



## Combustion gases in your home: What you should know about combustion spillage

### Are combustion gases spilling into your home?

Does your home have any of these combustion appliances?

- gas-fired furnace, boiler or water heater
- oil-fired furnace, boiler or water heater
- wood stove or fireplace
- portable propane, natural gas or kerosene heaters
- other fuel-burning devices (e.g. gas range)

They all produce heat and combustion gases as the fuel burns. Normally, these combustion products – which can include both visible smoke and various invisible gases – are vented to the outdoors through a chimney or vent pipe. Unfortunately, they may on occasion escape into your home, where they could raise a variety of health and other concerns.

Combustion spillage is a term for the unwanted flow of combustion gases into your home. The quantities involved are usually small. However, each year major or long-term incidences of combustion spillage do occur – sometimes with serious or tragic results. This important information about combustion spillage will alert you to some of the indicators and outline practical steps you can take to reduce the risks. You will learn how to keep combustion gases OUT of your home.

### Why the concern?

Because toxic compounds can be present in combustion gases, the presence of these gases in household air can lead to problems ranging from nuisance headaches to serious illness, carbon monoxide (CO) poisoning and even death.

Toxic and other harmful substances that can be found in the combustion gases include:

- CO (colourless, odourless and extremely toxic)
- polycyclic aromatic hydrocarbons
- aldehydes
- unburnt hydrocarbons

- sulphur oxides
- nitrogen oxides
- particulates (e.g. soot)
- carbon dioxide (CO<sub>2</sub>) and water vapour. Both are present in larger quantities and, although relatively harmless, can make the indoor environment uncomfortable or contribute to moisture problems in the home.

The composition and characteristics of combustion gases depend on several factors. These include the type of fuel being burned, the type of burner technology employed, the type of venting system used, and the condition of the heating system. These factors and how much fresh air circulates through your house affect the severity of their effects on your house and occupants.

## Understanding venting and spillage

### When things go right

Figure 1 illustrates a typical oil or gas forced-air heating system. The system generates two separate air flows.

#### Combustion air

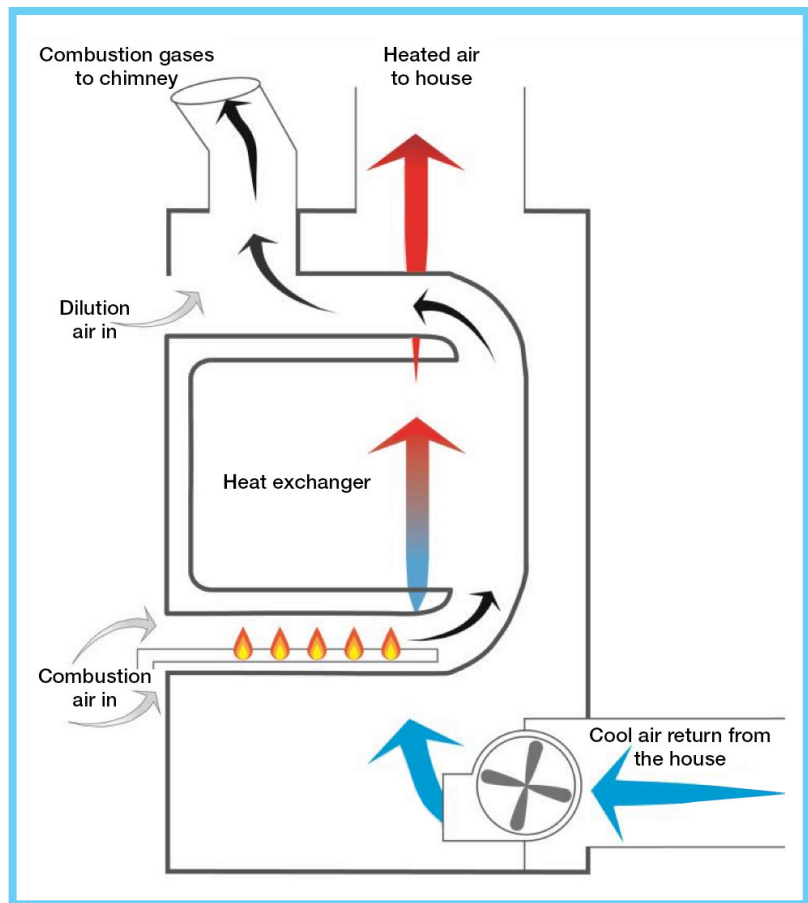
Depending on the type of heating equipment, the air required for combustion may be drawn into the equipment from the surrounding room or directly from outside the house. Heating equipment is designed to completely remove the resulting combustion gases from the home.

