



Carbon Monoxide A Silent Killer

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by Richard D. Seifert
Energy & Housing Specialist

You can't see it. You can't smell it. But you can be warned.

This guide focuses on promoting awareness of carbon monoxide poisoning. Since most cases of carbon monoxide (CO) poisoning occur in the home, most information is geared towards homeowners, renters and landlords. Even at low concentrations, CO can build up in the blood over time. Prolonged exposure to low levels of CO can be just as dangerous as short-term exposure to higher levels.

Carbon monoxide is the leading cause of poisoning in the United States, and during the 1990s Alaska had the highest death rate from CO in the country.¹ CO poisoning is the second leading cause of accidental death in the U.S. after motor vehicle crashes, making carbon monoxide the number one source of preventable accidental death in the U.S.

Americans spend 90 percent of their time indoors, where CO poisoning is most likely. In urban areas, Alaska also has high outdoor winter CO concentrations that can increase the risk of poisoning. CO poisoning is especially dangerous in the home because that is where we sleep, so a problem may not be noticed until it's too late. This guide will give you the tools you need to keep you and your family safe from the most common and insidious poison we encounter.

Recently a client related a story of a brush with carbon monoxide. The story she shared was a common Alaska adventure gone wrong. The woman and her husband had driven to their weekend cabin. Upon arriving late, they built a fire in the woodstove and went to sleep. The husband woke up several hours later, dizzy with the worst headache he had ever had. Recognizing the symptoms of carbon monoxide poisoning, he woke up his wife and got her outdoors. Both were having severe symptoms of weakness and confusion. Alarmed at how ill they

felt, they took turns driving back to Fairbanks and checked into the hospital.

Blood samples taken revealed high carboxyhemoglobin blood levels. Both patients were put on oxygen and recovered. These two people were lucky to have awakened. The source of the carbon monoxide was an improperly drafting woodstove.

Who is at risk?

Everyone is at risk, but some people are more sensitive. Pregnant women, infants, the elderly, smokers, persons with heart, respiratory ailments or anemia are more susceptible. Smokers may have normal carboxyhemoglobin levels as high as 10 percent, making them more susceptible to poisoning. Most fatalities from CO are children. Since the blood absorption rate for CO increases with altitude, climbers and pilots are at a greater risks. CO detectors are sold at aviation stores and are commonly placed on airplane instrument panels. Individuals who work in enclosed areas, where CO-producing machinery is used, are at greater risk because ventilation may not be adequate and exercise increases the rate of poisoning.

What is carbon monoxide and where does it come from?

Carbon monoxide is a colorless and odorless gas. Because we can't see, smell, or taste it, CO can affect you or your family before you even know it's there. CO is classed as an inorganic compound and is deadly because the oxygen-carrying hemoglobin prefers CO 210 times more than oxygen. CO in the bloodstream causes loss of oxygen to the body, but also results in subcellular damage, which is much more catastrophic than just being short on oxygen.

Carbon monoxide typically comes from incomplete combustion of carbon-based fuels. Since almost every combustion appliance in the home produces some CO, ventilation must be provided to both living areas and combustion equipment. Therefore, the most important action to take in preventing CO buildup is to properly maintain all fuel-burning

¹Paulozzi, L, MD et al. "Unintentional Poisoning Deaths-United States, 1999-2004." J. Am. Med. Assn. 2007.

appliances by making sure they are venting correctly. Get your boiler or furnace looked at every year, and clean your stove or other fuel-burning appliance regularly. Have your service technician operate your exhaust fan and dryer or other venting appliance while all of the heating appliances in the house are running to make sure no exhaust gases are being sucked out of the appliance and into the living or working space. Use exhaust fans and range hood vents when cooking with fossil fuels.

Attached garages are also a commonly seen source of CO in the home. The state of Alaska lists the following table of carbon-based, and thus potential CO-forming fuels.

