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Combustion Equipment Safety FACTSheet

Provide Safe Installation for Combustion Appliances

Efficient Combustion Appliances

Combustion appliances using natural gas, propane, oil, kerosene, or wood can be an efficient, cost-effective way to produce heat.

Examples include:

- furnaces
- space heaters
- fireplaces
- wood stoves
- water heaters
- range tops
- ovens
- clothes dryers

Combustion appliances have been used for many years in millions of homes. However, careful installation and maintenance of each unit is required to ensure safe and efficient operation, especially in today's energy-efficient, tightly sealed homes.

Problems Posed by Combustion Equipment

Combustion appliances burn fuel by using oxygen from supply air. They produce exhaust gases that should be directly vented to the outside to avoid introducing combustion by-products into the house. Exhaust gases may be released inside the house either knowingly—as in the case of unvented stoves, ovens, fireplaces, or space heaters—or unknowingly from leaky flues, cracked heat exchangers, or backdrafting. Three components of exhaust gases are especially troublesome when introduced indoors: carbon monoxide, water vapor, and nitrogen oxides.

Carbon monoxide is a toxic gas that is colorless, tasteless, and odorless. It can cause serious medical problems and is the cause of hundreds of deaths in U.S. homes each year. Carbon Monoxide is produced when insufficient combustion air is supplied to the appliance, the burner is improperly tuned, and/or the appliance is malfunctioning.

Water vapor is present in large amounts in exhaust gases as a result of burning all fuels. When water vapor is introduced into a house, it increases humidity levels and can lead to condensation on window panes, exterior walls, and interior surfaces of wall cavities. High humidity and wet surfaces promote mold growth, wood deterioration, and other health and structural problems.

Nitrogen oxides are usually present only in small amounts in exhaust gases, but they still present a health hazard to the inhabitants.

Fuel-fired furnaces, clothes dryers, and water heaters that are vented to the outside can also pose problems. If they use indoor air for combustion they increase household energy use since the air used for combustion must be replaced by outdoor air.

Concentration of CO in air (*ppm*)	Inhalation Time	Toxic Symptoms
9	Short term exposure	ASHRAE recommended maximum allowable concentration in living area.
35	8 hours	The maximum exposure allowed by OSHA in the workplace over an eight hour period.
200	2-3 hours	Slight headache, tiredness, fatigue, nausea and dizziness.
400	1-2 hours	Serious headache-other symptoms intensify. Life threatening after 3 hours.
800	45 minutes	Dizziness, nausea and convulsions. Unconscious within 2 hours. Death after 2-3 hours.
1600	20 minutes	Headache, dizziness and nausea. Death within 1 hour.
3200	5-10 minutes	Headache, dizziness, nausea. Death within 1 hour.
6400	1-2 minutes	Headache, dizziness, nausea. Death within 25-30 minutes.
12800	1-3 minutes	Death within 1-3 minutes

Source: engineeringtoolbox.com

Furnaces and Water Heaters

Most new fuel-fired furnaces have a *fan-assisted or powered combustion system*, meaning a small blower forces or draws combustion air and flue products through the furnace and exhausts combustion gases out the flue to the outside. Most fuel-fired water heaters, and some furnaces, still use an *atmospheric or natural draft vent*—the buoyancy of the hot exhaust gases carries these combustion products through the appliance and up the flue. Appliances with atmospheric vents that are installed inside the house are susceptible to backdrafting problems.

Most fuel-fired furnaces and water heaters use air surrounding the appliance for combustion. Others, known as *sealed-combustion or 100-percent-outdoor-air* appliances, bring combustion air directly into the burner via sealed inlets connected to the outside and usually have a fan-assisted exhaust. Because non-sealed-combustion appliances installed indoors rely on indoor air for combustion, they increase the infiltration rate of the house during operation and are more likely to have problems with insufficient combustion air and backdrafting.

Sealed-combustion furnaces and water heaters that are provided with sufficient combustion air and are unlikely to backdraft or impact the infiltration rate of the house.

