JOINT REGIONAL INTELLIGENCE CENTER

BULLETIN

12 July 2012

(U) Liquid Carbon Dioxide Leaks Can Pose Inhalation Hazard to First Responders and the Public

(U) Within the past year, first responders and members of the public have died of asphyxiation, or fallen ill, following accidental inhalation of concentrated carbon dioxide (CO_2) gas in public locations.[1,2] At least two recent incidents[i] are connected with significant gas leaks caused by the failure of liquid CO_2 lines connected to beverage dispensers in commercial facilities.[ii] Emergency personnel responding to medical or service calls can use signs and symptoms to determine possible CO_2 exposure and correspondent risks to first responders.

(U) Dangers Result from Change in Technology

(U) In the past, compressed CO_2 tanks were generally stored close to the point of use, and connected directly to equipment via short pipes or hoses (lines). New technologies make it possible to store liquid CO_2 tanks at external servicing points, in basements, or other locations far from the point of use, delivering gas via long lines concealed within walls and ceilings. Leaks in these lines can place patrons, employees, and first responders at risk for exposure to the gas.

(U) Leaking liquid CO_2 evaporates into a rapidly expanding gas that is heavier than air; it can displace enough oxygen in small, poorly ventilated rooms, basements, and other low-lying areas to create "Immediately Dangerous Life Hazard" (IDLH) environments.[4] (See the accompanying appendix for specific/technical aspects.) Building codes require sensors near CO_2 tanks to monitor oxygen levels; however, if these are not present along delivery lines, leaks in locations away

(U) Case Study: Phoenix, Arizona[3]

(U) Phoenix firefighters responded to a fast-food restaurant after a pregnant woman fell and could not regain her balance. She was found hyperventilating at the top of a staircase that led to the basement of the establishment. When firefighters entered the basement, they experienced a slight burning sensation in their mouths, but did not notice anything else suspicious. Returning upstairs, one firefighter fell, and both he and a fellow firefighter felt lightheaded. The restaurant was subsequently evacuated, and HazMat personnel were alerted. A site inspection revealed low oxygen levels (17.5 percent, where normal oxygen levels generally reside at 20.9 percent). A gas meter gave a false reading for the area as being nearly 100 percent natural gas. A CO_2 detector was located on site, but it had been disabled while maintenance personnel worked on the system. CO_2 linked to the carbonated beverage system was discovered to be the source of the leak. The Phoenix Fire Department has created a video about this incident.[iii]

[i] (U) Both incidents took place outside the Joint Regional Intelligence Center area of responsibility. Refer to the case study excerpt boxes for more information related to the specific incidents.

[ii] (U) As with other pressurized gasses, CO_2 tanks are vulnerable to explosion if subjected to heat, punctured, or otherwise compromised.

[iii] (U) See Phoenix Fire Department Incident Review video at: http://www.youtube.com/watch?v=eY_H-CMvw0

(U) Law enforcement personnel can report tips and leads to the JRIC via the Web site at www.jric.org, by e-mail at leads@jric.org, or by telephone at (562) 345-1100 or (888) 705-JRIC (5742).

from the tanks may go undetected.[5] Sensors may be susceptible to failure or tampering.

(U) Common Uses, Hazards of Liquid CO_2

(U) CO_2 is a slightly toxic, odorless, colorless gas that has a mildly pungent, acid taste. It is a gas at standard temperature and pressure conditions, but is commonly compressed into a liquid for easier transportation, usage, and cost efficiency. It is commonly utilized in the beverage industry to carbonate and dispense soft drinks, beer, and wine, and to prevent fungal and bacterial growth.[7]

(U) Leaks generally occur when tanks are being refilled, or after high-usage periods, and may not be immediately recognized due to the lack of odor or other indicators. In poorly ventilated, enclosed areas such as basements or bathrooms, the gas can displace oxygen, posing an inhalation hazard to those nearby.[8]

(U) Case Study: Pooler, Georgia[6]

(U) Leaking CO_2 in the restroom of a fast-food restaurant in southern Georgia contributed to the death of an 80-year-old woman, and caused nine others to fall ill. Investigators measured very high levels of CO_2 in the restroom and adjacent walls. A failure in the reinforced plastic tubing that ran through the restroom wall, which connected the establishment's CO_2 tank to the beverage machine, was discovered to be the source of the leak. A total of 10 people, including three firefighters, were sent to the hospital after succumbing to the fumes trapped in the restroom area.