Wood	Stove Oil	Natural Gas
Charcoal	Waste Oil	Propane
Coal	Kerosene	Methane
LPG & LNG (gas)	Gasoline	Diesel

At work, the leading cause of CO poisoning is from generators. Be extremely careful that exhaust is piped far away from work locations, and ensure an exhaust catalyst is used whenever possible.

In general, the higher the carbon content of a fuel, the hotter it must burn to avoid CO production. Charcoal and coal have high concentrations of carbon. Extreme care should be used when burning charcoal or coal. Dark smoke, creosote, or particulate matter are indicative of incomplete combustion but do not necessarily mean that CO is present in the conditioned space, e.g., the living area.

Most fuel-burning appliances, if properly maintained, produce little CO. The small amount produced by fuel-burning appliances is usually vented to the outdoors. However, if anything results in decreased oxygen to the burn chamber, or obstructs the chimney such as a bird's nest or clogged stovepipe, CO can back up into a house.

Propane ovens often cause CO problems. Whenever a propane stove or oven is used, the range hood exhaust fan should be on. Never block the air supply to a propane oven. CO is also produced by generators, forklifts, etc. and if used in a poorly ventilated space, even outside, CO concentrations can get high enough to cause major injury or death.

What are the symptoms?

Table 2 equates the concentration of CO in the air that the victim is breathing with the built-up levels of carboxyhemoglobin, or red blood cells that have

attached to CO, and the physical symptoms that accompany this condition. If you suddenly feel light-headed, nauseous, and have a very bad headache, you should remove yourself from your surroundings immediately and then contact a medical professional.

Carbon monoxide and the law

Alaska Statute 18.70.095, which deals with both smoke detectors and carbon monoxide detectors, states:

“... carbon monoxide detection devices shall be installed and maintained in all qualifying dwelling units in the state.” Any housing unit with an attached garage or installed fuel-burning appliance is covered by this law.

The law requires that CO monitors “must have an alarm, and shall be installed and maintained according to the manufacturer’s recommendations.”

In the case of rentals, the landlord must supply the detector, and the tenant is obligated to maintain the detector, test it regularly and not disable it. If someone dies or is injured in a rental where the landlord didn't supply a working CO detector, it can be considered negligence and the landlord could be liable for punitive damages.

Detectors

Unless you get your heat from a district heating system or electricity and don't have an attached garage or gas cookstove, you should have a CO detector in your home. If you operate machinery at work and think you may be exposed to carbon monoxide, you should consider using a personal CO detector badge.

For the home, a detector with an alarm is a must. Since most CO poisonings occur while the occupants are sleeping, the detector should be loud enough to wake you. For the hearing impaired, strobe-light and bed vibrating detectors are available. Contact your local hardware store, fire safety supplier, or Cooperative Extension agent for more information on detector purchases.



Features to look for in detectors

Detectors that use an electrochemical detection method are the current state of the art. We recommend purchasing an electrochemical-based detector due

TABLE 2

CO concentration (parts per million, ppm)	Physiological effects	Actions to take
0-7	Normal conditions in and outside Alaska homes.	None.
9	Maximum tolerable outdoor concentration over an 8-hour period (EPA NAAQS).	Reduce physical activity, check HVAC system.
25	Maximum allowable concentration for continuous exposure for healthy adults in any 8-hour period (Health Canada).	Reduce physical activity, call HVAC service immediately.
30	Slight headache possible. Blood concentration approx. 3 percent.	CO detectors must not sound alarm within 30 days.
70	Slight headache possible. Blood concentration approx. 3-10 percent.	Open doors and windows. CO detectors must sound alarm within one to four hours.
70-150 or "Hi" on detector	Early exercise-induced fatigue, impaired fine motor skills. Blood 20-30 percent.	CO detectors must sound alarm within 10 to 50 minutes. Vacate house THEN call 911.
200 or "Hi"	Headache, fatigue, dizziness and nausea after 2-3 hours.	CO alarm must sound within 35 minutes.
400 or "Hi"	Severe headache, weakness, dizziness, vomiting, collapse.	CO alarm must sound within 4-15 minutes.
800 or "Hi"	Dizziness, high pulse and convulsions with 45 minutes, death within 2-3 hours.	
1600, "Hi"	Respiratory failure. Death within one hour.	
13000, "Hi"	Danger of death within 1-3 minutes.	