#### Circulation air

The heat generated in the space heating equipment is transferred to the living areas of the home. A forced-air system circulates heated household air. Cooler air enters the furnace, is heated in a heat exchanger, and is returned to the house via the heating ducts. In a properly operating forced-air furnace, the combustion air and the circulating air both flow through the furnace as it operates, but never mix (see Figure 1).

Hydronic heating systems – systems that rely typically on water and radiators to distribute heat – do not have a circulating air stream. However, they do require the same supply of combustion air and the removal of combustion gases as the forced-air systems.

**Similarly, gas- or oil-fired water heaters, fireplaces, and wood stoves all require combustion air and all require the combustion gases to be vented to the outdoors.**



**Figure 1.** Airflows in a basic forced-air heating system

### When things go wrong

Unfortunately, combustion systems do not always work as they should, and combustion spillage can be the result.

Sometimes this spillage is obvious. For instance, if you have a wood stove or fireplace, you may occasionally see smoke escaping into the room.

Or a dark stain on the wall above your fireplace could indicate combustion product spillage into the room on start-up or during use. In other cases, spillage may not be so evident, in part because the space heating equipment and water heater are usually located away from the main living areas of the home and are relatively clean burning. In addition, many combustion gases, especially from natural gas and propane, are hard to detect because they are invisible and have little or no odour.

Three major factors, working alone or together, can create conditions conducive to combustion spillage in your home. In addition to these factors, unusual winds can sometimes be at fault.

### Factor 1. Chimney or vent problems

The chimney's purpose is to remove combustion gases from the home. However, the chimney will not work properly if it is poorly designed, poorly installed or poorly maintained.

The many causes of inadequate chimney performance or failure include:

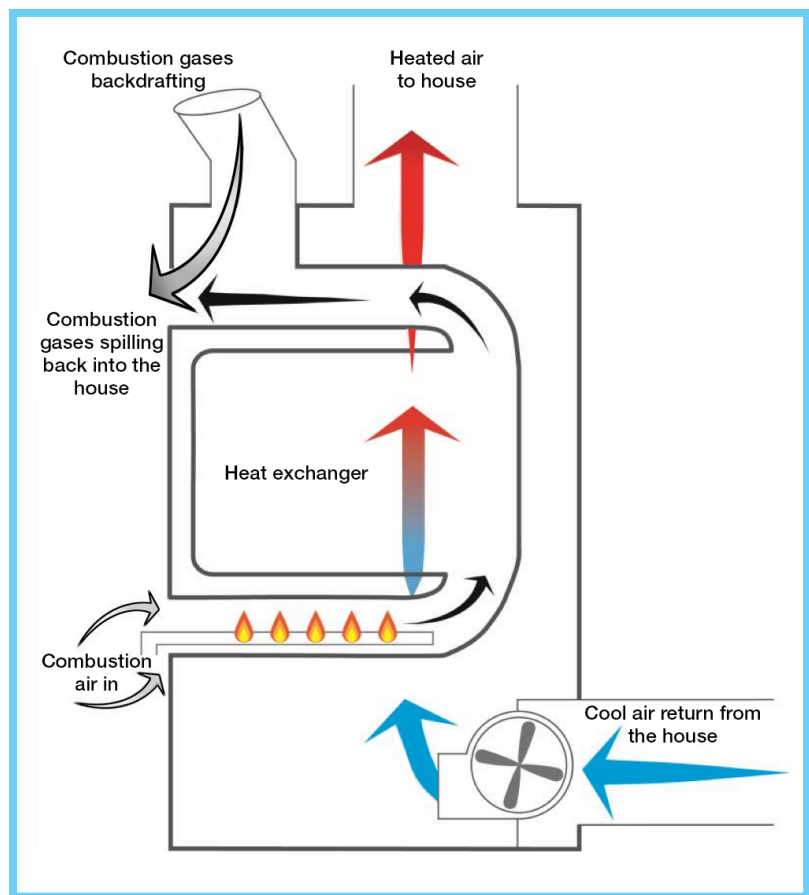
- **wrong size** - A chimney may be too small or too large to maintain adequate draft.
- **obstructions** - Bird nests, dead animals, broken bricks, collapsed liners and ice can block a chimney's air flow.
- **incorrect termination** – The wrong location or height of a chimney or the vent for combustion products can put the termination in a high pressure zone and cause draft problems.
- **corrosion** - Condensation, poor construction or poor installation can cause corrosion problems.
- **lack of insulation** - An uninsulated chimney on an exterior wall can become very cold when not in use. This can lead to condensation from moisture in the air. When the chimney next fills with moist combustion gases, the condensation may increase, at least until the chimney warms up. Condensation can damage the materials in the chimney and form ice. This in turn leads to problems such as crumbling

bricks and ceramic chimney liners, deformed metal liners, cracks, leaks, blockages, and poor draft.

### Factor 2. Equipment problems

Combustion appliances comprise several components and, like chimneys, they should be well-designed, properly installed, and regularly maintained. Otherwise, mechanical problems may prevent combustion gases from venting properly.

For example, a poorly maintained or damaged furnace or boiler burner may cause incomplete combustion of the fuel, resulting in low burner temperatures. This may cause initial spillage on start-up. Alternatively, a partially blocked or very cold chimney can also promote spillage (see Figure 2).



**Figure 2.** Combustion spillage from the dilution air inlet of a natural draft gas furnace

### Factor 3. Pressure problems

In the winter, we close up our homes. At the same time, we run exhaust fans and numerous other devices that exhaust air out of the house. In fact, many appliances, particularly fireplaces, can exhaust a considerable amount of air even when not operating. As a result, the air pressure indoors falls below the air pressure outdoors, and the house becomes depressurized. As the indoor pressure tries to equalize with the outdoors, fresh outdoor air is drawn into the house through openings such as cracks and gaps around windows, doors, and other openings in the building structure.

If the house is depressurized too much, air may be sucked back (i.e. the airflow reversed) through the chimney or vent system, especially in natural draft heating equipment. Natural draft equipment utilizes buoyancy to move the heated combustion products up the chimney or vent without the use of fans. When this happens, air flows down the chimney, rather than up – a condition known as a backdraft (see Figure 3). If you have ever opened the fireplace damper before lighting a fireplace and felt a big flow of cold air come into the room, you have encountered a backdraft.

Backdrafts occur most commonly during the “off” cycle of a combustion appliance. If the appliance starts while a backdraft is occurring, the downward airflow in the chimney may be difficult to reverse. Combustion product spillage could persist for as long after start-up as it takes for the backdraft to be reversed. In houses where the “on” cycle is short and the chimney is not insulated or warm, this type of start-up spillage may occur frequently because the chimney has little opportunity to heat up and establish a good draft.

