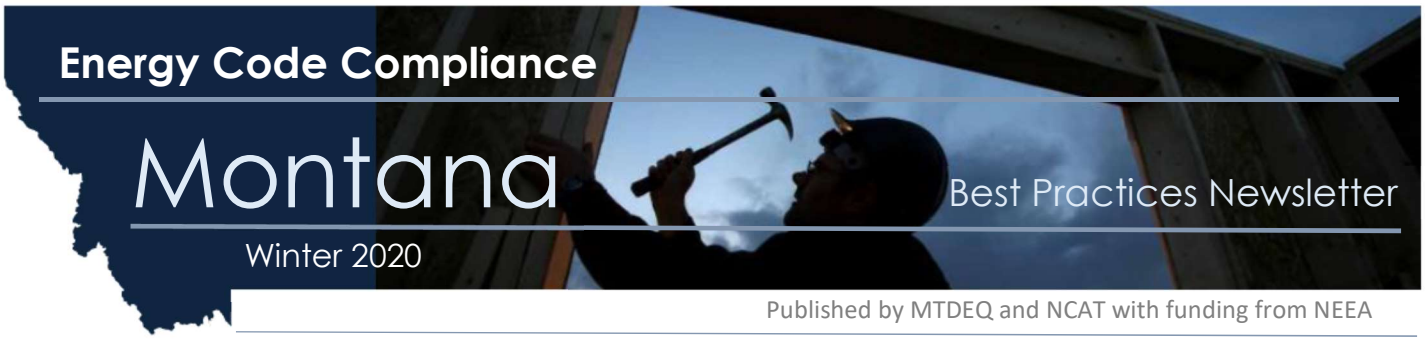

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Rooms Containing Fuel-Burning Appliances

A fundamental axiom of building science is that air will move from higher pressure to lower pressure. Anytime a condition creates a low-pressure condition inside a home's thermal envelope, replacement air must enter the thermal envelope. A combustion appliance—such as a gas water heater or furnace—will draw in air to supply oxygen for combustion and send flue gases out of the building, and create a low-pressure area. Without a mechanism to supply replacement combustion air, one of two conditions could result. In a house with a leaky envelope, replacement air will be pulled into the house through leaks. If a house is built according to modern code requirements and as a result a tight thermal envelope, a combustion appliance may not have enough replacement air, creating a dangerous condition called *backdrafting* where flue gases are pulled back into the building. The 2018 IECC attempts to remedy this situation through the requirement to use **combustion closets**.

2018 IECC 402.4.4 requires that:

> In Climate Zones 3 through 8, (Montana in Zone 6) where open-combustion air ducts provide combustion air to open- combustion fuel-burning appliances, the appliances and combustion air opening shall be located outside the building thermal envelope. Such rooms shall be sealed and insulated in accordance with the envelope requirements of Table 402.1.2, where the walls, floors, and ceiling shall meet not less than the basement wall R-value requirement. The door into the room shall be fully gasketed and any water lines and ducts into the room insulated in accordance with section R403. The combustion air duct shall be insulated where it passes through conditioned space to an R-value of not less than R-8.
>
> Exceptions:
>
> 1. Direct-vent appliances with both intake and exhaust pipes installed continuous to the outside
> 2. Fireplaces and stoves complying with Section 402.4.2 and Section R1006 of the International Residential Code[1]

[1] The 2018 IECC is in the process of being adopted in Montana. This provision has not been enacted as of the date of publication; however, it is offered in preparation for adoption of the code and as a best practice.

The commentary provided by the IECC notes that the ideal situation is one in which direct-vent, sealed-combustion and electric appliances solve the problems created by an open-combustion unit. However, when a less-expensive and less-efficient appliance is used, that appliance must be installed outside the thermal envelope or in what has become known in the industry as a *combustion closet*.

Three Problems Created by Atmospheric Combustion Appliances

When atmospherically vented appliances are located inside the thermal envelope, three problems are created. Code requirements endeavor to avoid these problems.

First, as mentioned above, when combustion appliances are running, they must pull combustion air from somewhere. An atmospherically vented appliance will pull the air from inside the house, creating a negative pressure and causing air infiltration into the house. As a result, the house will seem drafty when the appliances are running, and utility bills will likely increase.

Second, negative pressure can cause backdrafting, sending flue gases into the house. Under normal operating conditions, with the combustion gases exhausting up the flue, the combustion process results mainly in water vapor and carbon dioxide. However, backdrafting changes things. The flame may get starved for oxygen, causing incomplete combustion, which results in significantly more carbon monoxide entering the home. Carbon monoxide infiltration can be deadly. You don't want it in your house. All homes with an open combustion fuel burning appliance should have a carbon monoxide (CO) detector on each floor.

A gap between the water heater and the flue, shown in the photo, allows the water heater to pull air into the flue and the stack effect to carry flue gases to the outside. When installed properly, this design is an inexpensive and reliable way to operate these appliances. However, as homes have become tighter and better insulated, the danger of backdrafting increases.

Third, atmospheric combustion furnaces (usually with less than a 94 AFUE rating) have a *draft inducer*—a fan that pulls air up through the heat exchanger. That fan is monitored by a pressure sensor that will cut off the furnace if it detects that the pressure in the flue is too high. If the flue becomes obstructed, the sensor shuts off the furnace. When combustion appliances share a flue, however, the sensor cannot operate correctly because another appliance creates an escape route for flue gases, allowing them to be dumped into the house.

Combustion Closet Construction

The best practice in constructing a combustion closet is, as funny as it may sound, to create an insulated and sealed room or an outdoor space inside your thermal envelope. To accomplish this, the closet space must be completely air-sealed, just as you would your house's thermal envelope. The door should be weatherstripped and a threshold should be used to prevent any air leakage between the closet and the house. All penetrations that could allow air leakage into the house's thermal envelope must be sealed, as well.

Another best practice and code requirement is to install air inlets so that the appliances can be adequately supplied with combustion air drawn from outside the thermal envelope. This normally requires two supply vents where one terminates within a foot of the ceiling to supply plenty of air for the flue to operate properly, and one vent to terminate a foot from the floor to allow the appliance adequate air for the combustion chamber itself. A downside of a sealed-

combustion closet is that closet has the potential to become quite cold, since it draws in outside air, which reduces the efficiency of the appliances.

Determining the Size of the Inlets

The size of the inlets depends on the capacity of the furnace and or water heater and location of the inlets. According to the International Flue Gas Code, for most installations there must be one square inch for each 4,000 Btu/hour (550 mm2/kW) of input capacity. For example, a 100,000 Btu/hr furnace would need 25 square inches of air inlets.

https://codes.iccsafe.org/content/IFGC2018P3/chapter-3-general-regulations

Update on the 2018 IECC

The 2018 IECC is still in the process of being adopted in Montana. As of this writing, combustion closets as described in the 2018 IECC are not required in Montana but, as explained, they provide significant benefits for both comfort and safety. As always, a cost-benefit analysis should be conducted. In most cases, direct-vent appliances cost considerably more than atmospherically vented appliances. However, the increase in labor and materials to build a combustion closet may justify the higher cost of the appliance. Additionally, direct-vented appliances will operate more efficiently, creating even more long-term savings.

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