

Before you begin

To understand the health effects, signs, and symptoms of carbon monoxide (CO), review the material as well as the resources. Become familiar with potential sources within your facility. CO is a chemical asphyxiant that will displace oxygen and could result in mild or severe symptoms, including death, depending on level of exposure.



Introduction

According to the Centers for Disease Control and Prevention (CDC – March 2020), each year in America unintentional CO poisoning claims more than 430 lives and sends another 50,000 people to hospital emergency rooms for treatment. CO comes from incomplete combustion from gasoline, wood, propane, charcoal or other fuel. Improperly ventilated appliances and engines, particularly in a tightly sealed or enclosed space, may allow carbon monoxide to accumulate to dangerous levels. Common work-related sources include propane-powered industrial trucks, cracked heat exchangers, water/space heaters, gas-fired furnaces, and other processes such as welding. CO is harmful when inhaled because it displaces oxygen in the blood and deprives the heart, brain, and other vital organs of oxygen. Large amounts of CO can overcome you in minutes without warning – causing you to lose consciousness and suffocate. Because it is impossible to see, taste, or smell, CO can kill you before you are aware it is even present.

Definitions

Carbon monoxide (CO) – an odorless, colorless, and tasteless gas.

ppm – parts per million, a measurement of the mass of a chemical or contaminant per unit volume of air.

Occupational Exposure Limits (OELs) – airborne concentrations of substances that represent conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse health effects.

Chemical asphyxiant – an agent that prevents the delivery of oxygen (O₂) from the bloodstream to cells. For example, hemoglobin, which carries oxygen in the blood, has a greater affinity to CO than oxygen.

Ototoxin – refers to a drug or chemical agent which may cause damage to the inner ear, resulting in damage to the organs responsible for hearing and balance.

Discussion

Symptoms can vary widely from person to person. CO poisoning may occur sooner in those most susceptible: young children, the elderly, people with lung or heart disease, people at high altitudes, or those who already have elevated CO blood levels, such as smokers. Also, CO poisoning poses a special risk to unborn children.

Symptoms of carbon monoxide poisoning

	Concentration (ppm)
• Headaches (mild)	70 or (200 in 2 to 3 hours)
• Headaches (severe)	400 in 1 to 2 hours
• Fatigue/Muscle Weakness	70 or (200 in 2 to 3 hours)
• Drowsiness/Dizziness	70 or (200 in 2 to 3 hours)
• Confusion	70 or (200 in 2 to 3 hours)
• Nausea or vomiting	70 or (200 in 2 to 3 hours)
• Shortness of breath	150
• Sudden chest pain (may occur in people with angina)	150
• Blurred vision	150
• Loss of consciousness	150 to 1500 (within 1 hour)
• Death	150 to 1500 (within 1 hour)

Note: CO is a known ototoxin. Research demonstrates exposure to these chemicals may cause hearing loss or balance problems, regardless of noise exposure. Substances including certain pesticides, solvents, and pharmaceuticals that contain ototoxins can negatively affect how the ear functions, causing hearing loss, and/or affect balance. The risk of hearing loss is increased when workers are exposed to these chemicals while working around elevated noise levels. To learn more about ototoxins, cross-reference [“Preventing Hearing Loss Caused by Chemical \(Ototoxicity\) and Noise Exposure” NIOSH Publication # 2018-124](#).

Note: Due to sensor reliability, home CO detectors may be adequate for office settings but are not designed for industrial settings. Selection of a CO detector should be based on the environment it will be placed and the limitations of the sensor. Manufacturer’s literature or websites often provide details on the detectors and sensors to assist in selection.

In the event of an accidental over-exposure, follow the precautions described below:

1. Evacuate all occupants immediately.
2. Determine how many occupants are ill and determine their symptoms.
3. Call your local emergency number and when relaying information to the dispatcher, include the number of people feeling ill.
4. Do not re-enter the facility/home without the approval of a fire department representative.
5. Call a qualified professional to repair the source of the CO.

Preventing CO exposures

To reduce the chances of CO poisoning in the workplace, employees and employers should take the following additional actions:

- Promptly report complaints of dizziness, drowsiness, or nausea.
- Ensure proper ventilation in the workplace that will remove CO from work areas. This may include natural ventilation (NV) such as opening windows and doors, general ventilation (GV), or local exhaust ventilation (LEV). Make sure equipment has a clearance of 3 to 4 feet on all sides and above to ensure adequate ventilation.
- Conduct preventative maintenance (PM) on equipment and appliances (e.g., forklifts, furnaces, heaters, space heaters, gas-powered backup generators, etc.) that can produce CO and maintain in good working order.

- Substitute propane or gasoline-powered equipment for equipment powered by electricity, batteries, or compressed air, if it can be used safely.
- Prohibit the use of propane or gasoline-powered engines or tools in poorly ventilated areas.
- Install industrial CO detectors with audible alarms if applicable. Install at least one carbon monoxide alarm with an audible warning signal near areas where generation of CO is likely (i.e., Furnaces). Follow manufacturer's recommendations for the CO instruments. Ensure that the alarm has been evaluated by a nationally recognized laboratory, such as the Underwriters Laboratories (UL). CO alarms measure levels of CO over time and are designed to sound an alarm before a healthy adult would experience symptoms. It is very possible that you may not be experiencing symptoms when you hear the alarm. This does not mean that CO is not present.
- Educate workers about the sources and conditions that may result in CO poisoning as well as the symptoms and control of CO exposure.
- If you experience symptoms of CO poisoning, get to fresh air right away and seek immediate medical attention.
- Inform your doctor that you may have been exposed to CO if you get sick.

What actions do I take if my carbon monoxide alarm goes off?

What you need to do if your carbon monoxide alarm goes off:

1. Silence the alarm.
2. Turn off all sources of combustion (i.e. PITs, furnaces, etc.)
3. Ventilate the space/area with fresh air by opening doors/windows to increase natural ventilation.
4. Call a qualified professional (safety professional/industrial hygienist) to investigate the source of the possible CO buildup.

Occupational Exposure Limits (OELs)

OSHA-PEL = 50 ppm (regulatory standard)

ACGIH-TLV® = 25 ppm (**best practice/recommended**)

NIOSH-REL = 35 ppm

The OSHA PEL of 50 ppm does not reflect the most current scientific research. Therefore, best practice dictates adhering to the ACGIH TLV of 25 ppm or EPA guidelines for Indoor Air Quality (IAQ) of 9 ppm for office settings.

Conclusion

Incorporating the best practices above will go a long way in preventing injuries and fatalities resulting from exposures to carbon monoxide. Implementing effective employee training, hazard identification, and hazard correction in the workplace are necessary for a safe work environment.

Group activity

Brainstorm and ask employees to look for potential CO sources in their work areas in addition to their homes. Schedule time for a group discussion of their findings and solutions they proposed for each identified concern. Conduct a follow-up inspection to verify the corrective actions have been completed.

Resources

[OSHA: Carbon Monoxide Poisoning Fact Sheet](#)

[OSHA: Quickcard – Protect yourself from carbon monoxide poisoning](#)

[Ohio Department of Health: Carbon Monoxide Poisoning](#)

[CDC: Carbon Monoxide Poisoning](#)

[The National Safety Council: Carbon Monoxide – The Invisible Killer](#)

[United States Consumer Product Safety Commission – Carbon Monoxide Questions and Answers](#)