

CARBON MONOXIDE RISKS AT HOME

In the past decade, people have become more aware of the risk of carbon monoxide (or CO) poisoning in the home. The nonprofit NFPA offers this fact sheet to help people protect themselves and their families against CO poisoning.

What is carbon monoxide?

Carbon monoxide (CO) is an invisible, odorless, colorless gas created when fuels (such as gasoline, wood, coal, natural gas, propane, oil, and methane) burn incompletely. In the home, heating and cooking equipment that burn fuel are possible sources of CO. Vehicles or generators running in an attached garage can also produce dangerous levels of CO.

However, consumers can protect themselves against CO poisoning by properly installing, using, venting, and maintaining their heating and cooking equipment; by installing CO alarms inside their homes; and by being cautious with vehicles or generators in attached garages.

What is the effect of exposure to CO?

CO is poisonous and can kill cells of the body. CO also replaces oxygen in the bloodstream, leading to suffocation. Mild effects feel like the flu, while severe effects include difficulty breathing and even death.

Just how sick people get from CO exposure varies greatly from person to person, depending on age, overall health, concentration of exposure (measured in parts per million), and length of exposure. As with anything harmful that is inhaled, swallowed, or absorbed by the body, the severity of harm depends on the dose. The same dose of CO can be received through a long exposure to a low concentration or a brief exposure to a high concentration. Given time, the body will get rid of CO, unlike substances like lead or arsenic. Therefore, at the end of a long exposure to a low concentration, some of the initial CO may already have been expelled. That means that if the same amount of CO is received over a long period of time, its effect on the body may be less than if the same amount of CO had been received quickly, in high concentration. Table 1 shows typical symptoms, based on concentration and time of exposure.

TABLE 1

Effects of Exposure to CO*

Concentration (parts per million)	Symptoms
50	Threshold limit value for no adverse effects even with 6-8 hours exposure
200	Possible mild headache after 2-3 hours
400	Headache and nausea after 1-2 hours
800	Headache, nausea, and dizziness after 45 minutes; collapse and possible unconsciousness after 2 hours
1,000	Loss of consciousness after 1 hour
1,600	Headache, nausea, and dizziness after 20 minutes
3,200	Headache and dizziness after 5-10 minutes; unconsciousness after 30 minutes
6,400	Headache and dizziness after 1-2 minutes; unconsciousness and danger of death after 10-15 minutes
12,800	Immediate physiological effects; unconsciousness and danger of death after 1-3 minutes

Source: James H. Meidl, *Explosive and Toxic Hazardous Materials*, Glencoe Press, 1970, Table 28, p. 293.

* Just how sick people get from CO exposure varies greatly from person to person, depending on age, overall health, concentration of exposure (measured in parts per million), and length of exposure.

When blood carries CO rather than oxygen, the CO-carrying cells are called carboxyhemoglobin (COHb), in contrast to normal oxygen-carrying hemoglobin. The percentage of the blood that is carboxyhemoglobin — also called carboxyhemoglobin saturation — measures how badly a person is affected by CO. A doctor can measure COHb in the blood but cannot measure CO in the body directly. The more CO in the body, the higher the COHb, and the sicker the person will be. Table 2 links typical symptoms to the level of COHb saturation.



TABLE 2**Effects of Carboxyhemoglobin (COHb) Saturation**

COHb Saturation (%)	Symptoms
0 – 10	None
10 – 20	Tension in forehead, dilation of skin vessels
20 – 30	Headache and pulsating temples
30 – 40	Severe headache, weariness, dizziness, weakened sight, nausea, vomiting, prostration
40 – 50	Same as above, plus increased breathing and pulse rates, and asphyxiation
50 – 60	Same as above, plus coma, convulsions, Cheyne-Stokes respiration
60 – 70	Coma, convulsions, weak respiration and pulse; death is possible
70 – 80	Slowing and stopping of breathing; death within hours
80 – 90	Death in less than one hour
90 – 100	Death within a few minutes

Source: Gordon E. Hartzel, Ed., *Advances in Combustion Toxicology*, Volume One, Technomic Publishing, Inc., 1989, p. 23.

What is your risk of CO poisoning?

Deaths from unintentional poisoning by gas or vapors, chiefly CO — about 600 in 1998, including 500 in homes, according to the National Safety Council — are fairly rare, and the number has been declining somewhat steadily, down by half since the early 1980s. Of all the unintentional gas and vapor poisoning deaths in the U.S., more than one-third involve motor vehicle exhaust gas, and more than one-fourth involve heating or cooking equipment. The total reflects more than CO-related deaths; it also reflects deaths resulting from other gases, such as natural gas leaks from pipelines.*

Deaths from unintentional CO poisoning have dropped in recent years, thanks to lower CO emissions from automobiles and safer heating and cooking appliances. Deaths from “smoke inhalation” (largely CO) in fires and suicides involving CO are both far more common causes of gas-related suffocation deaths.

