



## Carbon Monoxide and Other Combustion Products

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*You k'n hide de Fier,  
But w'at you gw'ne do wid de  
smoke?*

Joel Chandler Harris

When any fuel is burned, the dangers of the flame are obvious. Hazards from combustion products—smoke—are also important. For many fuel burning appliances, these products are exhausted to the outside through a flue or chimney. Some appliances—gas ranges and unvented space heaters, for example, discharge combustion products directly into the living space.

### Products of Combustion

What are these combustion products, and how dangerous are they? Common household fuels—coal, wood, gas, oil, and kerosene—consist mainly of a group of chemicals called hydrocarbons. Under ideal conditions of temperature, air supply, and other factors, the hydrocarbons react with oxygen to break down into their simplest components: carbon dioxide and water. This process also releases energy, in the form of heat.

Things are rarely ideal, however. Contaminants are often present in the fuel, and combustion is rarely complete. Thus, combustion products usually include carbon monoxide, (CO) a highly toxic gas;

strong irritants such as sulfur dioxide, and oxides of nitrogen ( $\text{NO}_x$ ); unburned fuel, carbon (soot), partially burned fuel and other irritant or harmful products such as formaldehyde, PAHs (polycyclic aromatic hydrocarbons) and fine suspended particles (particulates, “smoke”).

These compounds are harmful; the problems they cause depend on concentration and degree of exposure. For example, low concentrations of carbon monoxide can cause headache, weakness, dizziness, and nausea. Larger concentrations cause death. About 500 Americans die in the home each year as a result of inhaling this odorless gas. Oxides of nitrogen irritate the eyes, nose and throat; prolonged exposure can cause drowsiness. Long-term exposure to PAH can increase cancer risk. Thus, the familiar, “Natural” odor of a fireplace or woodstove is actually loaded with harmful ingredients. Generally speaking, it is best to minimize exposure to combustion products: high-level exposures can cause death.

### Care and Use of Combustion Equipment

Some simple precautions, and attention to routine maintenance, will minimize the chances of indoor pollution problems from combustion equipment.



## Furnaces and Boilers

Problems arise when the chimney or flue becomes blocked. The chimney should be inspected at the beginning of each heating season. If it is relatively straight, inspection can be done with a small mirror inserted in the chimney clean-out door (make sure the heater is turned off!). Look for a clear path to the top of the chimney. Also, the metal flue pipe that connects the appliance to the chimney should be inspected for rust, holes or weak spots. These pipes eventually corrode, and if they collapse, the house can be rapidly filled with deadly gas. Other equipment in the house may cause chimneys to backdraft. See the box for information on this important subject.

Combustion equipment needs an adequate air supply. Furnace rooms should not be tightly sealed; a 1-2" door undercut can help to provide needed air.

*Note: Some modern heaters are "direct vented"; combustion products are exhausted through a pipe via a nearby wall or window. No chimney is used, so some of these recommendations do not apply. Combustion air may be provided by a similar pipe to the appliance.*

## Fireplaces and Woodstoves

Homes in which this equipment is used tend to have high indoor levels of combustion products, some of which are drawn in from outside as air drawn up the chimney is replaced. Pollutants include fine particles ("respirable particulates") which can irritate the throat and lungs, and PAH's, described earlier.

Avoid slow burning, smoldering fires which produce the largest amounts of these pollutants. Seasoned wood burns cleaner than green wood. Woodstoves sold after 1990 are required to meet federal emissions standards, and should be more efficient, as well as cleaner-burning.

Besides air quality hazards, space heaters also produce another hazard: fire. Statistics indicate that one of the greatest risks from this equipment involves house fires started because woodstoves and/or flue pipes were not installed according to directions, especially with regard to clearances from combustible surfaces.

*Note: Treated lumber should never be burned. Toxic metals, safely bonded in this wood, are released by burning. Ash and fumes pose a serious threat to people and the environment.*

## Unvented Fuel-Fired Space Heaters

These appliances are intended to be used indoors without directly expelling combustion products. At high concentrations, many of these products can harm human health. Whether these appliances cause problems for occupants depends on how the appliances are used and on the status of the occupants themselves. The elderly, the very young, and those who are infirm (especially with breathing problems) are most likely to be harmed by the use of this equipment.

Several precautions can reduce health risks. It is important to carefully follow manufacturers' instructions. On kerosene heaters, for example, setting the burner to produce a very high or very low flame can cause a big increase in production of pollutants.

Also, unvented, fuel-fired space heaters should not be operated in an enclosed space. Heater operation in a closed room will increase the pollution levels to which occupants are exposed, increasing health risks.

Gas-fired space heaters can produce pollutants as well. Serious problems have arisen after prolonged operation in an enclosed space. As the flame depletes oxygen in the surrounding atmosphere, combustion is impaired, and carbon monoxide

production increases. Modern gas heaters should be equipped with an automatic shutoff that reacts to such conditions.

### **Gas Ovens and Ranges**

This equipment also produces pollutants. However, in normal use the amounts are usually negligible. Problems do develop, however if these appliances are used as supplemental heaters. Operation for many hours, day after day, can cause unacceptably high levels of pollutants such as formaldehyde, oxides of nitrogen, and particulates.

## **Carbon Monoxide Detectors**

Potential problems with combustion equipment can be readily detected with carbon monoxide (CO) detectors, now widely available. Several different types are available. Inexpensive (about \$5) detector cards have a treated spot that should change color if exposed to elevated CO. More expensive devices, similar in appearance to smoke detectors, use electrical power to detect CO, and sound an audible alarm. These devices are powered either by batteries or house current. (For further information see *Consumer Reports*, May 1994, pp 334-336.)

### **Building Ventilation and Combustion Appliances Avoiding Backdrafts**

“Old” homes, including many built prior to the first energy crisis of the 1970s, were usually built without much concern about building tightness. As a result, most of these structures have many air leaks and are well ventilated.

Not only does this excessive ventilation reduce indoor pollution; it also ensures abundant air for combustion appliances—gas-and oil-fired furnaces, fireplaces, clothes dryers, etc. While the burner is operating, a residential furnace may consume air at the rate of two thousand cubic feet per hour (about the volume of air in a medium-sized room).

Occupants of homes that have been tightened to conserve energy should be aware that problems can develop if sufficient replacement air (called “makeup air”) is not available. In the simplest case of inadequate makeup air, com-

bustion will become “starved” and inefficient, producing excessive soot and poisonous carbon monoxide. In more serious cases, when several combustion appliances operate simultaneously, the suction created by the flue draft of the larger appliance (a fireplace, for example) can cause a reverse flow—backdraft—in other flues. Clothes dryers, exhaust fans, woodstoves, and some water heaters can also contribute to these problems. A backdraft introduces poisonous gases into the home. It can also be caused by using powerful exhaust devices, such as surface-mounted exhaust systems on range tops.

Such problems are easily prevented by providing for makeup air. A window can be slightly opened when operating exhaust fans or fireplaces. Windows in furnace rooms can be left slightly open during the heating season, although these areas should be protected from freezing temperatures.

## Summary

Household fuel-burning equipment is designed to strict standards to protect occupants from excessive exposure to combustion products that can irritate the eyes, nose and throat, and cause illness, even death. Nevertheless, problems can occur.

Safety features and careful design, however, cannot take the place of common sense. Such equipment should be used according to manufacturers' instructions. Also, users need to regularly observe these appliances for proper operation, and arrange for regular servicing and maintenance.

## References

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