Unvented Space Heaters and Fireplaces

Most energy and health experts advise against unvented space heaters or fireplaces. Even when operating properly, these units produce unhealthy exhaust gases such as nitrogen oxides and excess water vapor.

Stoves and Ovens

Five precautions will help prevent indoor air quality and moisture problems from fuel-fired stoves and ovens.

- Install a Carbon Monoxide detector in the living area near the kitchen.
- Always vent a kitchen exhaust fan to the outside and operate the fan whenever cooking.
- Have the stove or oven, as with all major appliances, serviced regularly (every 2 years is recommended).
- Do not use a range or oven as a space heater.
- Buy a range or oven with pilotless ignition.

Installation

All combustion appliances should be installed by knowledgeable technicians according to the manufacturer's installation instructions as well as following all national and local code requirements.

As part of the installation process, Carbon Monoxide measurements should be taken to ensure the proper operation of the units and the safety and health of the occupants. Carbon Monoxide should be measured in the combustion products of furnaces and water heaters before the diverter or before dilution occurs, and after the burner has run continuously for 5 minutes. Ovens should be tested while operating on the BAKE setting.

Combustion Closet Design

Use of sealed-combustion, fan-assisted furnaces and water heaters is preferred when locating equipment inside the house rather than building a sealed-combustion closet or utility room. A sealed-combustion closet can be difficult to build correctly and may cost the same as the incremental cost of the sealed and fan-assisted combustion equipment.

A sealed-combustion equipment closet separates the combustion appliance from the living space of the house. Too often, the combustion equipment closet is connected to the conditioned space of the home by louvered doors, air leaks, and uninsulated walls.

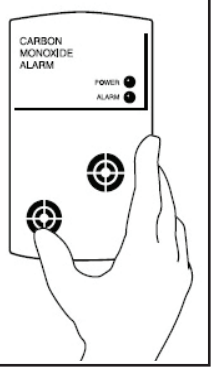
A sealed-combustion closet is like a "little piece of the outside located in the middle of the home." Fresh air for combustion is provided from sources not connected with the living space. Isolating the mechanical room from the living area protects the home against backdrafting and increased heat gains or losses due to infiltration or conduction.

A SEALED-COMBUSTION CLOSET IS CONSTRUCTED BY FOLLOWING THESE STEPS:

1. Insulate the four walls of the combustion closet.
2. Finish the walls and ceiling with drywall.
3. Seal all holes and air leakage pathways through the walls, floor, and ceiling that can connect the closet to the rest of the house—this includes plumbing, gas lines, wiring, electrical boxes, and the bottom plate of the walls.
4. Install a non-louvered door that is weather-stripped and equipped with a properly adjusted threshold.
5. Install two ducts in the closet, extending to the outside or to a ventilated attic or crawlspace, to provide outside air for combustion. Seal the ducts to the ceiling. Check with local codes—the ducts must be sized for the specific combustion appliances, and usually one duct should extend to within 12 inches of the closet floor while the other duct extends to within 12 inches of the ceiling. If the ducts are connected to the attic, they should extend 6 inches above the insulation level.
6. If a return plenum for a furnace is built below the closet, completely seal the plenum—including the plenum walls, plumbing, and connection of the furnace to the plenum.
7. Seal the ceiling around the flue using sheet metal.

Install a Carbon Monoxide Detector

Carbon Monoxide detectors are highly recommended in homes with fuel-burning appliances. The detectors signal homeowners via an audible alarm when Carbon Monoxide levels reach potentially dangerous levels. Some models have digital readouts of current Carbon Monoxide levels, which are useful to the homeowner to monitor household air quality, while some less-expensive models indicate varying levels of Carbon Monoxide with differing alarms. Carbon Monoxide detectors are either plug in or hard-wired.



Causes of Backdrafting

Backdrafting occurs when combustion gases are pulled down the exhaust flue and into the house rather than being vented to the outside. Appliances with atmospheric vents rather than powered combustion systems are most susceptible to backdrafting.

