Carbon Monoxide (CO)

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What is it?

Carbon monoxide (CO) is an odorless, colorless, and tasteless toxic gas that is not easily detected. It is often mixed with other gases that do have an odor. CO is produced by the incomplete burning of any material containing carbon, such as gasoline, natural or liquefied petroleum gas, oil, coal, or wood.

Where carbon monoxide is found

CO may be found in the following locations:

- Operations involving internal combustion engines. This includes non-electric forklifts, floor buffer/burnishers, pressure washers, concrete cutting saws, and generators. Operation of fossil-fueled equipment or tools indoors or in semi-enclosed spaces can cause the gas to rapidly build up to dangerous levels.
- In close proximity to engine exhaust (even outdoors)
- Rooms with improperly vented heating devices
- Compressed air when the air intake source is contaminated, when the compressor has overheated, or when excess oil is being used by the compressor
- Any work area of buildings where fresh air intake may pick up exhaust gases
- Welding operations
- Cigarette smoke

Prime occupational areas of concern are automotive garages, welding shops, parking structures, toll booths, around docks, near furnaces in foundries, and in interior building areas/temperature controlled rooms with forklift operations or other internal combustion powered devices (gas powered floor buffers, generators, etc.), abrasive blasters using gasoline fueled compressors, or oil-lubricated electrical compressors without proper filters and monitoring devices.

How carbon monoxide is harmful

CO inhalation interferes with the uptake of oxygen. CO combines reversibly with the oxygen-carrying sites on the hemoglobin molecule in the blood. CO has an affinity for the hemoglobin molecule ranging from 210 to 240 times that of oxygen. When carboxyhemoglobin forms, it prevents oxygen from being transported on that specific hemoglobin molecule to the body's tissues and organs.

Smokers have significantly higher carboxyhemoglobin levels than nonsmokers who are not exposed to other sources of CO. Smokers' carboxyhemoglobin levels will vary from 4% to 20%. The average for a one-pack-per-day smoker is 5% to 6%. A nonsmoker, who is not otherwise exposed to CO, should not show levels above 1% unless they are living in areas with heavy vehicle traffic. Commuters in heavy traffic may develop carboxyhemoglobin levels of 5%.

CO exposure levels can be correlated to the carboxyhemoglobin levels from an employee’s blood. ***If CO poisoning is suspected, it is important to seek medical treatment and obtain a blood carboxyhemoglobin test as soon as possible. Timing is crucial as CO is reduced by 50 percent in the blood in only five hours by breathing normal air.***

Health effects of carbon monoxide exposure

CO effects vary in different body systems, but the cardiac and central nervous systems (CNS) are particularly sensitive. Although many of signs and symptoms of CO exposure are non-specific and can be mistakenly attributed to other causes, most of the actual symptoms an individual shows are related to the CNS effects. High concentrations affect the heart and are usually responsible for CO poisoning deaths.

The general symptoms may include: headache, rapid respiration, weakness, dizziness, fatigue, drowsiness, dimness of vision, mental confusion, nausea, and vomiting. The effects of CO are aggravated by heavy labor, high ambient temperature, and altitudes above 2,000 feet. Pregnant women are particularly susceptible to the effects of CO because of the increased oxygen demands of the fetus. Because CO carrying hemoglobin has a bright red color, occasionally some individuals will exhibit bright red color of the fingernails, mucous membranes, and skin.

Occupational exposure limits

The Oregon OSHA Permissible Exposure Limit (PEL) for CO is 50 parts per million (ppm) as an eight-hour Time Weighted Average (TWA). Excursions in the employee exposures may exceed three times the PEL for no more than a total of 30 minutes during an eight-hour workday. Under no circumstances should exposure exceed five times the PEL, or 250 ppm, provided that the PEL-TWA is not exceeded.

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a Threshold Limit Value (TLV) as an eight-hour TWA of 25 ppm. Excursions in employee exposures may exceed three times the TLV for no more than 30 minutes during a workday, and under no circumstances should exposures exceed five times the TLV, or 125 ppm, provided that the TLV–TWA is not exceeded.

The TLV is intended to maintain blood carboxyhemoglobin levels below 3.5%, to minimize the potential for adverse neurobehavioral changes, and to maintain cardiovascular work and exercise capacities. This limit should also provide a margin of safety for individuals particularly susceptible to the adverse effects of CO exposure, including pregnant employees (and the fetus) and those with chronic heart and respiratory diseases.

The National Institute for Occupational Safety and Health (NIOSH) has set a Recommended Exposure Limit (REL) of 35 ppm for up to a 10-hour workday during a 40-hour work week. NIOSH has set a ceiling REL of 200 ppm not to be exceeded at any time.

Testing for carbon monoxide exposure levels

Air monitoring can be done in several ways, including:

1. Colorimetric or detector tubes can be used to get an estimate of airborne concentrations. It is important to note the limitations of this method. Colorimetric tubes are regarded as +/- 35 percent accurate with measurements down to one half the exposure limit and +/- 25 percent accurate up to five times the exposure limit. (Precaution: Diesel exhaust gases interfere with some colorimetric tubes.)
2. Direct reading instruments equipped with specialized sensors or integrating meters can be set up to record CO levels over long time periods to determine the eight-hour average readings. The instruments can also be used to determine the ceiling exposure levels. Careful calibration and equipment maintenance is necessary when using these instruments.

Recommendations

1. Provide sufficient ventilation in the work area to reduce the concentration of CO to safe levels. Do not allow gasoline or propane powered engines or tools in poorly ventilated areas.
2. Substitute gasoline or propane powered forklifts and tools with equipment that can be safely powered by electricity, batteries, or compressed air, especially when used indoors.
3. Propane powered vehicles must have their carburetor properly adjusted and the catalytic converter operating correctly or they will produce as much CO as a gas powered vehicle.
4. Tune the carburetor (air-fuel ratio) of equipment engines for complete combustion or minimum CO emission (lean mixture).
5. In buildings, all oil, gas, or wood stoves must be properly exhausted outside.
6. Where compressed air is used for ventilation or breathing air, the air intake lines on compressors must be well separated from the exhaust stack or other contaminants to prevent drawing these gases into the compressor.
7. Oil-lubricated compressors used for breathing air in respirators must use a high-temperature or CO alarm, or both. If only high-temperature alarms are used, the breathing air must be monitored at intervals sufficient to prevent CO levels from exceeding 10 ppm.
8. Educate employees about the symptoms of CO overexposure as well as sources or conditions that may lead to excessive exposure.
9. Conduct air sampling regularly in areas where CO may be present or install a reliable sensor/alarm system to monitor levels.

Resources

Oregon OSHA Topic Page: Carbon monoxide
http://osha.oregon.gov/Pages/topics/carbon-monoxide.aspx

CDC/NIOSH Workplace Safety & Health Topics: Carbon Monoxide
http://www.cdc.gov/niosh/topics/co-comp/