Combustion Equipment Safety

Combustion appliances are efficient

Fuel-fired combustion appliances are often the most efficient and cost-effective way to produce heat. Combustion appliances today commonly use natural gas, propane, oil, kerosene, and wood as their fuel. Examples include:

- ❑ furnaces
- ❑ space heaters
- ❑ water heaters
- ❑ ranges
- ❑ ovens
- ❑ fireplaces
- ❑ wood stoves
- ❑ gas clothes dryers

Although combustion appliances have been used for many years and have been installed in millions of homes, careful installation is still required to ensure their safe and efficient operation, especially in today's more energy-efficient homes.

Problems posed by combustion equipment

During the combustion process, the appliances burn fuel using oxygen from the air and release exhaust gases such as carbon dioxide, water vapor, nitrogen oxides, and carbon monoxide. While most combustion appliances operate properly and create no ill-health effects, occasionally a situation develops which can cause serious medical problems, and sometimes death. This occurs primarily from carbon monoxide poisoning when:

- ❑ Combustion appliances malfunction and exhaust high levels of carbon monoxide either directly into the home, into the ductwork, or into leaky exhaust flues;
- ❑ A negative pressure difference is created in a home that causes an appliance to *backdraft* – pull combustion gases down the exhaust flue and into the home.

What about fuel-burning stoves and ovens?

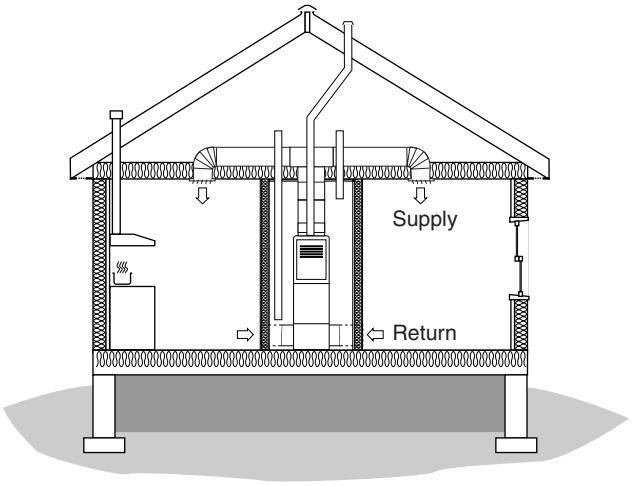
There is growing evidence that gas-fired stoves and ovens create high levels of carbon monoxide in homes.

There are five precautions which should help prevent problems from stoves and ovens:

- ❑ Install a carbon monoxide detector in the living area near the kitchen
- ❑ Always install a kitchen exhaust fan that is vented 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 stove as a space heater
- ❑ Buy a stove with pilotless ignition

Are unvented gas space heaters safe?

Most energy and health experts advise against unvented combustion appliances. Even when operating properly, these units produce unhealthy exhaust gases such as nitrogen oxides and excess water vapor. If these units are present, do not weatherize the home and advise occupants to crack windows open to ensure ventilation whenever the units are operating.



Balance the air pressure in the house and provide spot ventilation for non-vented combustion appliances, such as gas stoves.

Negative house pressures affect combustion appliances

Pressure differences that backdraft an appliance limit the supply of oxygen to the burner, which cause it to produce increased levels of carbon monoxide. While clothes dryers and vent fans may cause negative pressures, a major cause is due to imbalances created by heating and cooling systems with duct leakage or poorly designed return ductwork. Forced-air heating and cooling systems should be *balanced* — the amount of air delivered through the supply ducts should be equal to that drawn through the return ducts. If the two volumes of air are unequal, pressure imbalances will occur in the home.

Leaks in the supply side of a duct system can create a negative house pressure by pushing less air into the house and pulling more air in through the return side - this increases air infiltration from the outside and the possible backdrafting of flues and exhaust vents because the house is attempting to equalize the pressure by pulling air in from other sources. Another shortcoming of leaky supply ducts is a general loss of efficiency and increased energy costs.

