TechTip I3 – SPF and Open Combustion Appliances

Before applying SPF (spray foam polyurethane) insulation in an attic or crawl space it is important to determine if there are any appliances present, such as a water heater or a furnace, that are open-combustion and require a source of combustion air.

> Note: These same considerations apply to any air sealing modifications regardless of materials, as well as attic and crawl space modifications. BPI (see reference below) recommends performing combustion appliance safety inspections whenever 15% or more of the total building envelope is air-sealed.

Open-Combustion appliances, also referred to as “atmospheric-combustion” appliances, draw their combustion air directly out of the room or CAZ (combustion appliance zone) it is in. When located in an attic or crawl space, they draw their combustion air directly from that space. After the open combustion appliance burns the air and fuel mixture, it sends the fumes up and out through a dedicated exhaust flue. The flue is a small diameter sheet metal duct going up and out of the appliance to the outside. The combustion process requires that open-combustion appliances exhaust a greater volume of fumes than it takes in as air.

When open-combustion appliances are located in confined spaces, the volume of fresh air is limited. When the fresh air supply to the confined space is insufficient, incomplete combustion can lead to an increase in toxic fumes that need to be vented. If there is some leakage in the exhaust flue, a fraction of the exhaust fumes will accumulate in that space; toxic combustion gases (such as carbon monoxide) can then build-up inside the house.

Figure I3-1: Typical open-combustion water heater. Arrow indicates the entrance to the exhaust flue.

DEFINITIONS

Atmospheric-Combustion Appliance: Synonymous with Open-Combustion Appliance (see below).

CAZ (Combustion Appliance Zone): The room or space occupied by a combustion appliance.

Combustion Appliance: Any device or system within a house that burns a mixture of fuel and air.

ERV: Energy recovery ventilation.

HRV: Heat recovery ventilation.

Open-Combustion Appliance: A combustion appliance that relies on the natural ventilation within the space it resides (CAZ) to provide sufficient air for combustion and exhaust venting.

Sealed-Combustion Appliance: A combustion appliance that is provided with a dedicated air intake duct that is directly connected to the outdoors.

Spillage: Combustion gas leakage into the space occupied by a combustion appliance.

Worst-Case Depressurization Test (aka, Worst-Case CAZ Test): A test which compares outdoor ambient air pressure with the air pressure in a CAZ with all of the home's exhausting appliances operating at full capacity. Exhausting appliances, in this case, include combustion appliances as well as venting appliances (bathroom vents, range vents, clothes dryer vents, etc.).

Figure I3-2: Typical open-combustion furnace co-vented with open-combustion water heater. (Requires fresh air source.)

Open-combustion appliances are designed to operate efficiently in well-vented spaces. They can be installed in attics and crawl spaces, but only when these spaces are well ventilated. When SPF (or other construction material) is installed to create an unvented attic or crawl space, the source of combustion air supply is reduced minimized and or eliminated; open-combustion appliances in these spaces may then become a source of hazardous fumes and toxic gases if the exhaust flue is not well sealed. The imbalance of exhaust fumes and fresh air may not be limited to unvented attics and crawl spaces: open-combustion appliances in basements, utility rooms or other areas of the house may be affected as well when the building envelope is well-sealed with SPF.

Installation of SPF changes the design of the house as a system; open-combustion appliances may now reside within spaces with a lower flow of combustion air it can no longer be assumed that open-combustion appliances will operate efficiently under these conditions. When insulating with SPF, combustion appliances (or the spaces they occupy) may need to be modified in order for the appliances to operate efficiently and meet building code requirements.

SPFA supports the position of the Building Performance Institute: “A preliminary and post-installation safety inspection of all combustion appliances must be completed whenever changes to the building envelope and/or heating system are part of the work scope.” [BPI Technical Standards for the Building Analyst Professional[1]]

[1] http://www.bpi.org/Web%20Download/BPI%20Standards/Building%20Analyst%20Professional_2-28-05nNC-newCO.pdf

Such a safety inspection includes the following:

- Carbon monoxide test
- Draft measurement
- Spillage evaluation
- Worst-case depressurization test

> ***Caution:*** *Combustion-appliance inspections and modifications should only be performed by professionals trained (and as appropriate, licensed) to perform these tasks.*

Options if the house does contain open-combustion appliances:

1. Update the open-combustion appliances- (Recommended) Replace the appliances with AFUE 90+% direct vent or sealed-combustion appliances having dedicated air supply venting.
2. Isolate the open-combustion appliances- Build a dedicated utility room or closet around the open-combustion appliances. The dedicated room must be vented to the outside of the building envelope and air-sealed and insulated from the rest of the house (in effect, the dedicated utility room becomes outside, unconditioned space). The outside vents must be properly sized to supply the fresh air required by the appliances.
3. Change to electrical appliances- Replace open-combustion appliances with electrically-operated appliances.

Figure I3-3: Direct Vent water heater.

Sealed-combustion appliances are located close to an outside wall and vent through the wall. A double-walled vent tube functions as both air intake and exhaust flue. (No special requirements when air sealing building.)

Figure I3-4: Powered vent on a water heater.

Powered vents employ a blower to push exhaust gases out the exhaust vent pipe. Typically used for long vent runs. (No special requirements when air sealing building.)

Figure I3-5: Draft fan-assisted HVAC system in a crawl space.

The fan is designed to pull combustion by-products out of the heat exchanger and direct them into the exhaust flue. The fan does not propel the exhaust gases up the chimney; these appliances rely on the bouyancy of the hot exhaust to rise up the flue and vent out. This appliance is open-combustion and subject to the aforementioned considerations.

Figure I3-6: Typical sealed-combustion HVAC system. Air supply and exhaust is through the PVC piping. (No special requirements when air sealing building.)

*Photo credits Allison Bailes, Energy Vanguard

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