(U) Indicators of Possible CO_2 Exposure

(U) Obvious shortness of breath with visible symptoms will occur as the body compensates for lack of oxygen. The effects of oxygen deficiency, combined with the effects of CO_2 toxicity, may cause an individual to feel ill, potentially showing signs such as headache, nausea, dizziness, or mental confusion.[9,10] Most individuals will begin to show signs and symptoms when exposed to concentrations of CO_2, starting as low as seven percent, for approximately 15 minutes; symptoms may vary according to the level of CO_2 concentration and length of exposure.[11,12]

(U) Signs and symptoms indicating possible exposure to CO_2 include:[13]

- (U) Shortness of breath
- (U) Dizziness
- (U) Headaches and drowsiness
- (U) Stinging of nose and throat
- (U) Nausea and vomiting
- (U) Excitation, excess salivation, rapid breathing
- (U) Confusion
- (U) Unconsciousness
- (U) Frostbite or frozen skin from contact with escaping liquid or vapor cloud[14]

(U) Personal Protective Equipment

(U) High concentrations of gas can be lethal; therefore precautionary measures should be taken to ensure the safety of first responders; follow your agency's guidelines regarding response protocol and equipment. Specialized personal protective equipment (PPE) should be used when entering a situation that could potentially, or is confirmed, to involve a leakage of CO_2. This includes specialized equipment. Persons should not be allowed into the area unless properly trained and equipped until deemed safe by responsible agencies.

(U) Necessary PPE when confronting any CO_2 leak:

- (U) Positive pressure self-contained breathing apparatus (SCBA)

(U) Optional PPE, depending on amount of training:

- (U) Wear full protective clothing (helmet, hood, turnout coat and pants, boots, structure fire gloves)
- (U) If attempting to shut off a leaking liquid CO_2 valve, or touching any part of a liquid leak, must use insulated cryogenic gloves
- (U) Appropriate air monitor to determine density of spill[15]

(U) The lack of CO_2 warning properties heightens the risk for emergency personnel during a CO_2 leak, and may render them susceptible to oxygen deprivation and overexposure to CO_2. Although businesses may follow required building code regulations that permit the utilization of liquid CO_2 tanks for beverage systems, damaged lines or faulty CO_2 sensors may pose a significant threat. Emergency personnel should remain vigilant to the potential dangers that accompany compressed liquid CO_2 systems.

(U) Feedback, Questions, and Reporting

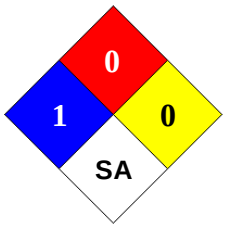
(U) To provide feedback about this product, please complete the online survey.

(U) Please continue to report suspicious activity to the JRIC through leads@jric.org. For comments or questions related to the content of this document, contact the JRIC at (562) 345-1100.

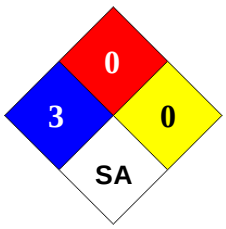
(U) Appendix: CO_2 Technical/Specific Information

- (U) CO_2 is a gas at standard temperature and pressure, and is converted into a liquid for ease of transportation, use and cost efficiency. Liquid CO_2 reverts to a gas upon return to standard temperature and pressure. It expands at a ratio of approximately 1:553, meaning every liter of liquid equates to approximately 553 cubic liters of gas, which can replace oxygen in the air with CO_2, and may result in an oxygen deficient atmosphere.
- (U) CO_2 at a 50 percent concentration can reduce oxygen to a level that is immediately dangerous to life; however, when inhaled, toxic effects begin at concentrations as low as 15 percent.
- (U) The concentration of CO_2 in the atmosphere is around 0.038 percent, or 380 parts per million (ppm). Leaks increase the concentration of CO_2 in the immediate environment, dramatically increasing the potential for adverse health effects among exposed parties.
- (U) CO_2 is not flammable; however, vessels containing carbon dioxide may rupture when heated. If safe to do so, move all carbon dioxide containers away from a fire. Cool containers with water from a protected location to avoid heat damage and excessive increase in pressure. If unable to keep containers cool, evacuate the area.

Interpretation of NFPA Hazard Rating Indices		
Health (Blue)		
4	Danger	May be fatal on short exposure. Specialized protective equipment required
3	Warning	Corrosive or toxic. Avoid skin contact or inhalation - can cause serious injury
2	Warning	May be harmful if inhaled or absorbed
1	Caution	May be irritating
0	-- -- -- --	No unusual hazard under fire conditions
Flammability (Red)		
4	Danger	Readily flammable gas or easily vaporized and extremely flammable liquid
3	Warning	Liquid or solid that will ignite under most ambient conditions.
2	Caution	Liquid or solid that is combustible if moderately preheated or exposed to high temperature
1	-- -- -- --	Combustible if heated significantly
0	-- -- -- --	Not combustible
Instability or Reactivity (Yellow)		
4	Danger	Will readily detonate at normal ambient temperature and pressure conditions
3	Danger	May be explosive if shocked, heated under confinement or mixed with water
2	Warning	Unstable (may violently decompose but not detonate) or may react violently if mixed with water
1	Caution	May react if heated or mixed with water but not violently
0	Stable	Not reactive when mixed with water
Special Fire-related Notices (White)		
~~W~~		**Water** Reactive - Substance poses a potential hazard if water is used for fire fighting
OX		**Oxidizing** Agent - Substance may increase the rate of combustion of other materials
SA		**Simple Asphyxiant** - Substance may cause asphyxiation when in contact