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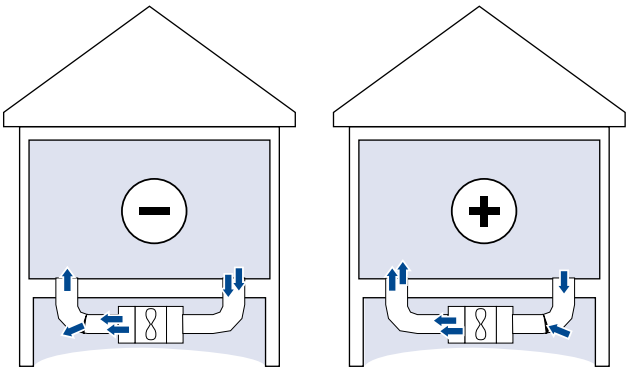
Positive pressures may be a problem too

Ductwork systems that are leaky on the return side have their own set of problems: the house becomes pressurized, generating air leakage out of the building envelope. Air from unconditioned sources, such as a crawlspace, is pulled in through the leaky return system into the living space - air that may be contaminated with radon, mold, pesticides, or toxic chemicals. Positive pressures in cold climates may drive moisture through walls and cause deterioration. Hot humid air is pulled into the ducts in summer - cold air is drawn into the ducts in winter. If leaky return ducts are located near combustion appliances, such as in an equipment closet or crawlspace, the negative pressure could cause flues and chimneys to backdraft.



Pressure differences in the conditioned space of a home can affect indoor air quality and energy use.

Special issues with pressure differences

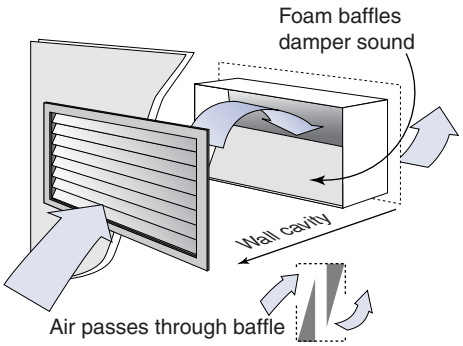
Pressure differences can also result in homes with tight ductwork if the home only has one or two returns. When interior doors are closed it may be difficult for the air in these rooms to circulate back to a central return duct. The pressure in the closed-off rooms increases, and the pressure in rooms open to the return decreases.

Rooms with one supply and no return should have:

- ❏ a 1-inch gap under the door connecting to an area with a return.

Rooms with two or more supplies should use one of the following:

- ❏ a transfer grille installed either in the door or through the wall between the room and the area with a return (a wall-mounted transfer grille must be totally sealed from the rest of the wall cavity) and it may contain a sound baffle to lessen noise transmission between rooms; or
- ❏ a jumper duct that connects the two rooms; or
- ❏ a separate return.



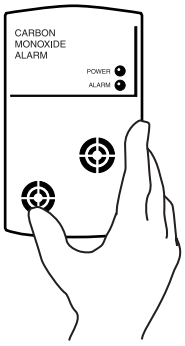
A transfer grille provides pressure equalization between rooms

Carbon monoxide hazards

Carbon monoxide (CO) is a colorless, tasteless, odorless gas that is poisonous. There are hundreds of deaths in the United States each year because of CO poisoning.

