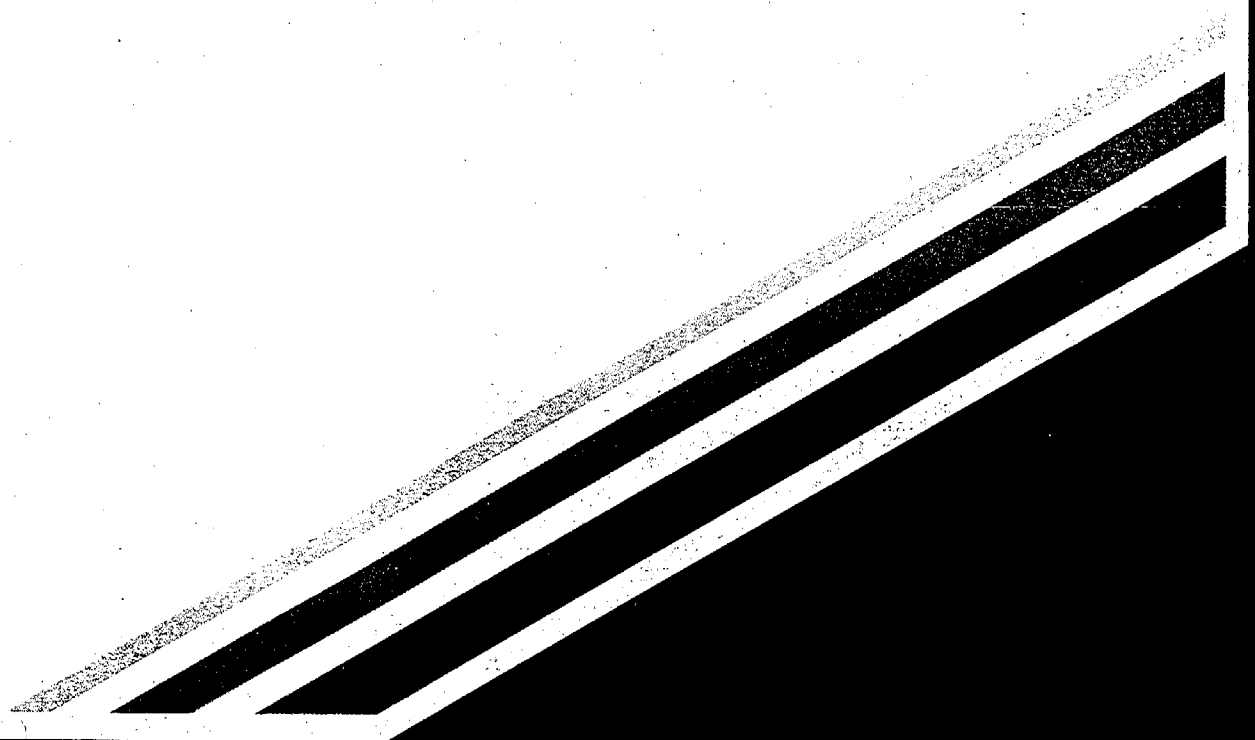


MAY 1994



Supplement to Indoor
Air Quality Guideline No. 2,

COMBUSTION POLLUTANTS IN YOUR HOME



CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY



**AIR RESOURCES BOARD
Research Division**

D
84.1
377
994

**Supplement to Indoor Air Quality Guideline No. 2,
COMBUSTION POLLUTANTS IN YOUR HOME**

LIBRARY-AIR RESOURCES BOARD

May, 1994

California Environmental Protection Agency

 **Air Resources Board**

PREFACE

The California Air Resources Board has directed its staff to develop health-based indoor air quality guidelines for non-occupational environments. "Combustion Pollutants in Your Home" is the second such guideline. The guideline and this Supplement were reviewed by the California Department of Health Services and the California Office of Environmental Health Hazard Assessment. The users of this Supplement are encouraged to consult California Air Resources Board staff for the latest information in this rapidly changing field.

TABLE OF CONTENTS	<u>Page</u>
Introduction	1
Sources of Combustion Pollutants	3
Health Effects of Combustion Pollutants	4
People Especially Sensitive to Combustion Pollutants	6
How You Can Reduce Levels of Combustion Pollutants in Your Home	6
Remove and Reduce Sources	7
Install, Use, and Maintain Combustion Appliances Properly	9
Ensure Balanced and Adequate Ventilation of Your Home	13
Use and Maintain Air Cleaning Equipment	15
Indoor Concentration Guidelines	15
Additional Benefits	18
Sources of Additional Information	19
Further Assistance	22



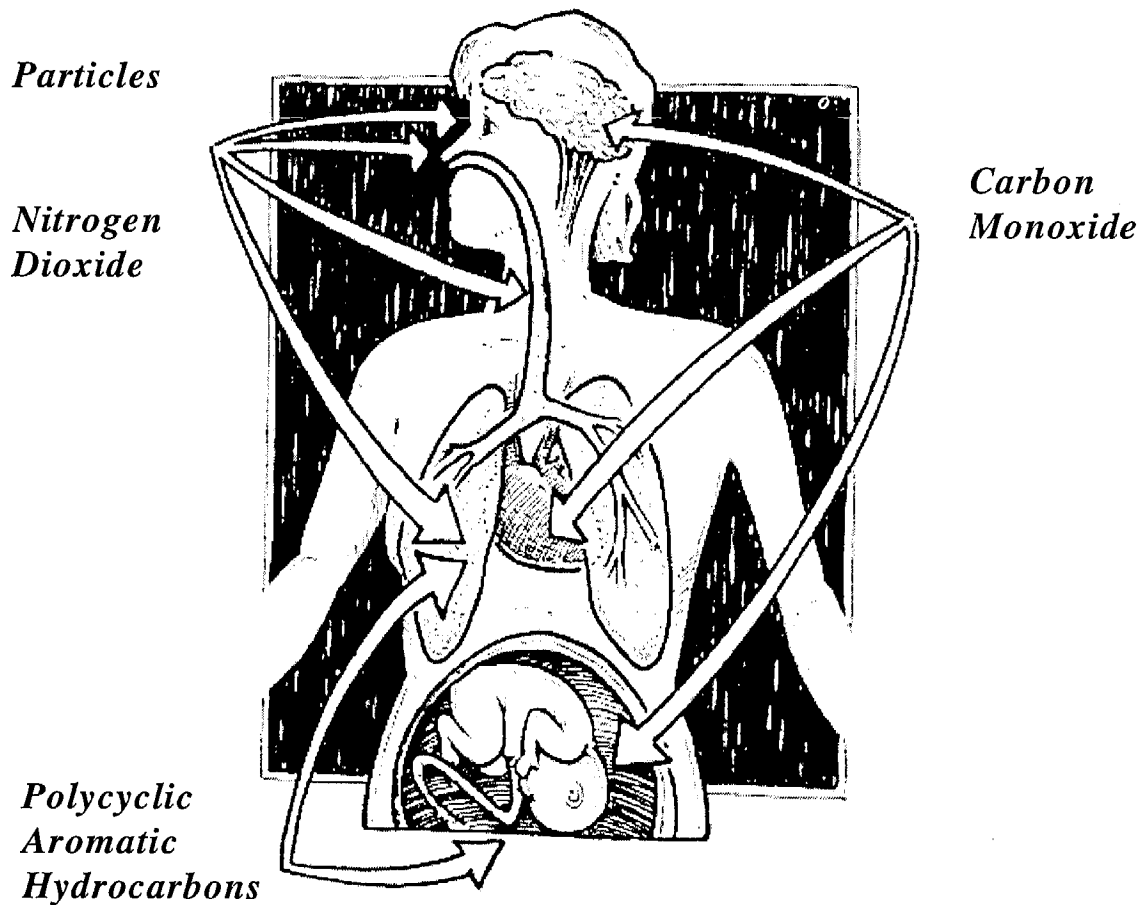
INTRODUCTION

This indoor air quality guideline presents information about the sources and health effects of indoor combustion pollutants. Most importantly, it suggests ways that you and your family can minimize your exposures to combustion pollutants.