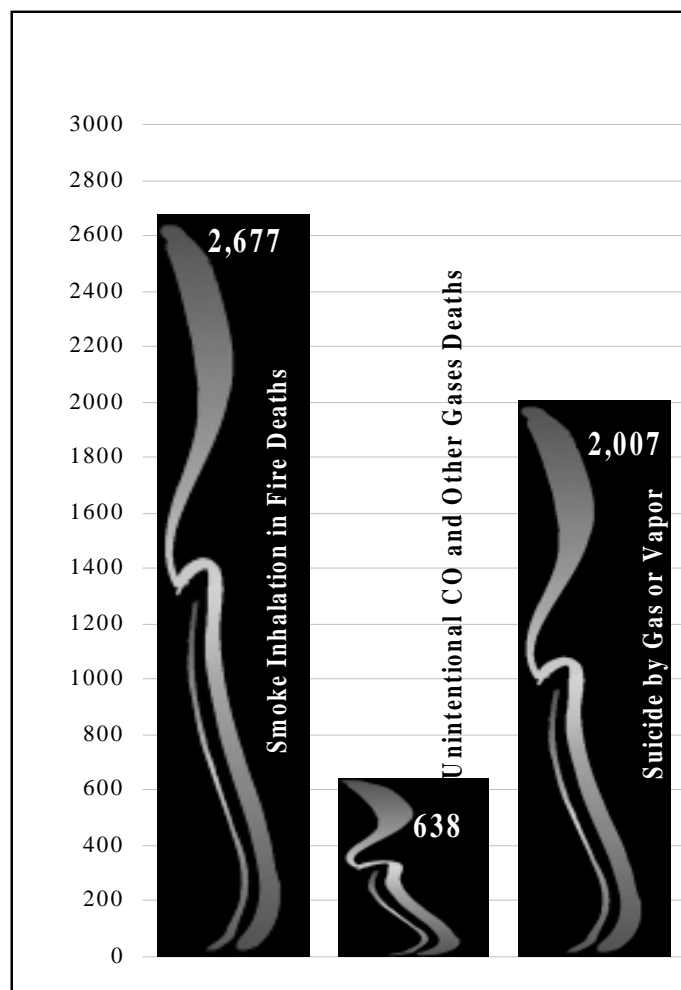
* National Safety Council's *Accident Facts*, 1981-99.

** The latest year for which statistics are available at this level of detail.

According to the U.S. Consumer Product Safety Commission, 207 CO-related non-fire deaths were attributed to heating and cooking equipment in 1996.** The specific types of equipment were:

- Gas-fueled space heaters (99 deaths)
- Gas-fueled furnaces (35 deaths)
- Liquid-fueled heating equipment (21 deaths)
- Charcoal grills (19 deaths)
- Gas-fueled ranges (15 deaths)
- Solid-fueled heating equipment (10 deaths)
- Gas-fueled water heaters (8 deaths)

As with fire deaths, the risk of unintentional CO death is highest for the very young (ages 4 or under) and the very old (ages 75 or above).

TABLE 3**1996 Deaths Involving CO and Related Gases**

Source: Dr. John Hall, Jr., *Burns, Toxic Gases, and Other Hazards Associated With Fires*, Fire Analysis and Research Division, NFPA, November 1999



How can you protect yourself from CO poisoning?

Install CO alarms inside your home to provide early warning of accumulating CO. However, a CO alarm is no substitute for safe practices.

The best defenses against CO poisoning are safe use of vehicles (particularly in attached garages) and proper installation, use, venting and maintenance of household cooking and heating equipment.

What are CO alarms?

Household CO alarms measure how much CO has accumulated. Currently, CO alarms sound when the concentration of CO in the air corresponds to 10% COHb level in the blood. Since 10% COHb is at the very low end of CO poisoning, the alarm may sound before people feel particularly sick. Most CO alarms now have silence/reset buttons and must be immune to elevated ambient levels such as those found in urban areas.

Do I need a CO alarm?

NFPA 720, *Recommended Practice for the Installation of Household Carbon Monoxide (CO) Warning Equipment*, 1998 Edition, recommends installing a CO alarm in households containing a fuel-burning appliance, fireplace, or in those having an attached garage.

What causes CO nuisance alarms?

Pollution and atmospheric conditions in some areas cause low levels of CO to be present for long periods of time. In fact, these “background” conditions may increase CO to over the 10% COHb equivalency level, causing older CO alarms to sound even though conditions inside the home are not truly hazardous. However, newer alarms have been designed to reduce sensitivities to compensate for these background conditions. Treat all CO alarm warning sounds as real, until it has been verified that there is no threat from equipment inside the dwelling.

SAFETY TIPS

If you need to warm up a vehicle, remove it from the garage immediately after starting it. Do not run a vehicle, generator, or other fueled engine or motor indoors, even if garage doors are open. CO from a running vehicle or generator inside an attached garage can get inside the house, even with the garage door open. Normal circulation does not provide enough fresh air to reliably prevent dangerous accumulations inside.

