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Healthy Homes — Managing Combustion Pollutants

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Gas furnaces, water heaters, and appliances are common in many homes. This NebGuide discusses carbon monoxide and other combustion pollutants, and how you can prevent these pollutants from affecting you and your family's health and safety.

A variety of combustion (burning) processes may occur in the normal operation of a home. Many homes have gas furnaces, water heaters, and ovens. While these are generally safe, consumers must take precautions to assure they remain that way. Combustion byproducts include gases and particles that come from smoking and the burning of fuels such as natural gas, propane, wood, oil, kerosene, gasoline, and coal. Combustion processes can produce a complex mixture of particulate and gaseous pollutants that can cause illnesses. Some of the resulting harmful gases include carbon monoxide, nitrogen oxides, and sulfur dioxide. Particulates and water vapor also are produced.

Combustion Pollutants and Their Health Effects

Combustion pollutants in homes can affect how you feel and cause illness. Some can be deadly.

Carbon monoxide (CO) is a major cause of poisonous deaths. Unintentional CO poisoning causes hundreds of deaths and thousands of injuries in the United States each year. The number of deaths and injuries from CO poisoning is higher in the winter. Of the deaths associated with CO poisoning, over two-thirds involved gas-fueled appliances, including space heaters, furnaces, water heaters, ranges and ovens, gas grills, and propane lanterns. Most deaths occur in the home.

Everyone is at risk of being poisoned by CO. However, individuals with existing health problems, such as heart and lung disease, smokers, and the elderly are especially vulnerable. Infants, children, pregnant women, and fetuses are at even higher risk.

CO is a colorless, odorless gas that interferes with the delivery of oxygen throughout the body. CO is produced by the incomplete combustion of carbon-containing fuels. CO can kill in minutes or hours, depending on the amount and length of exposure. It is sometimes difficult to determine initially if CO is the problem because symptoms are similar to flu symptoms. Low-level exposure can cause nausea, dizziness, fatigue, headache, weakness, and muscle ache, and can worsen cardiovascular conditions. Skin color may have a pink or red cast. Higher doses can impair judgment and can cause paralysis or coma, brain damage, convulsions, heart and lung failure, and death. Even low levels over a long period may have health effects. CO may be the problem if you feel bad only when you are inside the home and the symptoms gradually disappear after you leave, or if more than one person in the home has similar symptoms.

Nitrogen dioxide can irritate the skin and mucous membranes of the eyes, nose, and throat. Respiratory effects range from slight irritation to burning, chest pain, increased heart rate, coughing, and shortness of breath. People with chronic respiratory disease, including bronchitis, asthma, and emphysema, are more sensitive to nitrogen dioxide.

Nitrogen dioxide, produced by fossil fuel combustion, has been studied as a potential pollutant from gas stoves. Studies suggest that children who are exposed to combustion contaminants from gas stoves have higher rates of respiratory symptoms and illness. Other studies show homes with gas stoves have higher levels of nitrogen dioxide. Levels are affected by the amount the stove is used and whether the burners are properly adjusted. Exhaust-vent fans vented to the exterior are recommended.

Sulfur dioxide is a colorless gas with a strong, pungent odor. It can irritate the eyes, nose, and respiratory tract. The combustion from kerosene heaters and oil or coal furnaces is a primary source of sulfur dioxide. Studies suggest that some people, especially asthmatics, are more sensitive to sulfur dioxide.

Respirable particulates, released from incomplete combustion, are solid particles that can lodge in the lungs and irritate or damage lung tissue. They can cause eye, nose, and throat irritation and increase existing respiratory symptoms, especially in people with chronic lung disease or heart problems.

These small, solid particles may contain compounds that are carcinogenic. The health effects from inhaling particles depend on many factors, such as particle size, chemical makeup, and an individual's health.