Combustion pollutants are a complex mixture of gases and particles produced by burning any fuel, such as wood, natural gas, tobacco, and gasoline. Important combustion pollutants include **carbon monoxide** gas (CO), **nitrogen dioxide** gas (NO₂), small inhalable **particles** (PM₁₀), and the group of compounds known as **polycyclic aromatic hydrocarbons** (PAHs) commonly found in smoke, ashes, and diesel exhaust. Most sources of combustion pollutants produce several different pollutants. For example, wood smoke and tobacco smoke each contain thousands of different pollutants.

Exposure to combustion pollutants can increase the risk of heart or lung disease and cause fatal poisonings, cancer, and retarded fetal development. It can also irritate the eyes, damage the respiratory tract, and cause flu-like symptoms. Environmental tobacco smoke, or secondhand smoke, increases the likelihood of lung cancer as well as asthma attacks, respiratory infections, and ear infections in children. Wood smoke increases the likelihood of reduced breathing ability, respiratory symptoms, and respiratory infections, especially in young children and asthmatics.

PARTS OF THE BODY AFFECTED BY COMBUSTION POLLUTANTS



Combustion appliances are fuel-burning appliances such as fireplaces, wood stoves, gas furnaces, gas stoves and ovens, kerosene heaters, and charcoal grills. Their improper installation, use, or maintenance can cause pollutants to build up to unhealthful levels in the home. This is of special concern because of the large amount of time people spend in their homes and the large number of homes with potential combustion appliance problems. Based on recent California Air Resources Board studies, California children spend an average of 70 percent of their time indoors at home, and adults and adolescents spend about 62 percent of their time indoors at home. Several studies have found that a large number of Californians use **unvented combustion appliances** for heating their homes. This practice can be especially dangerous.

TABLE 1
HEALTH EFFECTS AND SOURCES
OF INDOOR COMBUSTION POLLUTANTS

POLLUTANT	DESCRIPTION	HEALTH EFFECTS	SOURCES
CARBON MONOXIDE (CO)	Colorless, odorless, tasteless gas	Death at very high levels, headache, fatigue, queasiness, poor vision and concentration, heart pains	Malfunctioning gas appliances, improper use of gas stoves, woodburning, kerosene heaters, charcoal grills, idling cars in enclosed garages, polluted outdoor air
NITROGEN DIOXIDE (NO₂)	Colorless, tasteless gas. Sharp odor	Lung damage, lung disease after long exposure, respiratory infections	Gas stoves, malfunctioning gas appliances, woodburning, kerosene heaters, charcoal grills, motor vehicles
PARTICLES (PM₁₀)	Small, inhalable particles	Nose, throat and eye irritation, emphysema, bronchitis, allergies, asthma, respiratory and ear infections, lung cancer	Tobacco smoke, woodburning, kerosene heaters, charcoal grills, cooking, incense burning, house dust, hobbies, polluted outdoor air
POLYCYCLIC AROMATIC HYDRO-CARBONS (PAHs)	Organic particles and gases	Lung, stomach, bladder, and skin cancer. Nose, throat, and eye irritation	Tobacco smoke, woodburning, kerosene heaters, charcoal grills, self-cleaning ovens, incense burning, cooking, hobbies, polluted outdoor air

In addition, many homes have **vented combustion appliances** that can produce dangerous levels of pollutants due to malfunctions or poor maintenance, even in newer homes. The malfunctioning of vented combustion appliances may be on the rise in California due to lack of maintenance and inadequate ventilation in tight buildings. Fortunately, we can all apply simple steps and common sense to greatly reduce our exposure to combustion pollutants.

SOURCES OF COMBUSTION POLLUTANTS

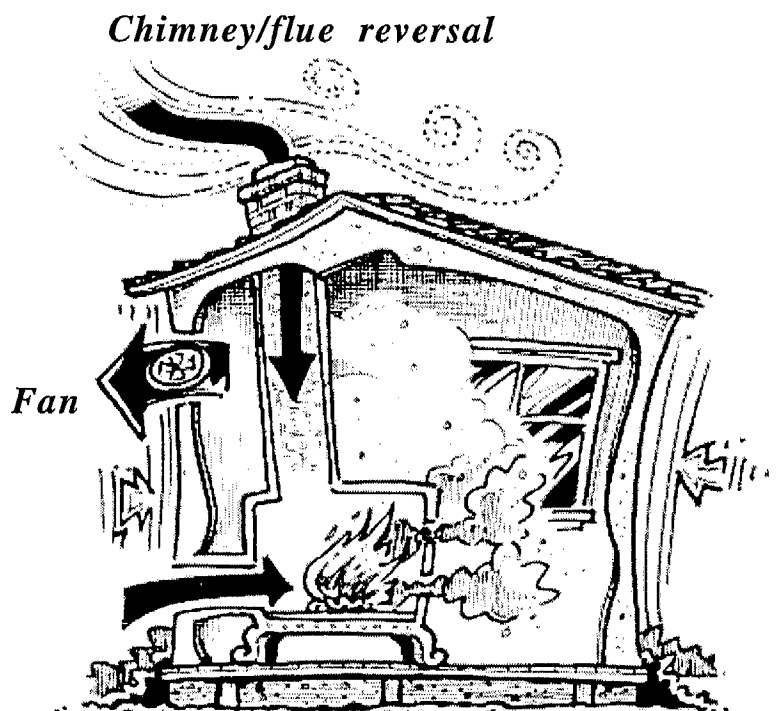
Numerous sources of combustion pollutants are present in California homes, as shown in Table 1. Almost all of these sources and their pollutants are avoidable. The type and amount of combustion pollutants in the indoor air depend on many factors — source type, fuel type, how the source is used, appliance installation and maintenance, house ventilation, and other factors, as discussed below.

Unvented combustion appliances, which include most gas stoves, kerosene space heaters, and charcoal grills, release combustion pollutants directly into the home. Consequently, they can routinely produce high levels of indoor air pollutants. The use of gas stoves for home heating and the use of charcoal grills indoors can produce dangerously high levels of indoor air pollutants. Even pilot lights in gas appliances within the living space can contribute to indoor air pollution.

Vented combustion appliances, which include most furnaces, woodstoves, fireplaces, gas water heaters, and gas clothes dryers, are designed to exhaust the combustion pollutants directly to the outdoors through a flue or chimney. However, they can sometimes produce very large amounts of indoor pollutants due to **exhaust leakage**. Exhaust leakage can be caused by a cracked heat exchanger, a leaking or blocked flue or chimney, or an uncovered pilot light in a floor furnace. Heat exchangers and flues typically last 10-15 years, but they sometimes develop cracks or leaks much sooner; they should be checked regularly.

Vented combustion appliances can also cause severe indoor pollution due to “**spillage**,” which is the flow of combustion pollutants from the appliance directly into the home. Spillage is more likely to occur in homes with a common vent for the furnace and water heater and in homes with large exhaust fans such as downdraft cooktop vents.

**SPILLAGE OF
COMBUSTION
POLLUTANTS
CAN BE CAUSED BY
BACKDRAFTING**



Spillage of combustion pollutants often follows a condition called “backdrafting,” which is air flowing backwards through a chimney or flue instead of outward as intended. Backdrafting can happen easily due to lowered air pressure inside a house, or “depressurization,” created by air being exhausted by other chimneys, exhaust fans, or forced air systems without adequate air replacement. Backdrafting is most likely to happen in milder climates, in homes with fireplaces, and in homes that are built air-tight without enough ventilation.

Environmental tobacco smoke (ETS), or second hand smoke, is a complex mixture of particles and gases that comes mostly from the tobacco smoldering between puffs. ETS is often **the major indoor source** of inhalable particles and PAHs. It is also a significant source of a number of other cancer-causing pollutants and strong irritants.

Other activities can also produce very high levels of indoor combustion pollutants. Examples of activities that can be significant include: idling motor vehicles or operating fuel-burning heaters in enclosed garages; grilling or burning food; using the oven cleaning cycle; hobbies using an open flame, such as welding; and burning incense.

Housedust and soil. Indoor particles and PAHs from combustion sources stick to housedust. Outdoor particles and PAHs from combustion sources stick to soil that is tracked into homes, especially by pets and children. Housecleaning activities such as vacuuming re-suspend housedust and tracked-in soil into the air. The pollutants in housedust can be inhaled, absorbed through the skin, or swallowed through hand-to-mouth contact. This is most likely to happen with young children, who spend much time on the floor.