For example, with wood burning, the combustion products during start-up are particularly dirty, so even minor spillage of this type is undesirable. Backdrafts can also occur while the combustion appliance is operating, such as in a fireplace with a smouldering fire. (See the section called *What about wood-burning fireplaces?*)

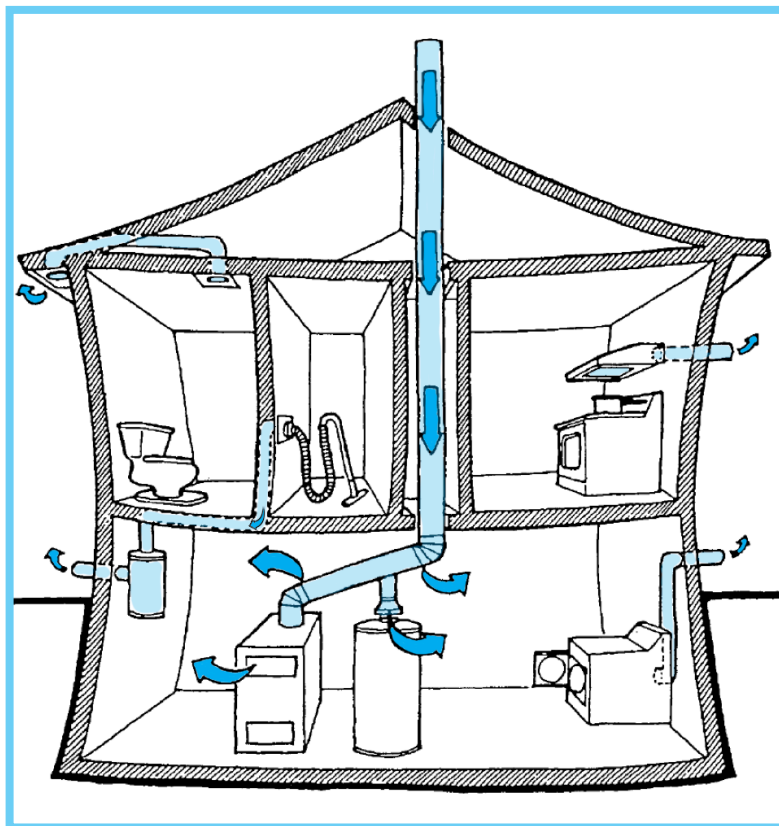


Figure 3. Backdrafts caused by depressurization

### Preventing combustion spillage

As the saying goes, prevention is the best cure. Some of the actions described here will be easier to implement if you are building, renovating or replacing existing equipment. Even if you are not, there is still a great deal you can do.

### Maintain combustion appliances

Start an annual maintenance routine for all your combustion appliances. Get help to do this from a qualified professional. The service person should check for heat exchanger leakage, evidence of start-up spillage, and condensation in chimneys. Maintenance should include a tune-up – a properly tuned combustion appliance rarely produces CO, the most serious threat. If necessary, have the heating equipment adjusted so that it operates on cycles that are six minutes or longer (to minimize start-up spillage). Remember that a thorough maintenance check may cost a little more than a simple cleaning, but it is money well-spent.

## Inspect and maintain the chimney

A blocked chimney will not vent combustion gases. Have a professional check that your chimney is not cracked and is clear of obstacles such as broken brick, ice or dead animals. This check should be done routinely as part of an annual or bi-annual service call.

## Upgrade the chimney

Talk to a chimney professional to find out how the chimney's performance can be improved. If you are building or renovating, try to have the new chimney located on an inside wall to keep it warm.

Have a specialist assess the air supply for the combustion appliances. Remember that even a properly designed combustion air duct will not, on its own, solve spillage or backdraft problems; chimney and depressurization problems also need to be resolved.

## Upgrade appliances

When replacing existing equipment or buying new equipment, invest in appliances that are less prone to spillage. Forced draft appliances, which rely on a fan to establish positive venting of combustion gases, are more resistant to spillage. Sealed combustion appliances utilizing direct vent technology isolate the combustion air and combustion gases from the living areas with individual sealed piping that further restricts the possibility of spillage. Ask the salesperson for advice.