Environmental Tobacco Smoke (ETS) — Secondhand smoke significantly increases the risk of lung cancer and causes about 50,000 deaths in adult nonsmokers in the United Sates each year. The National Academy of Sciences estimates that the risk of lung cancer is about 30 percent higher for nonsmoking spouses of smokers than for nonsmoking spouses of nonsmokers. In children, passive smoke substantially increases respiratory illnesses such as bronchitis and pneumonia; increases coughing and wheezing; and slows lung function growth. Pregnant mothers exposed to ETS are more likely to have low birthweight babies. ETS is associated with increased risk for Sudden Infant Death Syndrome (SIDS).

Potential Source of CO and Other Combustion Pollutants

CO is produced when fossil fuel burns incompletely because of insufficient oxygen. In properly installed and maintained appliances, gas burns clean and produces only small amounts of CO. Anything that disrupts the burning process or results in a shortage of oxygen can increase CO production. Sources of potential CO and combustion pollutants include:

Vents and Chimneys

- Incorrectly installed venting systems and chimneys.
- Chimneys too short to vent correctly.
- Appliances with no venting system, such as unvented portable kerosene heaters, or ventless fireplaces.
- Range exhaust fans not vented to the exterior.
- Venting systems and chimneys blocked by bird nests, ice, snow, or leaves.
- Disconnected, corroded, and damaged chimneys and flues or vent pipes.

Maintenance

- Failure to maintain furnaces and other combustion appliances.
- Cracked heat exchanger on furnaces.
- Malfunctioning fuel-burning appliances, including furnaces, gas ranges/stoves, clothes dryers, and water heaters.
- Malfunctioning fireplaces and wood-burning stoves.

Backdrafting and Changes in Air Pressure

- House air flow patterns, spillage, and downdrafting can cause vent failure.

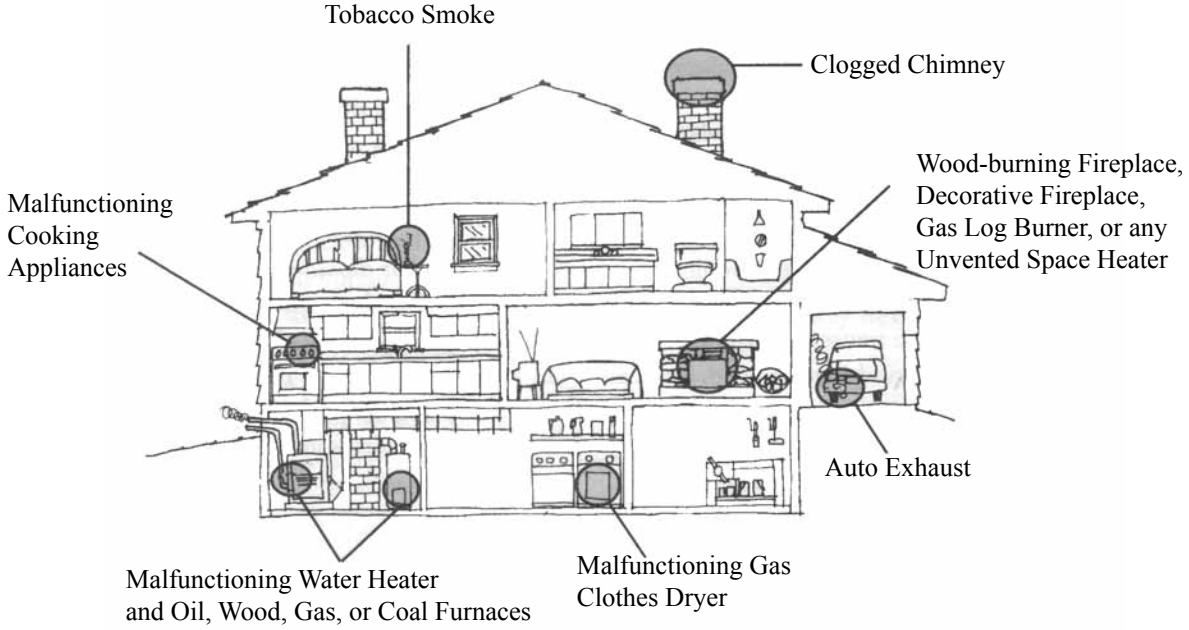
Other Sources of CO and Combustion Pollutants

- Smoking in the home.
- Use of charcoal or other fuel-fired grills inside, in the garage, or near entryways.
- Candles and incense. (Sooting also may be a problem.)
- Pollutants produced during food preparation — especially if a range exhaust fan is not used.
- Warming up a car in an attached garage, even with the door open. Backing a car out of an attached garage without letting fresh air clear the CO fumes before the door is closed.
- Gas lawnmowers, snow blowers, chainsaws, weed whips, generators, and water pumps.