Outdoor air that contains high levels of combustion pollutants can contaminate the indoor air, especially when windows or doors are left open. Examples of outdoor sources include: nearby woodstoves and fireplaces; outdoor barbecues; nearby vehicle traffic; gasoline-powered lawn and garden equipment; and portable generators.

HEALTH EFFECTS OF COMBUSTION POLLUTANTS

The health effects of combustion pollutants are diverse and serious. Some combustion pollutants can be very toxic, even at concentrations sometimes found in homes. Some, such as carbon monoxide and nitrogen dioxide, act within minutes or hours, while others may have an effect such as cancer or chronic bronchitis that does not show up for many years. People usually inhale combustion pollutants along with other pollutants encountered at the same time, which may increase the overall toxicity. The major health effects of indoor combustion pollutants are summarized in Table 1 and discussed further below.

Carbon monoxide (CO) is especially hazardous because it is a colorless, odorless gas that can quickly starve your blood of oxygen. About 25 people die each year in California from accidental CO poisoning caused by indoor combustion sources that are installed, used, or maintained improperly. High, non-fatal exposures to CO cause memory loss, personality changes, and vomiting. CO poisoning can be difficult to diagnose because blood CO is only a good indicator if measured immediately after CO exposure.

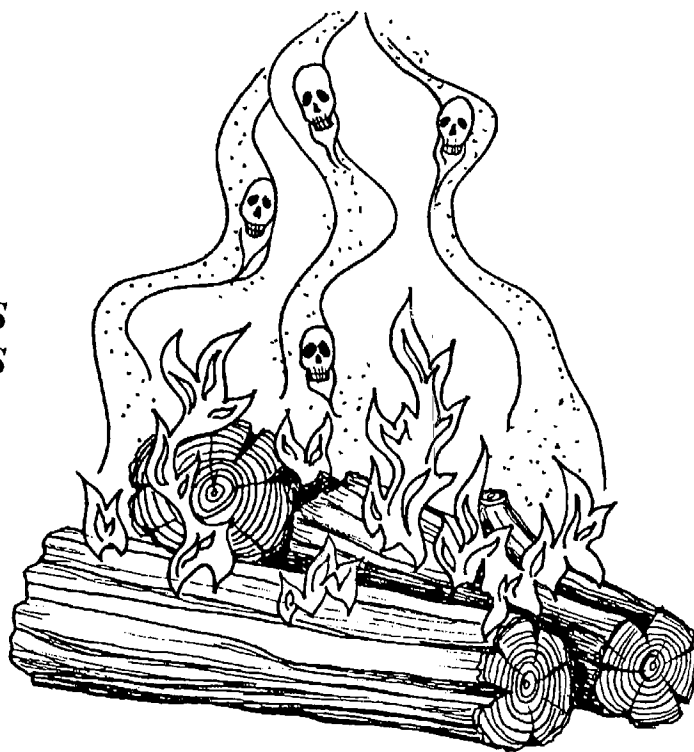
Moderate exposures to CO can produce symptoms that are often confused with influenza symptoms. These symptoms include headache, fatigue, nausea, dizziness, chest tightness, and impaired vision and coordination. Such exposures can also worsen the symptoms of cardiovascular disease such as angina and reduce one's capacity for physical exertion. Another potential warning sign of high CO levels is when household pets show fatigue, vomiting, or poor coordination, or when they die unexpectedly; it may be due to CO exposure.

Nitrogen dioxide (NO₂) is a colorless, sharp-smelling gas that irritates your eyes, nose, throat, and lungs. It can cause coughing, headache, and nausea. Short-term exposures to NO₂ at levels that can occur indoors can reduce breathing ability and increase the risk of respiratory infection, especially in young children. Long-term exposure may result in permanent damage to lung tissues. Nitrogen dioxide or some of its acidic by-products may also magnify the health effects of other air pollutants such as ozone and particles.

Particles produced by indoor combustion sources are typically small enough to be deposited deep in the lung. These particles, together with the toxic substances attached to them, remain in contact with the most sensitive parts of the lung. Long-term exposure to these particles can cause lung cancer, heart disease, and bronchitis. The immediate effects of exposure to particles are irritation of the eye, nose, and throat, coughing, and an increased risk of respiratory infections.

Polycyclic aromatic hydrocarbons (PAHs) exist as both gases and particles. They are often tar-like and can be found in smoke, soot, ash, and creosote. The main indoor sources of PAHs are tobacco smoking and wood burning, and the grilling and burning of food. Most sources of airborne PAHs emit several PAH compounds that have been linked in human studies to cancers of the lung, stomach, skin, and bladder. Exposure to burning incense, which produces large amounts of PAHs and other pollutants, has been linked to cancer. Although the primary health concern from PAHs is cancer, some studies indicate that very high levels of exposure to PAHs may also affect the reproductive system.

***COMBUSTION PRODUCES
MANY TOXIC POLLUTANTS***



It should be noted that some types of smoke, such as cigarette and wood smoke, contain many different toxic substances besides those discussed above. In addition, combustion appliances can also produce large amounts of moisture; ongoing spillage from unvented or vented combustion appliances can lead to indoor mold and fungus problems.

PEOPLE ESPECIALLY SENSITIVE TO COMBUSTION POLLUTANTS

People in certain age groups or with certain health conditions can be especially sensitive to some of these pollutants. That is, they suffer more severe health effects than other people at the same level of pollutant exposure. Specific examples are listed below:

- o **Young children** exposed to environmental tobacco smoke (ETS), wood smoke, or NO₂ are more likely to have respiratory infections and reduced breathing ability. Children exposed to ETS are also more likely to have chronic ear infections and behavioral problems.
- o **People with asthma**, especially young children, are more likely to suffer more severe or frequent symptoms when exposed to ETS, wood smoke, particles, or NO₂. ETS exposure can also increase the likelihood of children becoming asthmatic.
- o People with certain kinds of **heart disease** can experience sharp heart pains (angina) at much lower exposures to CO than those that affect healthy people.
- o People with **heart or lung disease, who are often elderly, and people with anemia** (reduced oxygen transport by the blood) are more sensitive to the effects of combustion pollutants than most people. Unfortunately, they often spend more time indoors and have longer exposure to indoor pollution.

In addition, some people may be more susceptible to CO toxicity after certain activities, such as drinking alcohol or being recently exposed to high levels of CO outside of their home, such as in heavy vehicle traffic

HOW TO REDUCE LEVELS OF COMBUSTION POLLUTANTS IN YOUR HOME

You can take several easy steps to reduce the health risks of combustion pollutants to you and your family. In general, you should always:

1. remove the sources of combustion pollutants in and around your home;
2. ensure proper installation, use, and maintenance of vented combustion appliances; and
3. ensure balanced and adequate ventilation of your house.

The specific steps you should take depend on your personal circumstances, including the combustion sources present in your home, your family members' sensitivity to combustion pollutants, and the

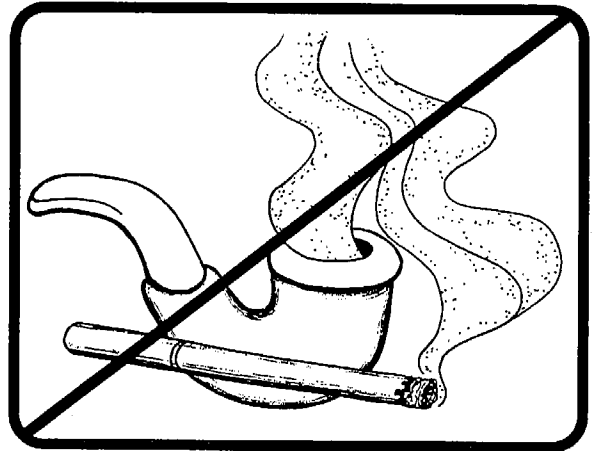
practicality of each approach for you. To **develop your own action plan**, select the following steps that best fit your situation.

1. REMOVE THE SOURCES OF COMBUSTION POLLUTANTS IN AND AROUND YOUR HOME.

The only sure way to eliminate indoor combustion pollutants is to **keep combustion sources out of your house**. Some indoor pollutants are very difficult to remove once they have spread throughout the house, especially if the pollutant levels are high or the pollutants attach to carpets, furniture, and other surfaces.