Clothes dryers, ventilation fans in bathrooms and kitchens, and whole-house fans are examples of household equipment that can reduce the air pressure surrounding the combustion appliance to levels that cause it to backdraft. The potential for backdrafting increases the closer the fan is to the appliance, when several fans run simultaneously, and when the appliance cannot be isolated from the fan through the use of a closed door or other means.

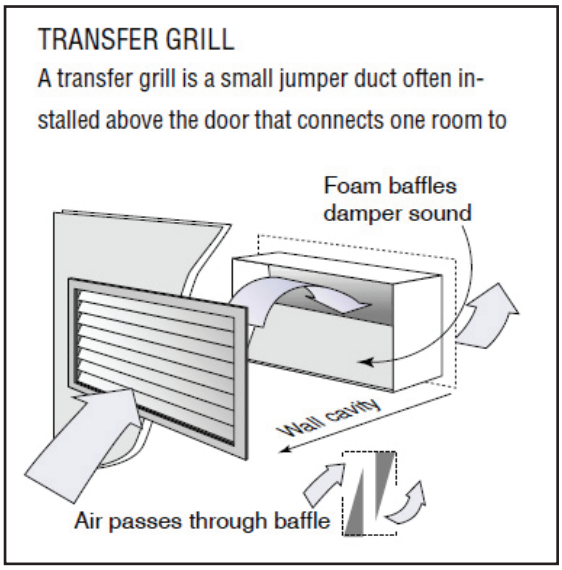
Leaks in heating and cooling ducts or poorly designed ductwork can also be a major cause of backdrafting.

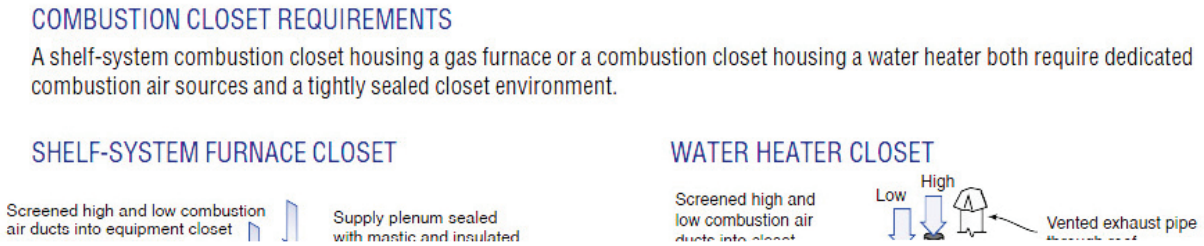
- Leaks in supply ducts can create a negative pressure in the house (the pressure in the house is less than outside) because less air is being returned to the house through the supply ducts than is being removed from the house by the return ducts. If this negative pressure is large enough, it can prevent combustion gases from rising up the flue and cause combustion products to spill into the house.
- A return register that is too close to the combustion appliance (especially if it is the only return register in the house) can create a negative pressure around the appliance that draws exhaust gases into the house. A leak in a return duct or return plenum that allows air surrounding the appliances to be drawn into the return system creates a similar effect.
- Negative pressures can also be created in the main part of a house, where the combustion appliance often is located, when interior doors are closed. This can occur especially when there are only one or two return registers in the house and even in homes with tight ductwork. When the doors to rooms with supply registers are closed, it may be difficult for the air in these rooms to circulate back to a central return register. The pressure in the closed-off room increases, and the pressure decreases in the main part of the house open to the central return.

Preventing Backdrafting

The potential for backdrafting can be reduced by

- Using appliances with powered combustion systems rather than atmospheric vents.
- Installing appliances with atmospheric vents in a sealed combustion closet.
- Sealing all supply and return duct leaks.
- Installing return registers in all rooms with supply registers.
- Making sure rooms without a return register have at least a 1-inch gap under the door (recommended only for rooms with one supply register) or a transfer grill to provide pressure equalization between rooms.





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