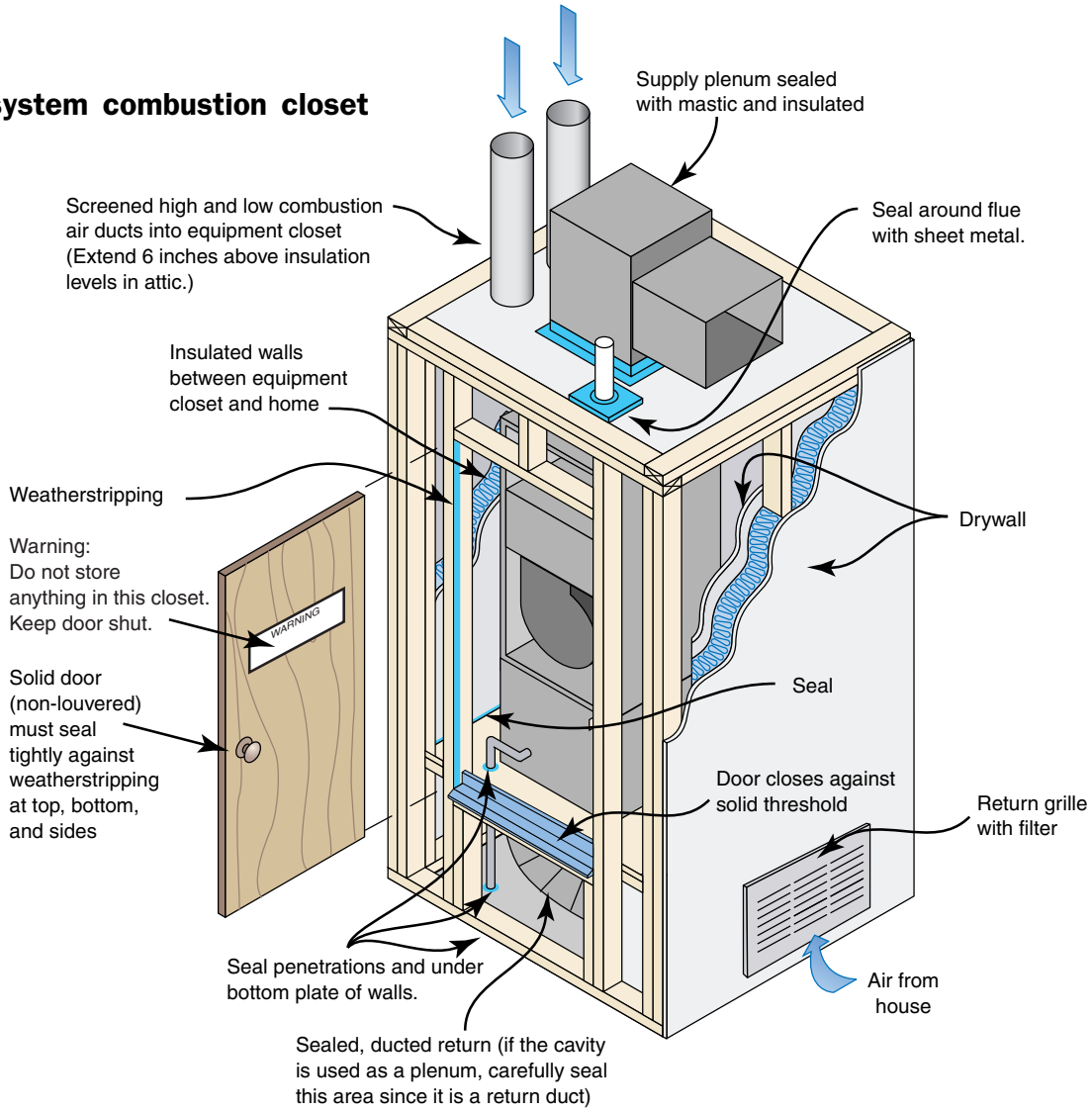
Effects of CO exposure

CO (ppm)	**Time**	**Symptoms**
35	8 hours	Maximum exposure allowed by OSHA in the workplace over an eight hour period.
200	2-3 hours	Mild headache, 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 within 2-3 hours.
1600	20 minutes	Headache, dizziness and nausea. Death within 1 hour.



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 CO levels reach potentially dangerous levels. Some models have digital readouts of current CO levels, which are useful to the homeowner to monitor household air quality, while some less-expensive models indicate varying levels of CO with differing alarms. CO detectors are either a plug-in variety or can be hard-wired and should be installed in rooms with direct connection to combustion appliances, such as kitchens with fuel-burning stoves and ovens, areas near combustion closets for fuel burning heating systems, and rooms with fuel-burning space heaters. A low wall socket location is preferred for plug-in models since CO is heavier than air.



A shelf-system installation with a closed combustion closet provides a compact and safe arrangement for an atmospheric gas furnace.

Combustion closet design issues

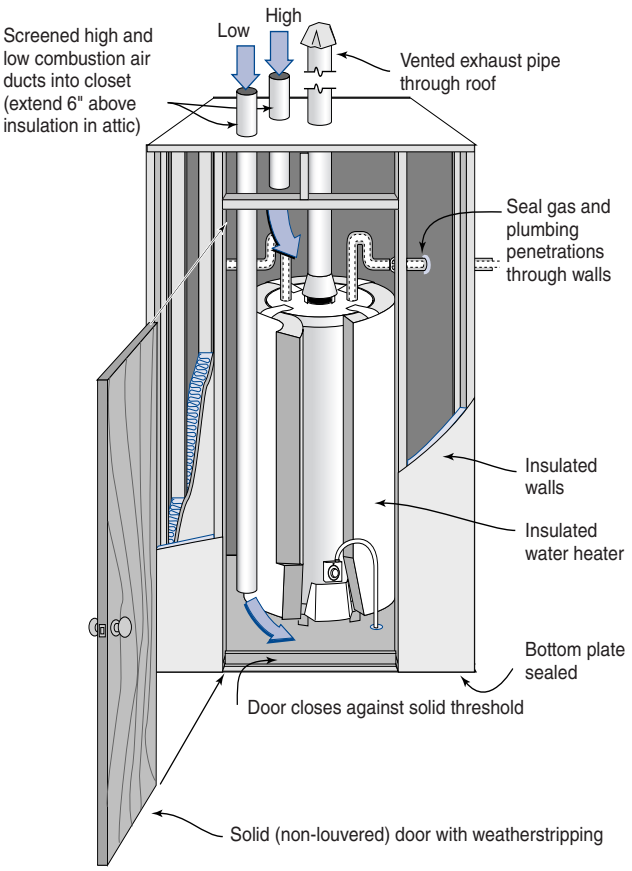
Too often, combustion equipment closets are connected to the occupied rooms of the home via air leaks or louvered doors – this can be dangerous and is not recommended. Carbon monoxide, and other pollutants present in the combustion closet, can leak into the rest of the home and create dangerous conditions for the homeowners. Also, using room air for combustion robs efficiency since that air must be replaced by infiltration. The combustion closet should be air sealed and *isolated* from the rest of the house and ventilated to the outside.