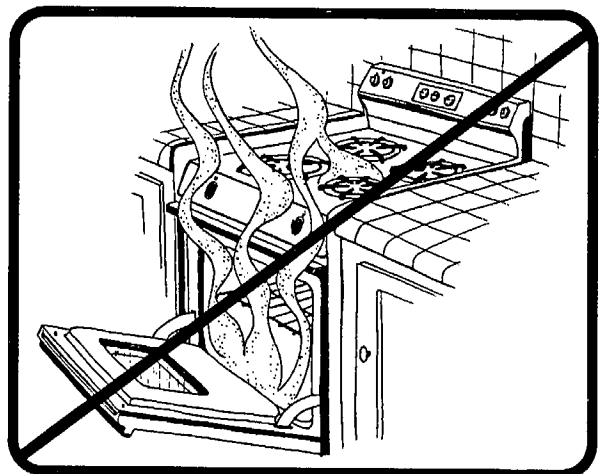
Keep any smoking product outdoors.

- o **Keep tobacco smoke outdoors** and away from open doors or windows, especially if children or chronically ill people are present. ETS lingers in rooms, attaches to surfaces and house dust, and is hard to remove by ventilation. ETS increases the likelihood of cancer in nonsmokers.
- o **Remove burned food** or smoking pans to the outdoors.
- o **Avoid burning incense indoors.** If you must, close the door and open the windows when burning incense so that pollutants cannot spread to other parts of the house.
- o If a **hobby or repair activity** produces smoke or fumes, perform it outdoors, in an open garage, or under a hood (use of a range hood may be appropriate) vented to the outdoors. Examples include welding, soldering, and the hot-sealing of nylon fabrics.

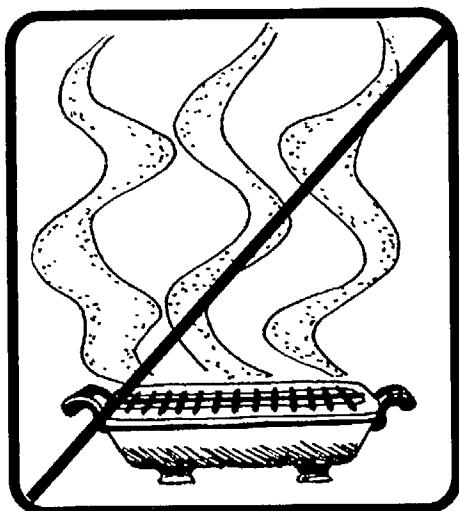
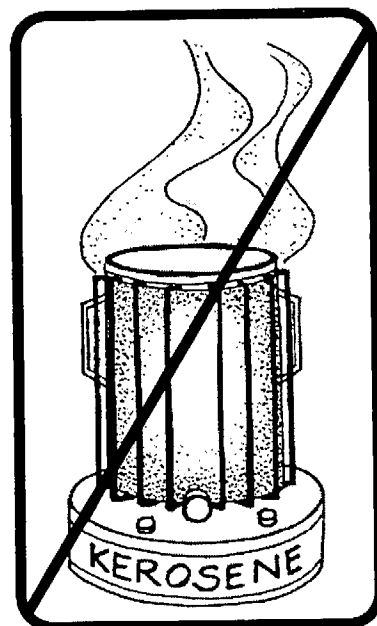


Do not use UNVENTED combustion appliances indoors.

- o **Gas stoves and ovens should not be used for heating your house.** When cooking with gas appliances, be sure to use a range hood that vents to the outdoors, or at least open windows for cross-ventilation.



- o **Do not heat rooms or houses with kerosene- or gas-fired space heaters.** California law prohibits the advertising and sale of such unvented combustion space heaters for residential use, and State building standards require combustion heating systems to be vented directly to the outside.

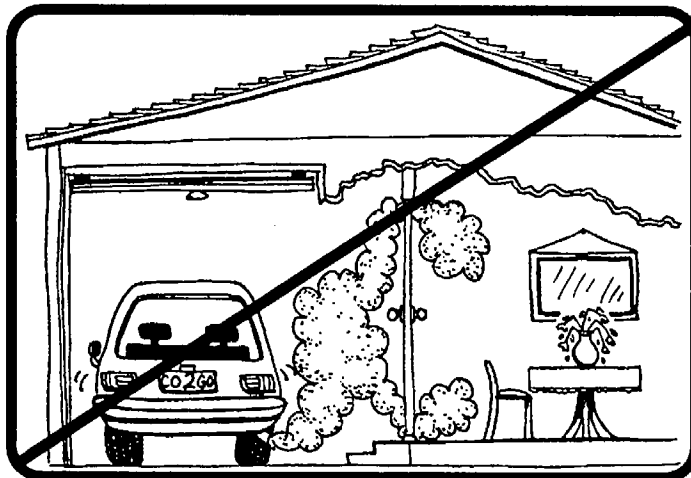


- o **Do not use charcoal grills indoors** for cooking or heating. This is an extremely hazardous practice.

Consider alternatives to unvented combustion appliances:

- o **Weatherize your home** to reduce heating needs. Contact the California Department of Economic Opportunity, your county social service department, your local utility, and the California Energy Commission for information and possible financial assistance. Be sure to provide balanced ventilation before your house is made very air-tight.
- o **Use your central heating system** if you have one. If it is inadequate, have your central heating system tuned up or replaced with a more efficient model. It may be cheaper in the long run than using an unvented heater, and it is certainly safer.
- o **Install a gas fireplace with a sealed combustion (direct-vent) feature** (but not an unvented gas log). Gas fireplaces look like wood stoves and are vented to the outdoors. They are relatively very efficient (up to 81%), less expensive to install and use, easier to maintain, and of course, much cleaner-burning.

Do not operate motor vehicles, lawnmowers, or other combustion engines in an enclosed garage attached to your home or near an open window. These situations can rapidly produce very high concentrations of indoor combustion pollutants in your garage and in your home. You should also weatherstrip any doors or openings from the house to the garage, and make sure that a furnace or air conditioner does not pull air from the garage into the house.



Turn off pilot lights on gas stove tops and use sparker instead. You can easily turn off the pilot lights by lifting up the stove top and then completely closing the screw that adjusts the gas supply to the pilot. Check for leaks in the small gas line to the pilot lights by applying a soapy solution and looking for bubbles. If you see bubbles, call your local utility for assistance in fixing the leak.

If your gas line is fine, you can use a hand-held sparker to start stove-top burners. Sparkers can be purchased at hardware stores for \$3-10. If the burner does not light at first, turn off the burner and ventilate the area before trying again. Using a sparker will reduce indoor pollutant levels and save energy too.

2. INSTALL, USE, AND MAINTAIN VENTED COMBUSTION APPLIANCES PROPERLY.

Choose and install vented combustion appliances carefully.

- o **Choose new appliances that are unaffected by backdrafting (depressurization),** such as sealed combustion (direct vent) appliances, induced-draft appliances, electric appliances, or solar systems. Induced-draft systems, which use a fan to assist removal of combustion pollutants through the flue, can also be added to existing furnaces.