Downdrafting

Most home fuel-burning appliances are vented to the outdoors through a chimney or vent that removes gases, particulates, and carbon monoxide. Downdrafting results when air flow reverses in a vent or chimney, pulling air and flue gases back into the house instead of expelling them.

Warm air is lighter than cold air and typically "rises." Chimney or flue air rises and this buoyant effect carries combustion gases out of the house. When buoyant forces are weak,



they can be overcome by other air movements, such as those created by bathroom exhaust fans, clothes dryers, air leaks in the house, and wind direction. High winds around the outside of the building or too short a chimney can create a downdraft. This occurs when a vent fills with cooler air that tends to fall, and the vent continues to be filled with more outside cold air, resulting in backdrafting.

Anything that moves air out of a house can cause depressurization and downdraft in a chimney. For example, turning on the range fan and/or the dryer might be sufficient to downdraft a nearby gas water heater. Depressurization and downdraft also can be caused by exhaust fans, other vented heating appliances, fireplaces, and holes in the ceiling. Tight homes also can downdraft when insufficient air is available for complete combustion.

Preventing Combustion Pollutants and CO Poisoning

- Every year, the heating systems and gas appliances, vents, chimneys, and flues should be inspected and cleaned by a qualified professional. Over time, components can be damaged or deteriorate.
- Regularly examine vents and chimneys for improper connections, visible rust, or stains.
- Install appliances according to manufacturers' instructions and adhere to local building codes. Most appliances should be installed by professionals and inspected after installation.
- Follow the manufacturers' operating directions.
- Install a CO alarm on every level.
- Use sealed-combustion fuel-burning appliances, when possible. These have pipes in which outside combustion air is supplied directly to the burner chamber, and pollutants are expelled through a separate sealed-combustion pipe.
- Some appliances have fans that assist in expelling gases and pollutants.
- Choose properly sized wood stoves that are certified to meet EPA emissions standards and have them correctly installed. Doors should fit tightly.
- Avoid using unvented space heaters — especially while sleeping and if no CO alarm is in the area. If a portable kerosene heater must be used, open windows and have a CO alarm in place.
- Be aware of potential backdrafting or downdrafts when combustion appliances are in use.
- Avoid smoking in the home.
- Avoid using gas-powered motors and equipment in the basement, garage, or enclosed areas.
- Avoid using charcoal grills in enclosed areas.
- Avoid using a gas range or oven for heating a room — even for a short time.

Potential Clues of Combustion Problems

Look for and respond to problems such as:

- Decreasing hot water supply.
- Furnace runs constantly or is unable to heat home.
- Sooting, especially on appliances. Streaks of soot around appliance service doors.
- Moisture collecting on windows and walls of furnace rooms.
- Unfamiliar or burning odors.
- Loose or missing furnace panel or vent pipes.
- Loose, damaged, or discolored chimneys.
- Excessive rusting on flue pipes or appliance jackets.
- Absence of chimney draft.

Maintenance and Service Checks

Annual maintenance of combustion appliances and at least one UL-listed CO alarm in the home is critical. CO alarms are not a substitute for good maintenance. Annual maintenance includes, for example, adjusting the air-fuel mixture in the fuel burner; removing soot from the heat exchanger surface; inspecting the heat exchanger for possible cracks, and checking that exhaust vents are intact and unblocked. Special instruments should be used to test for CO or leaks. Backdraft indicators should be installed.