## Avoid conditions that cause backdrafts

With a little care, you can minimize conditions that might cause backdrafts by reducing differences in the indoor and outdoor pressures.

Precautions include:

- Be wary of operating several powerful exhaust devices simultaneously, such as a high capacity kitchen range hood and a clothes dryer.
- If you install a new range-top with a powerful exhaust fan, get expert advice on how to

balance the fan's exhaust flow from the home's air supply side.

- Avoid operating combinations of appliances that are likely to create depressurization, such as a fireplace and a range-top fan.
- If the furnace, boiler or water heater is enclosed in a small separate room, allow air to move freely between the mechanical room and the rest of the house by installing louvered doors or door and wall grills.
- If you have a forced-air heating system, be sure the return air is not being drawn from the immediate vicinity of the combustion appliances. Also make sure the blower door on the furnace is in place and that the air filter opening is sufficiently covered with the air filter frame or is sealed.

## What about wood-burning fireplaces?

Wood-burning fireplaces can be a significant combustion spillage threat. Many fireplaces emit small puffs of smoke when the fire is lit. Users may not know that the smouldering embers of a dying fire can release high concentrations of CO. This happens because when a fire is burning down, little heat is being released; the chimney draft may be very weak which allows the CO to easily spill into the home, sometimes after the occupants have gone to bed.

Fireplace safety measures include chimney maintenance, warning devices and avoiding conditions that cause backdrafts. Extra air from outdoors should always be provided while the fireplace is burning strongly or smouldering. Keeping fireplace doors tightly shut as the fire burns down can also help reduce the potential for spillage. Consider adding tight-fitting doors if there are none or, better still, install an energy-efficient fireplace insert.

## Be careful with unvented appliances

If you have an unvented gas range in your home, be sure to use the outdoor vented range hood and provide extra ventilation when the appliance

is operating. Recirculating range hoods do not remove combustion products. Never use an unvented natural gas cooking appliance as a space heating device – there is a real potential for CO poisoning.

**Do not use unvented portable space heaters indoors. Never use a charcoal or gas barbecue indoors.**

## Detecting combustion spillage problems

Even with a good prevention program, you should watch for combustion gas spillage.

Warning signs include:

- repeated headaches, persistent flu-like symptoms, skin and throat irritations, shortness of breath or impaired motor function
- combustion odours anywhere in the house
- hot and muggy air around the heating equipment
- soot stains around any combustion appliance, ductwork, registers, or unusual rumbling sounds when it is operating
- melted plastic fittings at the top of a domestic water heater