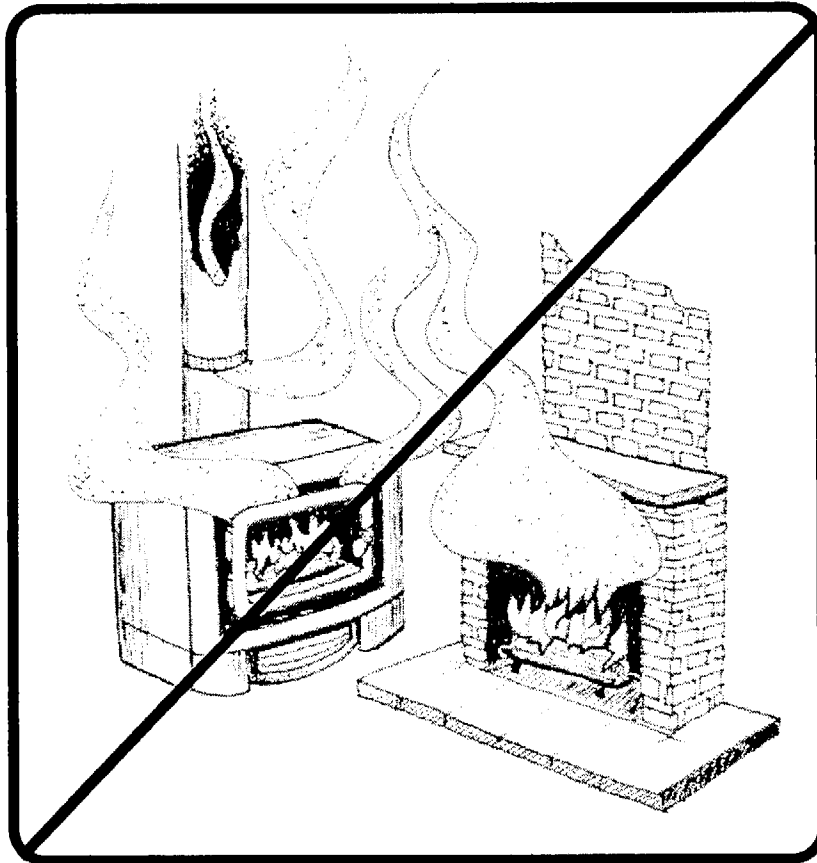
For example, you can choose a safer alternative to woodburning appliances, such as the sealed combustion gas fireplace discussed above. Fireplaces and woodstoves are prone to spillage and may cause spillage from other combustion appliances as well. This can produce a very hazardous situation, especially overnight while you are sleeping. Fireplaces also waste much energy. **You should especially avoid woodburning if young children or people with chronic lung disease, such as asthma, live in the home.** Wood smoke pollutes the outdoor air in your neighborhood, and subsequently pollutes the indoor air. (See ARB's Woodburning Handbook for further information on the impacts of woodburning). If you are building or remodeling a house, you can **save thousands of dollars by not installing a wood stove or fireplace.**

- o **Balance the air flows from exhaust fans and blowers,** especially for high-flow devices such as downdraft and island range hoods, by carefully matching exhaust and supply flows. You can wire the supply and exhaust fans to operate at the same time. To avoid drafts from the outdoor air, place the air supply away from main living areas and supply the air through a ceiling diffuser to ensure good mixing.

Use and maintain vented combustion appliances properly .

- o **Use and maintain fireplaces and woodstoves properly.** Remember that all components should be inspected and repaired before each heating season, and that wood stove catalysts require replacement about every 5-7 years. See ARB's Woodburning Handbook for tips on operating and maintaining the lowest-polluting type of woodstoves. For additional information on proper maintenance and reliable in-home performance over time, see the Best Emission Stove Technology report by Oregon's Department of Environmental Quality. Good operation and maintenance of woodburning appliances will greatly reduce, but not completely eliminate, the escape of pollutants to the indoors.

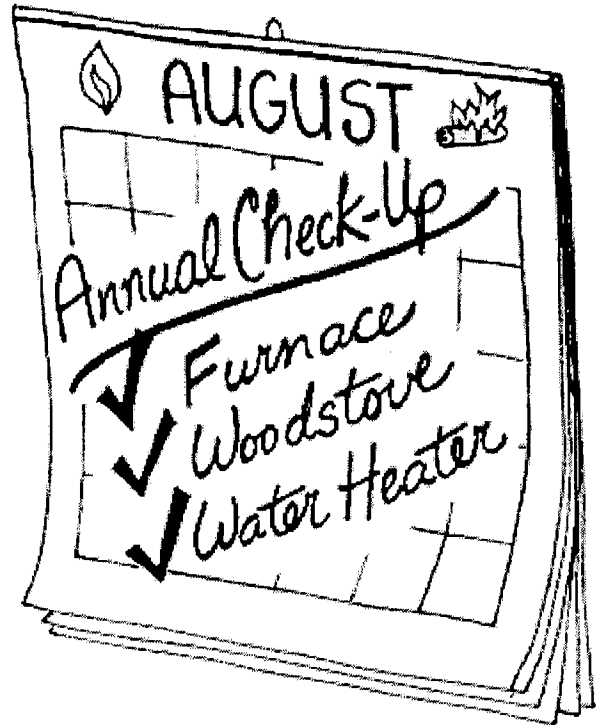
***DO NOT USE LEAKING OR MALFUNCTIONING
FIREPLACES OR WOODSTOVES***



- o **If you smell wood smoke or charred wood odors** from your fireplace or wood stove at anytime, then you have a spillage or backdrafting problem that can harm your family's lungs or risk their lives. Make sure the flue pipe and appliance are airtight. Install a small fan that is specifically designed to supply outdoor air near the appliance. Install a chimney cap to prevent backdrafting from high winds. See the following section on ventilation to find out how to prevent spillage and backdrafting.

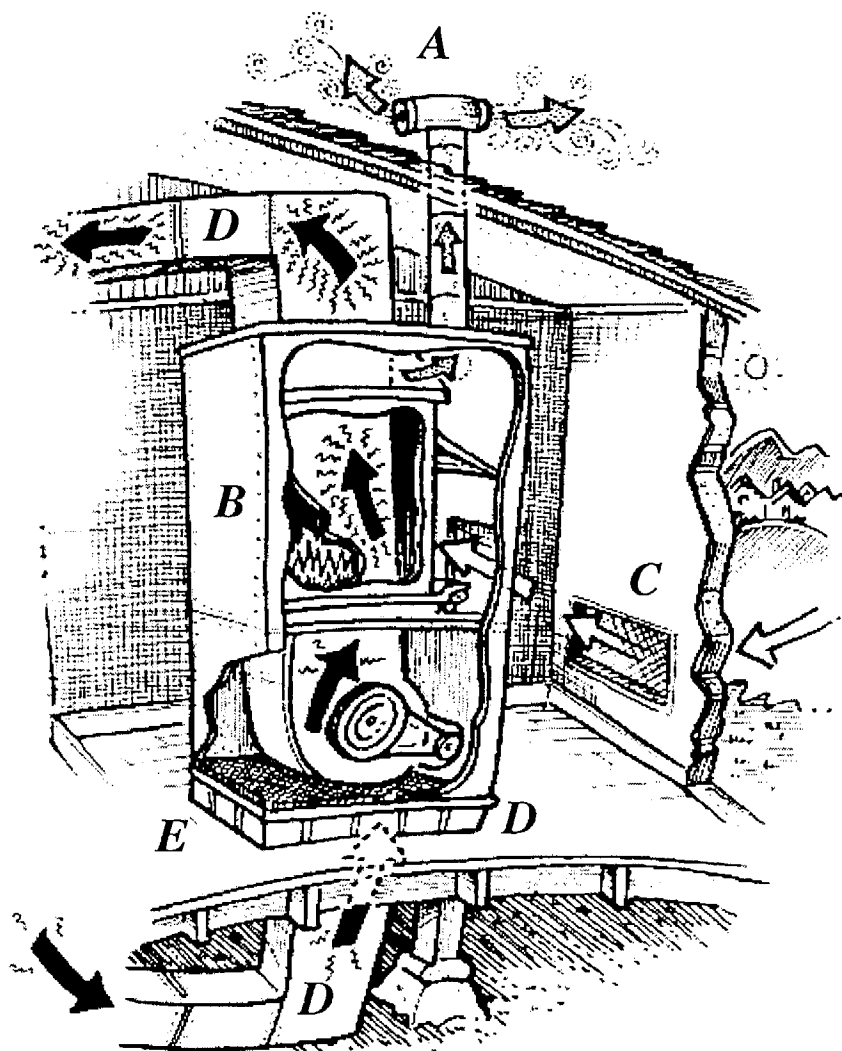
- o **Have a trained professional inspect, clean, and tune your gas appliances every year.** Look for an orange or yellow flame in the furnace burner as a rough indication of a cracked heat exchanger or other problems; the flame should be blue. For a reliable indication, have the heat exchanger tested with a tracer gas test or CO monitor that detects 10 parts per million or less. Have propane-fueled appliances checked for the proper conversion features. Clean the burners and check the air supply. Utility service personnel often conduct safety checks free of charge, but they may only conduct limited inspection and testing. Contact the California Department of Economic Opportunity for information on combustion safety tests, including backdraft testing and prevention. Make any necessary repairs promptly.