If you think you have a CO or combustion problem, contact the gas company, city mechanical inspector, or a local heating contractor for inspection and repair. If that professional is unable to adequately diagnose and solve the problem, a person with the following house diagnostics equipment and training should be consulted:

- Micromanometers to measure very small pressure differences.
- Blower doors to determine the home's air leakage characteristics.
- Smoke pencils.
- Carbon monoxide measurement equipment.
- Training in carbon monoxide investigations and pressure measurement.

Buying CO Alarms

Both battery- and alternating current (AC)-powered alarms have advantages. You may want to buy one of each and place them in different areas or levels of the home. Battery-operated alarms are easy to install and operate during power outages when emergency heating systems might be used. A plug-in alarm may not depend on a battery and may not require battery replacement. AC line-powered alarms with battery backup also are available offering advantages of both.

CO Alarm Features You Should Consider

- AC or battery operation or combination
- UL listed and approved — look for a UL 2034 or IAS-696 label on the alarm.

- Sensor and/or battery replacement
- Consumer evaluations
- Reliability of the company
- Ease of testing
- Digital readout; recall of highest reading
- Need for visual as well as audible sound alarm
- Levels at which low, medium, and high levels of CO are detected and how quickly the alarm is activated.

Read the operating instructions. Alarms vary in how they work, when they are activated, placement, at what levels or ppm of CO the alarm is triggered, and how to reset. They differ in whether replacement sensors or batteries are needed and low battery detection.

Note: CO alarms have a life of 5 to maybe 7 years under good conditions. Replace the alarm or have it recalibrated when it is 4 to 5 years old.

Placement of a CO Alarm

Recommendations for placement vary. Generally, they should be located near sleeping areas but away from where they can be bumped, from drafts and household chemicals, and from gas-fired appliances. An improper location can affect the sensitive electronic components. Install one CO alarm in the hallway near each sleeping area and one on every level of the home.

Test alarms yearly. Most alarms are set to alarm when CO levels reach a high level in a short time. However, low-level, long-term CO exposure is a concern, especially for infants, children, and the elderly. Digital alarms that display both high and low levels or peak levels are available. Look for alarms that detect and register CO levels as low as 10 ppm or under.

Procedure if a CO Alarm Sounds

If a CO alarm sounds, take action! Immediately evacuate the home. If CO poisoning is suspected and people have symptoms, immediately evacuate the home and get everyone into fresh air. Call 911 and the utility company or a qualified service professional. Do not re-enter under any circumstances until help has arrived; CO detection instruments have been used to monitor the gas; and the problem is corrected.

If CO poisoning is suspected, seek medical care immediately. The diagnosis is made with the help of a blood test. The treatment is supplemental oxygen.

A Word About Safety

Take special precautions if you must use an unvented kerosene or gas space heater. More than 100 people are killed annually by CO poisoning from space heaters. Follow directions. If a heater absolutely must be used, use the proper fuel (water-clear ASTM 1-K kerosene) and provide fresh air. Open windows and keep doors to the rest of the house open. Do not use it in enclosed or sleeping spaces. Use unvented space heaters only if CO alarms are in place.

Know the safety features of your combustion appliances. Gas-fired space heaters should have an oxygen depletion sensor (ODS). An ODS detects reduced levels of oxygen and shuts the heater off. However, these sensors are not foolproof in preventing CO poisoning. A vented space heater should have a thermal shut-off device that interrupts heater operation if the appliance is not venting properly. Safety pilot valves turn off the gas to the heater if the pilot light goes out.

When using a fireplace or wood-burning stove, do not use green or wet woods, painted scrap wood, or wood treated with preservatives. They can release toxic pollutants such as arsenic or lead. Plastics, charcoal, metal, trash, and colored papers should not be used. Never burn anything that the fireplace or stove manufacturer does not recommend.

Remember, proper maintenance, regular inspections, and correct operation and installation of appliances and equipment are good proactive actions to prevent combustion pollutants in your home. Install CO alarms. Look for safety devices on the combustion equipment you buy.

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Index: Safety/Health
Home Safety
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