Combustion equipment closet features

Insulate the interior and exterior walls of the combustion closet, finish the walls and ceiling with drywall, seal all holes and leaks between the closet and the rest of the house, and install a non-louvered, weather-stripped door. In addition, provide outside air for combustion by installing two ducts in the closet that are sized for the specific combustion appliances. One duct should extend to within 12 inches of the floor of the closet, while the other extends to within 12 inches of the ceiling (check with local codes). The ducts should extend to the outside, to a ventilated crawl space, or to a ventilated attic.

The sizes of the outside air ducts depend on local mechanical and building codes. Typical sizing methods for appliances in a combustion closet require a given number of square inches of ductwork per 1,000 Btu/hour of fuel used by the appliances. Consult with local mechanical engineers to design the combustion air ducts.

Creating a combustion equipment closet serves to separate the combustion appliance from the living space of the house. With a guaranteed source of combustion air in the mechanical room isolated from the living area, the home will be better protected against backdrafting and carbon monoxide problems.

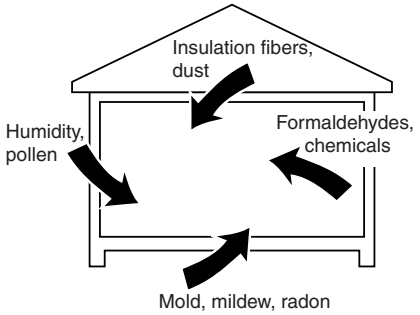


A closed combustion closet is, "a little piece of the outside located in the middle of the home". Fresh air for combustion is provided from sources not connected with the living space.

Furnaces and water heaters

Common combustion appliances, such as furnaces and water heaters, require air for combustion and to vent exhaust gases. Most of these appliances are *non-direct vent* units–they use air surrounding the appliance for combustion, and are more affected by pressure differences in the house. Others, known as *direct vent* furnaces, bring combustion air directly into the burner via sealed inlets connected to the outside.

Direct-vent combustion appliances can be installed within the conditioned area of a home since they do not rely on inside air for safe operation. Non-direct vent combustion appliances must receive adequate outside air for combustion and exhaust venting. The primary concern with non-direct vent units is that a malfunctioning heater may allow flue gases to enter the area around the furnace and be pulled into the living space.



Air quality in airtight homes

While any home may encounter pressure imbalances, homes that are more airtight generate pressure differences more easily. However, a few simple design measures can prevent these problems and still permit the virtues of a more airtight home.

Airtight homes...

- ❏ Reduce indoor air problems because they prevent pollutants from entering through the attic or crawlspace (or even moist, unfiltered air from outside)
- ❏ Provide intentional ventilation for the occupants
- ❏ Save energy by reducing the cost normally required to heat, cool, and control moisture in outside air leaking to the inside by infiltration
- ❏ Require intentional air for combustion appliances

See Air Sealing Energy Bulletin for more information

Most new furnaces have *forced draft* exhaust systems, meaning a blower always propels exhaust gases out the flue to the outdoors, and are unlikely to backdraft. *Atmospheric* furnaces and water heaters do not have a forced draft fan. Atmospheric furnaces are less common today due to federal efficiency requirements but this venting method is still common in many water heaters.

Atmospheric furnaces and water heaters should be isolated from the conditioned space. Those units located in well ventilated crawl spaces, basements and attics usually have plenty of combustion air and encounter no problem venting exhaust gases to the outside.

Combustion appliances located inside the house should be carefully installed in a combustion closet to ensure proper, efficient operation and prevent indoor air quality problems. If there are concerns that poor equipment or pressure imbalances may cause backdrafting or other indoor air quality problems, consult with a qualified contractor.