***SCHEDULE REGULAR
MAINTENANCE OF YOUR
COMBUSTION APPLIANCES***



- o **Be sure that the exhaust venting systems of your combustion appliances are installed properly, and check regularly for potential blockage or leakage.** Ensure that all exhaust flues go directly to the roof or exterior wall. Check that exhaust flues do not slope downward, have no more than a few bends, and are not blocked by a bird nest, debris, and so on. Make sure the cone over the water heater exhaust vent is not tipped or filled with dust or debris. Look for loose flue pipe connections and leaks between sections; wood stove flues may show tar or discoloration near leaks.
- o **Check your forced air heating system for proper air distribution in order to reduce the need for heating with furnaces, stoves, or space heaters.** First check each vent to be sure it is open and supplying a reasonable amount of air flow. If you smell gas or propane, call your utility or service person to fix this safety hazard before taking the next steps. You or a weatherization contractor should check all ductwork and connections for leaks, using an incense or smoke stick near duct connections while the blower fan is running. Clean the surfaces around leaks with a small amount of solvent, then seal any leaks with mastic cement or caulks for ducts (SMACNA or UL approved). Do not use duct or aluminum tape because it usually falls off within a short time.

WHAT TO CHECK ON YOUR FURNACE

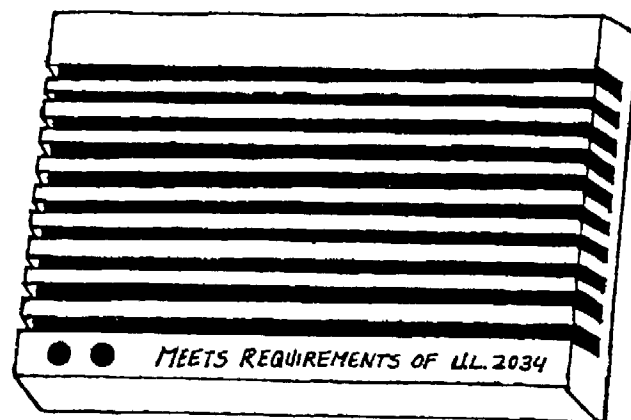


- A. *Blocked flue or chimney*
- B. *Cracked heat exchanger*
- C. *Blocked combustion air supply*
- D. *Leaky ducts*
- E. *Dirty filter*

Consider installing a carbon monoxide alarm.

If you have an older combustion appliance, a wall or floor gas furnace, a propane appliance, a fireplace, a wood stove, or a combustion appliance in a very tight home, you should install one or more CO alarms. Several CO alarms certified by Underwriters Laboratory are available that will reliably warn you of life-threatening levels of CO. Some CO alarms will also warn you of unhealthy but non-lethal levels of CO. Carbon monoxide alarms currently cost about \$40-\$80, depending on the features and available discounts. Contact the ARB for further information on CO alarms and monitors.

CARBON MONOXIDE ALARM

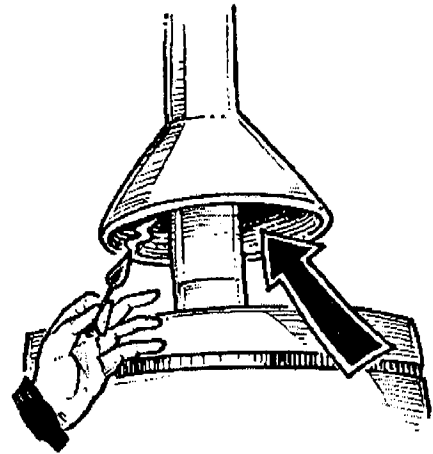


3. ENSURE BALANCED, ADEQUATE VENTILATION OF YOUR HOUSE.

Check your exhaust ventilation systems for backdrafting and spillage.

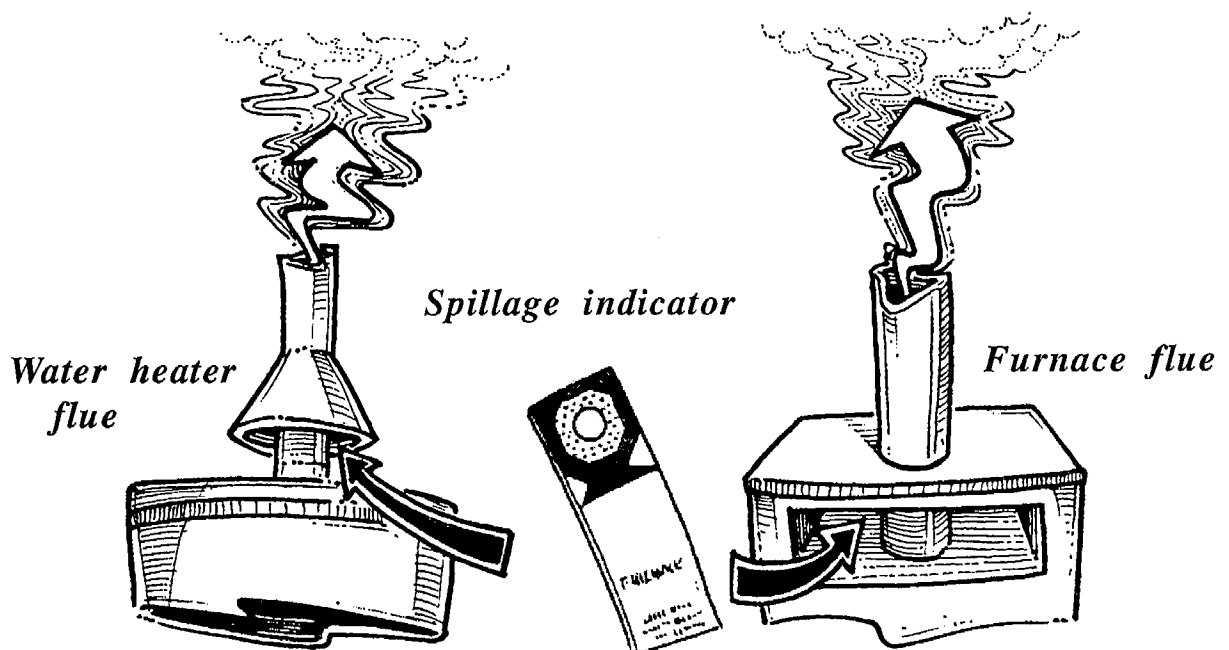
- o Check chimney/flue reversal by using the Homeowner's Chimney Safety Checklist developed by the Canada Mortgage and Housing Corporation (CMHC). A smoke source such as an incense stick or burning wooden matchstick is used to make sure smoke goes up the chimney or flue while exhaust devices (including the furnace blower and clothes dryer) are activated. If you do not have a fireplace, a wood stove, or high-flow exhaust fans, you probably do not need to use this Checklist.

**MAKE SURE CHIMNEYS AND
FLUES VENT WHEN FANS
AND BLOWERS ARE ON**



- o **Spillage indicators** are heat-sensitive dots on a small card that will change color if they detect any significant spillage of hot combustion gases. They cost about \$3. Consider attaching them to gas furnaces and water heaters. Check them weekly and replace them annually. Also check near the flue for extensive rust or soot as an indicator of spillage.

INSTALL SPILLAGE INDICATORS



- o **If you are building a new home or weatherizing an older home, hire a qualified contractor to conduct the Chimney Safety Test**, also developed by CMHC. The duct leakage is checked and indoor-outdoor pressure differences are tested with a special fan to ensure that the recommended house depressurization limit is not exceeded. The contractor should have experience conducting combustion safety tests for State and utility weatherization programs.
- o **Make sure that sufficient combustion air from outside the house is supplied to gas furnaces and water heaters.** The best approach is to use a sealed-combustion appliance, or a “direct-vent” model, whose combustion air and exhaust venting are completely separated from the home’s interior. If your furnace or water heater is located outside the heated space of your home in an interior closet or a basement, check with the local building department for information on proper sizing of the supply air ducts or floor openings. After ensuring that the appliance has its own air supply, seal any openings to the living space or ductwork.

Use and maintain range hoods for gas stoves.

