

CARBON MONOXIDE (CO)

Carbon monoxide (CO) is a colorless, odorless, and tasteless gas with no warning properties.

SOURCES

CO is generated environmentally in combustion processes due to incomplete oxidation of carbon and carbonaceous fuels. Common sources of CO indoors are: fuel-powered vehicles such as fork lift trucks, poorly ventilated or malfunctioning heating furnaces, fuel-powered equipment, and welding.

PERMISSIBLE EXPOSURE LIMITS

General Industry:

35 ppm as 8-hour, time weighted average

200 ppm as Ceiling

No Short Term Exposure Limit (STEL) established

Construction (Standard Industrial Classification Codes 15-17):

50 ppm as 8-hour, maximum allowable concentration

TOXIC EFFECTS

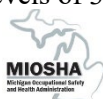
CO poisoning occurs by inhalation. CO binds tightly to hemoglobin in blood to form carboxyhemoglobin (COHb) thereby reducing the oxygen-carrying capacity of the blood. Exposures can be determined by measuring concentrations of CO exhaled in air or COHb in blood.

CO does not accumulate in the body. Once an exposure ends, the lungs exhale CO and COHb reverts back to oxyhemoglobin, the form of hemoglobin that can carry oxygen. Half of the CO in the blood will be removed in approximately 5 hours. This half-life can be reduced by breathing pure oxygen or using a hyperbaric chamber.

COHb can occur in normal humans. A COHb level in blood of 1%-3% would be normal in a non-smoker. Heavy smokers may have levels of 5%-10%.

The symptoms resulting from CO exposure depend on concentration in air and duration of exposure. Early symptoms of CO exposure are nonspecific: headache, dizziness, weakness, nausea, visual disturbances, and confusion. The poor warning properties of CO may allow exposure to continue. Improvement of symptoms upon exposure to fresh air and the absence of a sore throat or fever can distinguish CO poisoning from the flu. Symptoms may not develop until the CO concentration exceeds the permissible exposure limits.

COHb levels in the blood of 10-20% causes tightness around the forehead, possible slight headache, and an increase in size of blood vessels at the skin. COHb levels of 20-30% result in headache and throbbing in the temples. Individuals can experience severe headaches, weakness, dizziness, dimness of vision, nausea, vomiting and even collapse at COHb levels of 30-40%. Fainting, increased respiration and pulse,



coma with intermittent convulsions and irregular heart action and respiration occur at COHb levels of 50-60%. COHb levels of 60-70% may end in coma and possible death; whereas, COHb levels of 70-80% usually end in a weak pulse, respiration and death.

Concentration in the air of 200 ppm or greater of CO can cause headaches and nausea after a few hours and can become dangerous. Air concentrations of CO above 1200 ppm can cause rapid collapse and possibly death.

EXPOSURE CONTROL METHODS

Depending on the source of CO, any or all of the following control methods should be used to reduce the exposure:

1. Provide general and/or local exhaust ventilation along with tempered make-up air to prevent backdrafting of fuel fired equipment. The Industrial Ventilation Manual published by the American Conference of Governmental Industrial Hygienists addresses ventilation designs for specific purposes.¹ Ventilation requirements are also specified in some existing standards such as those for tunnels, permit-required confined spaces, spray booths and more.
2. Inspect and maintain fuel fired equipment on a periodic basis.
3. Install carbon monoxide alarms in those areas which may have reoccurring, dangerous carbon monoxide concentrations.

The following measures can be used to reduce employee exposure to CO from the exhaust of fuel-powered fork lift trucks.

- A. Tune engines for the lowest possible CO concentration.
- B. Utilize catalytic converters that remove most of the CO and other toxins from the exhaust, if applicable for the type of lift truck used.
- C. Shut off engines when not in use.
- D. Provide general dilution ventilation if local exhaust ventilation is not feasible. See the Industrial Ventilation Manual published by the American Conference of Governmental Industrial Hygienists for specific ventilation rates.
- E. Utilize CO detectors and meters to monitor employee work areas. The monitors may be fitted with alarms and can be connected to exhaust systems.
- F. Replace fuel-powered hi-lo trucks with electric ones when possible. This will eliminate the measures recommended above.

¹[American Conference of Governmental Industrial Hygienists](#), 6500 Glenway Ave / Bldg. D-7, Cincinnati, Ohio 45211-4438. (513) 661-7881.

When compared to fuel-powered trucks, they represent larger initial investment but lower maintenance costs, longer service life and lower energy costs. (An eyewash and personal protective equipment like goggles, gloves, and eyewear and dilution ventilation would be required in the battery recharging area).

TRAINING

Train employees to recognize the beginning health effects of CO exposure, sources of CO, and on the measures to protect themselves from exposure.

MONITORING

CO can be monitored continuously throughout the workshift with direct-reading instruments to determine an 8-r, TWA. Colorimetric detector tubes can be used for estimating concentration, inexpensively. An 8-hour, time-weighted average can be determined with a CO specific dosimeter.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Engineering controls are the preferred way to reduce and control the hazard. Supplied-air respirators or self-contained breathing apparatus may be used for operations that require entry into tanks, closed vessels or for emergency situations. (See Permit-Required Confined Spaces, R 325.63001-325.63049).

FIRST AID

Move exposed persons into fresh air and summon a physician. Give artificial respiration if breathing has stopped.

Note: This guide is intended for the benefit of the public and may not contain all of the information pertinent to a specific hazard identification and/or control of personal exposure. For further information consult the Consultation Education and Training Division at:

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