Source of some data: CMHC Carbon Monoxide Publication CE 25.

to a number of safety-enhancing benefits. "CO Experts" and the KIDDE "Nighthawk" devices are considered good electrochemical detectors. A detector capable of displaying CO concentrations of under 10 ppm is valuable, since it can signal a problem before it becomes life threatening. Often, a more expensive detector, such as those in the \$100-\$150 range, are cheaper in the long run because the chemicals used in the detection process will last longer than a \$25 detector.

Generally, three kinds of CO detectors are available: battery-operated detectors, wire-in line voltage detectors and plug-in detectors. There are also smoke detector/CO detector units available. Since the combination units don't work when the power is off and should be installed near the ceiling to detect smoke, these units should be used in conjunction with a battery-operated detector.

Where do I put a CO detector?

Follow the manufacturer's recommendations on where to put the detector. The following are general guidelines when more guidance is needed. CO mixes well with air, but is usually warmer than air, since it comes from combustion. Therefore, carbon monoxide often can be found around a ceiling. Because of the different situations in which CO can be found, detectors should be placed at breathing level. A detector should be present on every floor of a dwelling. When using a personal CO detector, keep the detector as close to the head as possible, especially while lying or sitting.

To avoid both damage to the unit and to reduce false alarms, do NOT install CO detectors:

- in unheated basements, attics or garages
- in areas of high humidity
- where they will be exposed to chemical solvents or cleaners, including hair spray, deodorant sprays, etc.

TABLE 3

	Battery operated detectors	Wire-in detectors	Wall plug-in detectors
Benefits	Goes anywhere Sounds an alarm when battery needs replacement Most units have a digital readout and fast reset time Usually electrochemical based	Fewer battery changes Many models have battery backup for when power goes out Smoke/CO detectors available in one unit	Goes most places Fewer battery changes Possibility for vibrating or strobe alert Better backup
Drawbacks	Frequent battery changes may be needed May be biomimetic instead of preferred electrochemical sensor Digital display shuts off when not in use	These are typically MOS, or metal-oxide-semiconductor detectors, and are less sensitive Difficult to install Damage to wiring may go unnoticed Short battery backup life	Short battery backup life Wall socket may be located in unsafe location May be MOS or gel-plate based (biomimetic) instead of preferred electrochemical Avoid wall switch-controlled outlets

Note: Carbon Monoxide detectors do not last forever. Replace your detector every 3 to 5 years, depending on the model.

- near vents, flues or chimneys
- within 2 meters (6 ft.) of heating and cooking appliances
- near forced-or unforced-air ventilation openings
- within 2 meters (6 ft.) of corners or areas where natural air circulation is low
- where they can be damaged, such as an outlet in a high traffic area
- where directly exposed to the weather.

References:

Canadian Mortgage and Housing Corp. (CMHC). 2005. *Carbon Monoxide CE 25*. Ottawa, Ont.: Canadian Mortgage and Housing Corp.

Haber, Deborah. 2005. *A profile of U.S. Poison Centers in 2004: A survey conducted by The American Association of Poison Control Centers*. Alexandria, Va.: American Association of Poison Control Centers.

Paulozzi, L, Dr. et al. 2007. "Unintentional Poisoning Deaths--United States, 1999-2004." *Journal of American Medical Association*. Chicago.

U.S. Environmental Protection Agency. 2000. *Air Quality for Carbon Monoxide.*, Available online at www.epa.gov/NCEA/pdfs/coaqcd.pdf.

See Spring and Summer 2003 *Alaska Building Science Newsletter*, archived at: www.uaf.edu/ces/faculty/seifert.

Content assistance by Garrison Collette, Energy Program Assistant

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