- o Range hoods that are vented to the outdoors can greatly reduce indoor levels of pollutants, odors, and excess humidity produced by cooking. To prevent blockage of the fan’s air flow, **clean the metal mesh filters** on exhaust fans with detergent when they begin to look grimy, especially if you fry food often. Most filters can be washed in a dishwasher.
- o **Check your exhaust fan for proper installation.** Ducting to the outside should have at least a 4-inch width, avoid very long runs, have no more than a few bends, and use only half-inch screen mesh at the outlets in order to maintain adequate air flow.
- o Some range hoods (the ductless type) blow back into the room, so they do little to clean the air. If you have one of these, open a nearby window or door when you use the stove. Seriously consider **replacing a ductless range hood with a properly ducted hood.**
- o If you are building or remodeling a home, **select range hoods that are quiet, easy to use and maintain, and efficient at removing pollutants.** To avoid noise and vibration problems, choose a range hood with a balanced fan and the lowest noise rating available. The lowest noise levels of currently available hoods with fans are about 4.5 sones (a sone is a unit of sound level similar to decibels). **Much lower noise levels are achieved by installing the fan in a remote location** (roof, outside wall, or attic), or by installing a ducted whole-house mechanical ventilation system. Quiet fans may be more expensive in the short run, but they will pay for themselves in reduced maintenance and energy costs.

For the most effective removal of pollutants by the range hood: 1) **install the stove and hood on a wall** rather than in a peninsula or island layout; 2) **cover the cooking surface** as much as possible and locate the hood 24 inches or less above the cooking surface; 3) **use the rear cooking surface** of the stove whenever possible; and 4) use **full-length side shields** made of heat-resistant material to help contain cooking emissions during cooking. Downdraft units and microwave hood units are not nearly as effective as conventional hoods in removing cooking pollutants. The hood should be able to exhaust **at least 200 cubic feet of air per minute when installed.** If you use a high-flow exhaust fan (300 cubic feet per minute rating or more, such as a downdraft stovetop exhaust), make sure to **check for backdrafting problems** (see above).

4. USE AND MAINTAIN AIR CLEANING EQUIPMENT.

- o **Consider improving the air filter in your central air system.** Typical air cleaning equipment in homes only removes a small portion of the particles (about 10-20 percent efficient) and practically none of the gases in combustion emissions. You can easily upgrade to a **furnace filter with a pleated or extended surface** that has a medium-efficiency (about 50 percent efficient). You can purchase these for a few dollars more at hardware or home supply stores.

High-efficiency filters (90-95 percent efficient) can be added to central air systems at a somewhat higher cost. However, they may require a more energy-efficient fan to maintain adequate circulation. Use weatherstripping or duct tape to get an air-tight seal around the filter if necessary.

- o **Check your furnace filter at least every month or two** during periods of use (heating or cooling); change the filter if it is covered with dust.
- o **Consider other steps to remove particles from your home.** Frequent house cleaning with a vacuum cleaner that has a high-efficiency filter will help keep indoor particle levels down, especially if there are children or pets running in and out of the house. Leaving your shoes by the door, using a door mat outside, damp mopping the floors, and dusting with a damp cloth also help. Central vacuum systems, which exhaust air to the outdoors, can efficiently remove indoor dust particles, but they require a balanced supply of outdoor air when used.

Some air cleaners can help reduce certain pollutant levels. Large stand-alone air cleaners that use electrostatic precipitation can have particle removal efficiencies of greater than 90 percent. Combination air cleaners for both gas and particle removal usually include a layer of charcoal and can be effective in small areas, such as single rooms where a person is confined due to illness. Small desk-top air cleaners are generally not effective. Remember that air cleaning equipment and vacuum cleaners must be cleaned and checked regularly for leaks, dirty filters or bags, and other malfunctions in order to remain effective.

INDOOR CONCENTRATION GUIDELINES

Several health-based air concentration guidelines or standards for combustion pollutants have been developed by public health institutions. These standards and guidelines define the maximum legally allowable or recommended **concentrations of pollutants for specific measurement periods such as one hour or eight hours**. The concentration values are given as parts per million (ppm) or micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). The most applicable guidelines and standards for combustion pollutants are summarized in Table 2.

As shown in Table 2, the standards adopted by the California Air Resources Board are usually the most health-protective of outdoor air standards. The World Health Organization guidelines deal with both indoor and outdoor levels of pollutants, while the Canadian guidelines address only pollutants commonly found inside homes. Because these standards and guidelines are defined as the concentrations and exposure times that are safe and above which harm to human health may occur, **they can be applied equally well to indoor or outdoor environments.**

TABLE 2

AIR POLLUTION STANDARDS AND GUIDELINES FOR COMBUSTION POLLUTANTS
AND OUR RECOMMENDED MAXIMUM EXPOSURE LEVELS¹

COMBUSTION POLLUTANT	MEASUREMENT PERIOD	OUTDOOR AIR STANDARDS ² EPA CARB	INDOOR GUIDELINES ³ WHO CANADA	RECOMMENDED EXPOSURE LEVELS	MAXIMUM LEVELS
CARBON MONOXIDE (CO)	8 hours	9 ppm	9 ppm	11 ppm	9 ppm
	1 hour	20 ppm	25 ppm	25 ppm	20 ppm
	1 hour, emergency action	40 ppm			40 ppm
NITROGEN DIOXIDE (NO ₂)	24 hours		0.08 ppm		0.08 ppm Avoid repeated high exposures
	1 hour	0.25 ppm	0.21 ppm	0.25 ppm	0.25 ppm
PARTICLES (PM ₁₀)	24 hours	50 ug/m ³			50 ug/m ³
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)		No safe level	No safe level	No safe level	Avoid or minimize exposure

1. "ppm" (parts per million) is a unit of pollutant concentration; it is equivalent to one drop of a pollutant in a million drops of water. "ug/m³" (micrograms per cubic meter of air) is a unit of pollutant concentration; it is equivalent to a pollutant weight of one-millionth of a gram in a space of one cubic meter (about one cubic yard) of air. See Sources of Additional Information for references for the standards and guidelines.

2. "CARB" is the California Air Resources Board. "EPA" is the U.S. Environmental Protection Agency.

3. "WHO" is the World Health Organization, a part of the United Nations. "Canada" is the Health Canada agency.

Our recommendations for maximum exposure levels in indoor air are also presented in Table 2. Exposure to levels at or below these concentrations over the specified measurement periods should be healthful for the general population, including pollution-sensitive people.

In general, **if you take the steps described above to reduce combustion pollutant levels in your home, your pollutant levels should be well below those indicated in Table 2.** Measurement of indoor combustion pollutant levels can be expensive and is not recommended unless, after taking the actions described in this Supplement, you still suspect a problem because of health symptoms experienced by household members, or because CO alarm signals or spillage indicator results indicate you may have a problem. For information on how to measure pollutant levels inside your home, contact the California Air Resources Board at the address listed at the end of this Supplement.

Carbon monoxide standards and guidelines. The State outdoor air quality standard for CO is 9 ppm or less over eight hours, and 20 ppm or less over one hour. This standard is designed to prevent blood CO levels from exceeding 2.0 percent in order to prevent angina attacks in heart disease patients and other adverse effects of CO. Outdoor CO concentrations of 40 ppm or more over one hour can trigger step-wise emergency abatement actions by local and State officials. Even healthy, less sensitive people may begin to experience adverse health effects at that exposure level.

Our recommended carbon monoxide guideline. Residential indoor CO levels typically average less than 5 ppm over 8 hours. We recommend that you maintain indoor levels of CO no greater than 9 ppm for eight hours and 20 ppm for one hour. If indoor levels of 40 ppm for one hour or more are measured in your home, act immediately to remove the source of CO (turn off the appliance or car and ventilate the building, for example) or evacuate the occupants until corrective actions are taken. This recommendation is consistent with the State standard and emergency plan; it should prevent adverse health effects known to occur in some individuals at both low and high levels of exposure.

If one or more of your household members or pets show any of the health effects listed in Table 1 for **CO and you have reason to suspect CO poisoning**, get your family/household members out of the building right away. See a doctor immediately, especially if you or a family member are in one of the sensitive groups listed earlier, and ask to have your blood CO levels checked. Call the fire department for immediate help in identifying any CO problem. If no obvious problems are found, you should consider calling a qualified weatherization contractor to conduct a detailed combustion safety test. Some CO problems can be difficult to identify.

