
- https://www.youtube.com/watch?v=Ha3_MFZ_MaM
- https://www.youtube.com/watch?v=eY__H-CMvw0
- https://www.phoenix.gov/firesite/Documents/COMPRESSEDGASALERT.pdf

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