

# CARBON DIOXIDE CO<sub>2</sub> Safety Awareness

## What is CO<sub>2</sub>?

CO<sub>2</sub> is a toxic gas—not a simple asphyxiant

Carbon dioxide is non-flammable and will not burn, and it is not considered to be an oxidizer in a fire. Carbon dioxide is a common and abundant gas on earth. As of 2015, carbon dioxide had a concentration of approximately 0.04%, or 400 ppm (part per million) in the atmosphere. It is relatively stable and nonreactive in the air. Its concentration is far below the three most common gases in the atmosphere, which are nitrogen (78%), oxygen (20.9%) and Argon (0.8%). It is heavier than air, with a density of ~1.53 times the air mixture of nitrogen, oxygen and argon. Because of this, it tends to collect in low lying areas and can remain there for long periods of time if there is little ventilation.

The molecule carbon dioxide has the chemical formula CO<sub>2</sub> and is made of one atom of carbon covalently bonded to two atoms of oxygen. At the normal range of temperatures on earth (from -60°F to 140°F), carbon dioxide is a gas. It is odorless, tasteless, and colorless, and because of these characteristics, it is considered to have no “warning properties.” That is, an individual being exposed is unable to detect it without doing chemical testing; in other words, humans have no way to detect its presence.

## Symptoms of Overexposure

CO<sub>2</sub> is odorless, tasteless, and colorless, there is no indication that it is even there

Symptoms of overexposure by inhalation include but are not limited to dizziness, headache, nausea, rapid breathing, shortness of breath, deeper breathing, increased heart rate (tachycardia), eye and extremity twitching, cardiac arrhythmia, memory disturbances, lack of concentration, visual and hearing disturbances (including photophobia, blurred vision, transient blindness, hearing loss and ringing in the ears), sweating, restlessness, vomiting, shaking, confusion, flushed skin, panic, parathesis (a sensation of numbness in the extremities), disorientation, convulsions, unconsciousness, coma, and death.

Concentrations as low as 1,000 ppm impair thinking, concentration and logical thought processes.

At a concentration of 5,000 ppm (0.5%), the International Space Station crew experienced headaches, lethargy, mental slowness, emotional irritation, and sleep disruption, even though oxygen concentrations were maintained at 20.9%.

Several studies have demonstrated that breathing concentrations of 30% carbon dioxide, even with 70% oxygen, leads to unconsciousness in 30 seconds.

According to the EPA,

- Exposure of humans to carbon dioxide concentrations ranging from 17% to 30% quickly (within one minute) leads to the loss of controlled and purposeful activity, unconsciousness, coma, convulsions, and death.
- Exposure to concentrations from greater than 10% to 15% carbon dioxide leads to dizziness, drowsiness, severe muscle twitching, and unconsciousness within a few minutes.
- Exposure to a concentration of 6% carbon dioxide can produce hearing and visual disturbances within 1 to 2 minutes.

Even in the presence of normal concentrations of oxygen, death will occur in only 5 minutes at exposures of 7% carbon dioxide.(NIOSH)

At a concentration of only 2,500 ppm for 2.5 hours, most measured cognitive functions were impaired to the extent that the individuals were rendered cognitively marginal or dysfunctional. The functions measured included task orientation, initiative, information usage, and use of basic strategy.

This study demonstrates that exposure levels as low as 1,000 ppm adversely impacts judgement, decision-making ability, and thinking skills on a short-term basis, even for healthy individuals.

When there is exposure to very high levels of CO<sub>2</sub>, in excess of 5% (50,000 ppm), the body's compensatory mechanisms can become overwhelmed, and the central nervous system (brain and spinal cord) functions are depressed, and then fail. Death soon follows.

## Know Your Process!

Recognize the hazards

Carbon dioxide is approximately 50% heavier than air and tends to sink. Limited ventilation can allow carbon dioxide to reach very hazardous concentrations. Although carbon dioxide is heavier than air, warm or heated CO<sub>2</sub> rises and floats away. It can then travel to remote locations as it cools, collecting in unsuspected areas, depending upon air temperature, wind direction and speed.

Recognize where carbon dioxide can accumulate – especially during different processes, seasons and weather conditions.

Many areas exist where under the right conditions, CO<sub>2</sub> can reach very high levels in a brief amount of time. Hazard assessments are critical for evaluating where CO<sub>2</sub> can collect.

The legal exposure limit set by OSHA has not been updated since 1970, and is 5,000 ppm averaged over an 8-hour workday, with the subsequent 16 hour having no exposures above fresh air concentrations and exposures totaling 40 hours per week. Under no circumstances should the CO<sub>2</sub> level be higher than this.

## Be Safe

Use Monitors to Detect CO<sub>2</sub> Levels

Many different types of equipment are available to detect the presence of carbon dioxide, from levels that exceed background up to levels that exceed life-threatening concentrations. The electronic monitors are the fastest, the most reliable and the most accurate. These include portable single gas monitors that can be worn or hand held, portable multi-gas monitors that are excellent for confined space entry and other uses, and single-gas, stationary CO<sub>2</sub> monitors that can give an audible alarm, flashing lights and also be tied in to a computer remotely to inform workers when an area of the facility exceeds a set threshold level of CO<sub>2</sub>.



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