Gas CO_2



Liquid CO_2

(U) National Fire Protection Association (NFPA) Hazard Rating Information is summarized on a diamond-shaped diagram that can rapidly alert personnel to substances that require special vigilance. Hazards are rated from 0 (no unusual hazard) to 4 (severe hazard). Ratings are given for Health, Flammability and Instability (or Reactivity) and displayed in three colored diamonds. A white diamond at the bottom of the diagram is reserved for information on special hazards associated with firefighting - alerting to reactivity with water or significant oxidizing potential. Further information may be obtained online at http://www.uigi.com/msds_intro.html

(U) Endnotes

[1] (U) Jane E. Allen, "Georgia McDonald's Toxic Fumes a Deadly Mystery"; ABC News; 9 September 2011; available at http://abcnews.go.com/Health/georgia-mcdonalds-toxic-fumes-deadly-mystery/story?id=14484014; accessed 2 July 2012.

[2] (U) Phoenix Fire Department, "Phoenix Fire CO_2 Incident Review"; Phoenix Fire Department You Tube Channel; 28 September 2011; available at http://www.youtube.com/watch?v=eY__H-CMvw0; accessed 2 July 2012.

[3] (U) Catherine Holland, "CO_2 Lead Sparks Evacuation at Phoenix McDonald's"; AZFamily.com; 1 June 2011; available at http://www.azfamily.com/news/local/CO2-leak-sparks-evacuation-at-Phoenix-McDonalds-122939268.html ; accessed 2 July 2012.

[4] (U) National Institute for Occupational Safety and Health (NIOSH) CAS number 124-38-9, "Documentation for Immediately Dangerous to Life or Health Concentrations"; Centers for Disease Control; date unknown, but posted at current Web site; available at http://www.cdc.gov/niosh/idlh/124389.html; accessed 2 July 2012.

[5] (U) Federal Technology Alert, "Demand-Controlled Ventilation Using CO_2 Sensors"; Federal Energy Management Program, US Department of Energy; March 2004; available at https://www1.eere.energy.gov/femp/pdfs/fta_co2.pdf; accessed 2 July 2012.

[6] (U) David Beasley, "Carbon Dioxide Lead Blamed for Death at McDonald's in Georgia"; Reuters; 14 September 2011; available at http://www.reuters.com/article/2011/09/14/us-mcdonalds-death-idUSTRE78D7U120110914; accessed 2 July 2012.

[7] (U); "Carbon Dioxide Properties, Uses, Applications: CO_2 Gas and Liquid Carbon Dioxide"; Universal Industrial Gases, Inc.; 2008; available at http://www.uigi.com/carbondioxide.html; accessed 9 July 2012.

[8] (U) "Basic Information on Carbon Dioxide"; Canadian Center for Occupational Health and Safety; 19 February 1999; available at http://www.ccohs.ca/oshanswers/chemicals/chem_profiles/carbon_dioxide/basic_cd.html; accessed 9 July 2012.

[9] (U) "Health Effects of Carbon Dioxide Gas"; Canadian Centre for Occupational Health and Safety; 23 December 1997; available at http://www.ccohs.ca/oshanswers/chemicals/chem_profiles/carbon_dioxide/health_cd.html; accessed 2 July 2012.

[10] (U) Material Safety Data Sheet, "Gaseous CO_2"; Universal Industrial Gases, Inc.; 23 March 2012; available at http://www.uigi.com/MSDS_gaseous_CO2.html; accessed 2 July 2012.

[11] (U) "Health Effects of Carbon Dioxide Gas"; Canadian Centre for Occupational Health and Safety; 23 December 1997; available at http://www.ccohs.ca/oshanswers/chemicals/chem_profiles/carbon_dioxide/health_cd.html; accessed 2 July 2012.

[12] (U) Material Safety Data Sheet, "Gaseous CO_2"; Universal Industrial Gases, Inc.; 23 March 2012; available at http://www.uigi.com/MSDS_gaseous_CO2.html; accessed 2 July 2012.

[13] (U) "Safety Precautions for Carbon Dioxide"; Praxair; 15 August 2009; available at http://catalogs.praxairdirect.com/issue/27114/15; accessed 9 July 2012.

[14] (U); Praxair Material Data Safety Sheet, "Carbon Dioxide, Refrigerated Liquid"; Praxair; 2009; available at http://www.praxair.com/praxair.nsf/AllContent/0B7CAFA656A6D3DE85256A860080D21E/$File/p4573d.pdf; accessed 9 July 2012.

[15] (U) Material Safety Data Sheet, "Gaseous CO_2"; Universal Industrial Gases, Inc.; 23 March 2012; available at http://www.uigi.com/MSDS_gaseous_CO2.html; accessed 2 July 2012.