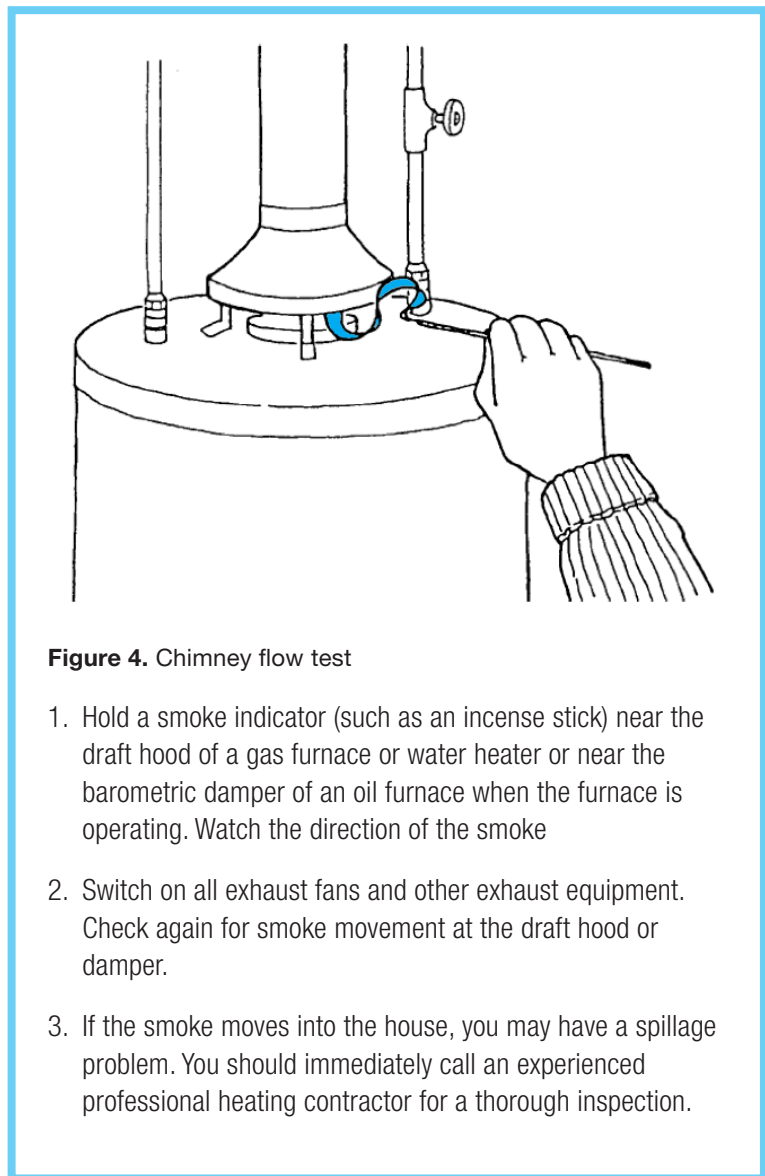
Do the chimney flow test – a quick and simple procedure that will indicate how well your chimney is working, as shown in Figure 4. Note: this test is not possible for sealed combustion appliances.

Install warning devices. Smoke and CO alarms should be used where combustion appliances are present. Use a CO alarm certified to the current Canadian Standards Association (CSA) 6.19 *Residential Carbon Monoxide Alarming Devices Standard*. Install smoke and CO alarms according to the manufacturers' instructions and local building codes. Your local fire department or building official may be able to make recommendations about installations.

Be aware that CO poisoning can occur at varying levels of CO. It can be caused by exposure to a large amount of CO over a short period or by a

small amount of CO over a long period, especially if a person's body has limited ability to use oxygen (e.g. people suffering from asthma and other respiratory problems).

Locating a CO detector so that it is close to or audible from bedrooms is also a good idea. However, be aware that CO alarms may not be triggered by some situations such as long term, low-level exposures.



**Figure 4.** Chimney flow test

1. Hold a smoke indicator (such as an incense stick) near the draft hood of a gas furnace or water heater or near the barometric damper of an oil furnace when the furnace is operating. Watch the direction of the smoke
2. Switch on all exhaust fans and other exhaust equipment. Check again for smoke movement at the draft hood or damper.
3. If the smoke moves into the house, you may have a spillage problem. You should immediately call an experienced professional heating contractor for a thorough inspection.

Also, though not related to combustion spillage, an idling vehicle in an attached garage may trigger a home CO alarm when exhaust fumes migrate through leaky common walls, doors and ceilings. Avoid idling a vehicle in a garage.

Note that all smoke alarms and detectors have expiry dates and should be replaced per instructions. In addition, for battery-powered units or electric units with battery back-up, change the batteries annually or per manufacturers' instructions. CO alarms should also bear the CSA logo.

## Correcting combustion spillage problems

If you have a combustion spillage problem, it is important to deal with it promptly. Often, solutions to existing problems and prevention of future problems require similar strategies. Once you have determined that you have a problem or have identified a cause, consider the relevant actions described in the section *Preventing combustion spillage*. Ensure that all necessary repairs or improvements are done as quickly as possible, by experienced professionals. If you are unsure about your options, consult the Internet or the local telephone directory to find professionals who specialize in, ducting, building inspection, indoor air quality, chimneys, or heating equipment. Your fuel supply company may also be able to provide help.

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