Nitrogen dioxide standards and guidelines. The State outdoor air quality standard for NO₂ is 0.25 ppm or less for one hour. This standard is designed to protect children and sensitive adults from lung irritation and adverse changes in biochemistry and lung structure, and to limit atmospheric discoloration. The World Health Organization recommends air quality guidelines of 0.08 ppm or less for 24 hours and 0.21 ppm or less for one hour. The 24-hour value is intended to provide a margin of protection against long-term effects. The one-hour value is intended to provide a margin of protection for asthmatics.

Our recommended nitrogen dioxide guideline. Residential indoor NO₂ levels are typically 0.010 to 0.030 ppm over a two-day period, depending on the presence of significant indoor and/or outdoor sources. We recommend that you maintain indoor levels of NO₂ no greater than 0.25 ppm for one hour. This recommendation is based on the State standard, which is designed to protect sensitive individuals. We also recommend that you maintain indoor levels of NO₂ no greater than 0.08 ppm

for 24 hours in order to protect against long-term effects. These recommended levels may also provide additional protection from the effects of other related irritant nitrogen compounds.

Particle standards and guidelines. The State outdoor air quality standard for particles of 10 micrometers or less in diameter, called PM₁₀, is 50 ug/m³ or less over a 24-hour period. This standard is designed to prevent deaths from short-term exposures, worsening of respiratory disease symptoms in sensitive patients, and reduced breathing ability, especially in children.

Our recommended particle guideline. Residential indoor levels of PM₁₀ are typically about 40 to 100 ug/m³ (24-hour average), but daytime levels of PM₁₀ measured near people's breathing spaces as they move about are generally higher due to individual activities or sources near the person. We recommend that you maintain indoor PM₁₀ levels no greater than 50 ug/m³ over 24 hours. This recommendation concurs with the State standard, and offers protection to sensitive individuals. However, you should try to minimize all exposure to particles whenever possible because of the many toxic pollutants and allergens they contain.

Polycyclic aromatic hydrocarbon guidelines and standards. PAHs come from smoke produced by tobacco smoking, woodburning, cooking, and so on. Under Proposition 65, the State of California has listed a number of PAHs known to cause cancer. The California Air Resources Board has listed the group of chemicals known as Polycyclic Organic Matter (POM), which includes PAHs, as a Toxic Air Contaminant that is subject to regulation. As part of the Toxic Air Contaminant Program risk assessment process, the California Office of Environmental Health Hazard Assessment has concluded that benzo[a]pyrene, one of the most common PAHs, is a probable human carcinogen with no safe level or threshold of toxicity. Some other PAH compounds may be more toxic than benzo[a]pyrene. Based on the cancer-causing effects of PAHs, the World Health Organization has also concluded that there is no safe level for PAHs.

Our recommended PAH guideline. Indoor levels of individual PAHs in California homes typically vary from 0 to 0.001 ug/m³ over a 24-hour period. We recommend that you take all reasonable precautions to avoid PAHs or other pollutants that are known or suspected to cause cancer at any level. You should minimize your exposure to PAHs as much as possible, since no truly safe level of exposure has yet been identified by knowledgeable scientists.

ADDITIONAL BENEFITS

The actions recommended in this Supplement can greatly reduce your short- and long-term health risks from indoor combustion pollutants. They can also help you **save on your energy bills** and reduce the entrance of soil gases, such as radon, into your home. Other benefits of taking these actions include **reduced fire hazards and reduced impacts on outdoor air quality**. Finally, you can use some of the general approaches discussed here to reduce your family's pollutant exposures in **other enclosed spaces** such as motor homes, tents, and motor vehicles. In particular, carbon monoxide exposure in motor vehicles and motor homes can be a serious problem and has led to many deaths in California. Many of the general concepts discussed here also apply to schools, offices, and public buildings.

SOURCES OF ADDITIONAL INFORMATION

GENERAL INFORMATION, CARBON MONOXIDE ALARMS, SPILLAGE INDICATORS, AND POLLUTANT MONITORS:

California Air Resources Board
Indoor Exposure Assessment Section
Research Division
PO Box 2815
Sacramento, CA 95812
(916) 322-8282 (message line)

COMBUSTION APPLIANCES AND BUILDING CHARACTERISTICS:

Best Emission Stoves Technology Project, 1988. Crane, S. Report No. 88-2. Oregon Department of Environmental Quality, Air Quality Div., 811 SW 6th St., 11th Floor, Portland, OR 97204. 503/229-5353.

Certified Home Ventilating Products Directory, 1994. HVI #911, 11d, Residential Equipment, Air Delivery and Sound Levels. Home Ventilating Institute, 30 West University Drive, Arlington Heights, IL 60004-1893. 708/394-0150.

Homeowner's Chimney Checklist and Chimney Safety Test. Canada Mortgage and Housing Corporation, 700 Montreal Rd., Ottawa, Ontario K1A 0P7, Canada. 613/748-2000.

Indoor Air Quality Environmental Information Handbook: Building System Characteristics, 1987. U.S. Department of Energy, DOE/EV/10450-H1. Available from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161.

Kitchen Ventilation Series and Backdrafting (brochures). Minnesota Extension Service, University of Minnesota, St. Paul, MN 55108. 612/624-3780.

Residential Indoor Air Quality & Energy Efficiency, 1989. duPont, P. and Morrill, J. American Council for an Energy-Efficient Economy, 1001 Connecticut Avenue, N.W., Suite 535, Washington, DC 20036.

Residential Ventilation: Achieving Indoor Air Quality, 1988. Kadulski, R. The Drawing-Room Graphic Services Ltd., Box 866267. North Vancouver, B.C. V7L 4L2, Canada.

Woodburning Handbook, 1992. California Air Resources Board, Compliance Division, PO Box 2815, Sacramento, CA 95812. 800/952-5588.

HEALTH EFFECTS:

A Summary of the Emission Characterization and Noncancer Respiratory Effects of Wood Smoke, December 1993. Larson, T.V. and Koenig, J.Q., University of Washington, Seattle, WA. U.S. Environmental Protection Agency, Air Risk Information Support Center, Research Triangle Park, NC 27711, EPA-453/R-93-036. 919/541-0888.

Air Quality Standards in California: Particulate Matter (December 1982), Carbon Monoxide at Sea Level (August 1982 and December 1989), Nitrogen Dioxide (September 1985), Air Pollution Emergency Plan (September 1990). California Air Resources Board, Research Division, PO Box 2815, Sacramento, CA 95812.

Air Quality Guidelines for Europe, 1987. The World Health Organization, European Series No. 23. Available from WHO Publication Center, 49 Sheridan Avenue, Albany, NY 12210.

Benzofalpyrene as a Toxic Air Contaminant, 1994. California Air Resources Board, Stationary Source Division, PO Box 2815, Sacramento, CA 95812.

Exposure Guidelines for Residential Indoor Air Quality, 1987. Health Canada, Publications, Jeanne Mance Building, 19th Floor Tunney's Pasture, Ottawa K1A 0K9, Canada.

Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders, 1992. U.S. Environmental Protection Agency, Center for Environmental Research Information, Cincinnati, OH 45628, EPA/600/6-90/006F.

The Health Consequences of Involuntary Smoking, a Report of the Surgeon General, 1986. U.S. Department of Health and Human Services, DHHS(CDC087-8398). For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.



YOUR NOTES:

FURTHER ASSISTANCE:

California Air Resources Board, Indoor Exposure Assessment Section, Research Division, PO Box 2815, Sacramento, CA 95812. 916/322-8282 (message line).

Department of Economic Opportunity, Home Energy Assistance Program : 916/322-2940.

County Social Services Department (see "Government" section in local phone book; ask them for a listing of State Weatherization Contractors in your area): _____

State Weatherization Contractors (contractors qualified to do combustion safety testing for the Low Income Housing Energy Assistance and Weatherization Assistance Programs:

Utility Weatherization Programs (see "Gas and/or electric utility services" in local phone book)

Heating and Ventilating Contractors (see local phone book for contractors licensed to design and maintain combustion appliances, fans, and ductwork):

Chimney Sweeps (see local phone book):

Fire Department (see local phone book):

