



Carbon Monoxide (CO)

What It Is

Carbon monoxide (CO) is an odorless, colorless and tasteless toxic gas. Due to its properties, you may not have any immediate sense of its presence. However, it is often mixed with other gases that do have an odor. It is produced by the incomplete burning of any material containing carbon, such as wood, gasoline, natural or liquefied petroleum gas, oil, coal, or wood.

www.saif.com/employer

- ▶ Safety
- ▶ Safety & health guides

SS-413

last updated

November 2009

© SAIF Corporation

This publication provides practical loss control and safety information to assist you in making your workplace safer. It is not legal advice. SAIF Corporation has made every effort to bring significant Oregon Occupational Safety and Health Administration (OR-OSHA) regulations to your attention. Nonetheless, compliance with OR-OSHA remains your responsibility. You should read and understand all relevant OR-OSHA regulations that apply to your job site(s). You may want to consult with your own attorney regarding aspects of OR-OSHA that may affect you.

Note: The information in this publication is time sensitive. Do not rely upon this document if its publication date is more than three years old. Please check the Employer Guide "Safety" section of our web site at www.saif.com/employer for a more recent, printable copy. You'll also find a variety of other valuable safety information designed to help your business prevent injuries and control costs.

Where Carbon Monoxide Is Found

Carbon monoxide may be found in the following locations:

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

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

How CO 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 percent. The average for a one-pack-per-day smoker is 5 to 6 percent. A nonsmoker, who is not otherwise exposed to CO, should not show levels above 1 percent unless they are living in areas with heavy vehicle traffic. Commuters in heavy traffic may develop carboxyhemoglobin levels of 5 percent.

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% 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 system (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 OR-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 tubes or direct reading tubes can be used to get an estimate of the eight-hour averages and for the ceiling exposure level. 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 carbon monoxide to safe levels. Do not allow gasoline or propane powered engines or tools in poorly ventilated areas.
2. Change the equipment to reduce or eliminate carbon monoxide emissions. Substitute electric powered forklifts and tools for gasoline or propane powered equipment. This is extremely important in temperature controlled or unventilated spaces. (Propane powered vehicles must have their carburetor properly adjusted and the catalytic converter operating correctly or they will produce as much carbon monoxide as gas powered.)
3. Tune the carburetor (air-fuel ratio) of the engine for complete combustion or minimum carbon monoxide emission (lean mixture).
4. In buildings, all oil, gas or wood stoves must be properly exhausted outside.
5. 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.

6. Compressors for breathing air should be carbon vane pump specially designed for respirator use. Such pumps are electric or air-driven, oil-free, and are equipped with inlet and outlet filters. If oil lubricated compressors are used, a charcoal filter must be used in the airline and it must have a high temperature or carbon monoxide alarm, or both. If only a high temperature alarm is used, the breathing air must be frequently tested for carbon monoxide.
7. Educate employees about the symptoms of CO overexposure as well as sources or conditions that may lead to excessive exposure.
8. Conduct air sampling regularly in areas where CO may be present or install a reliable sensor / alarm system to monitor exposures.

Resources

Copies of the Oregon Occupational Safety and Health Division (OR-OSHA) regulations are available on the web or contact OR-OSHA at 503.378.3272.
<http://www.cbs.state.or.us/external/osha/>

OR-OSHA Hazard Alert: Carbon Monoxide Poisoning From an Internal Combustion Engine
http://www.cbs.state.or.us/external/osha/pdf/hazards/2993_11-2005_carbon-mon.pdf

Federal OSHA Fact Sheet on Carbon Monoxide
http://www.osha.gov/OshDoc/data_General_Facts/carbonmonoxide-factsheet.pdf

Federal OSHA "Quick Card" Protect Yourself: Carbon Monoxide Poisoning
English:
http://www.osha.gov/OshDoc/data_Hurricane_Facts/carbon_monoxide.pdf

Spanish:
http://www.osha.gov/OshDoc/data_Hurricane_Facts/carbon_monoxide_sp.pdf

NIOSH Alert: Preventing Carbon Monoxide Poisoning from Small Gasoline-Powered Engines and Tools
<http://www.cdc.gov/niosh/cofact1.html>