If you have any symptoms of CO poisoning, have your vehicle inspected for exhaust leaks.

Have fuel-burning household heating equipment (fireplaces, furnaces, water heaters, wood stoves, and space or portable heaters) checked every year before cold weather sets in.

All chimneys and chimney connectors should be evaluated by a qualified technician to verify proper installation, and check for cracks, blockages, or leaks. Make needed repairs before using the equipment.

Before enclosing central heating equipment in a smaller room, check with your fuel supplier to ensure that air for proper combustion is provided. NFPA 54, *National Fuel Gas Code*, provides requirements for openings to allow sufficient air for the proper combustion of gas.

When using a fireplace, open the flue for adequate ventilation.

Open a window slightly whenever using a kerosene or gas heater. (Kerosene heaters are illegal in many states. Always check with local authorities before buying or using one.) Only refuel outside, after the device has cooled.

Only use barbecue grills — which can produce CO — outside. Never use them in the home or garage.

When purchasing new heating and cooking equipment, select products tested and labelled by an independent testing laboratory. Do not accept damaged equipment. Hire a qualified technician (usually employed by the local oil or gas company) to install the equipment. Ask about — and insist that the technician follow — applicable fire safety and building codes.

When purchasing an existing home, have a qualified technician evaluate the integrity of the heating and cooking systems, as well as the sealed spaces between the garage and house.

When camping, remember to use battery-powered heaters and flashlights in tents, trailers, and motorhomes. Using fossil fuels inside these structures is extremely dangerous. NFPA 1192, *Standard on Recreational Vehicles*, requires the installation of CO detectors in recreational vehicles.

Boat operators should be aware that CO is emitted from any boat’s exhaust. When your boat is moored or anchored alongside others’, be aware of the effect your exhaust may have on those vessels and vice versa. The trim of the boat, as well as side curtains, can contribute to increased concentrations of CO by altering the air flow. Fuel burning appliances located in accommodation spaces need to be properly ventilated and maintained.



If you buy CO alarms:

- Select alarms listed by a qualified, independent testing laboratory.
- Follow recommendations of NFPA 720 and manufacturer's recommendations for placement in your home.
- Install CO alarms in a central location outside each separate sleeping area in the immediate vicinity of the bedrooms. Each alarm should be installed on the wall, ceiling, or other location as specified by the manufacturer's instructions that accompany the unit.
- Call your local fire department's non-emergency telephone number. Tell the operator that you have purchased a CO alarm and ask what number to call if the CO alarm sounds. Clearly post that number by your telephone(s). Make sure everyone in the household knows the difference between the fire emergency and CO emergency numbers (if there is a difference).
- Test CO alarms at least once a month, following the manufacturer's instructions.
- Replace CO alarms according to the manufacturer's instructions.
- Follow manufacturer's instructions for battery replacement.

What to do if your CO alarm sounds:

- Have everyone move to an area with fresh (outside) air. Open windows to ventilate.
- Report the CO alarm warning, following the instructions you received from the fire department when you bought the alarm.
- Be on the lookout for any symptoms of CO poisoning. Evacuate the home if symptoms are present. Get immediate medical attention if anyone shows signs of CO poisoning.
- Call a qualified technician to inspect all equipment.

Safety checklist

- CO alarms are not substitutes for smoke alarms. Smoke alarms react to fire by-products, before CO alarms would sound. Smoke alarms give earlier warning of a fire, providing more time to escape.
- To guard against smoke and fire, be sure that your home has working smoke alarms on every level and directly outside and inside all sleeping rooms
- Know the difference between the sound of the smoke alarms and the sound of the CO alarms.
- Have a home escape plan for any home emergency and practice the plan with all members of the household regularly, at least twice a year.

About the NFPA

The nonprofit NFPA prepared this fact sheet as a guide for consumers who are concerned about possible CO poisoning at home. NFPA publishes NFPA 720, *Recommended Practice for the Installation of Household Carbon Monoxide (CO) Warning Equipment*, 1998 Edition.

NFPA has been a worldwide leader in providing fire, electrical, and life safety to the public since 1896. The mission of the international nonprofit organization is to reduce the worldwide burden of fire and other hazards on the quality of life by developing and advocating scientifically-based consensus codes and standards, research, training and education. Publisher of the *National Electrical Code*®, the *Life Safety Code*®, and 300 other codes and standards through a full, open-consensus process, NFPA is currently developing NFPA 5000, *Building Code*™, the first consensus-based building code. NFPA also produces educational curricula, including the *Risk Watch*® community-based injury prevention curriculum and the *Learn Not to Burn*® fire safety curriculum, as well as the *Remembering When* program for fall and fire prevention for older adults.

Visit NFPA's Web sites at www.nfpa.org and www.sparky.org.

