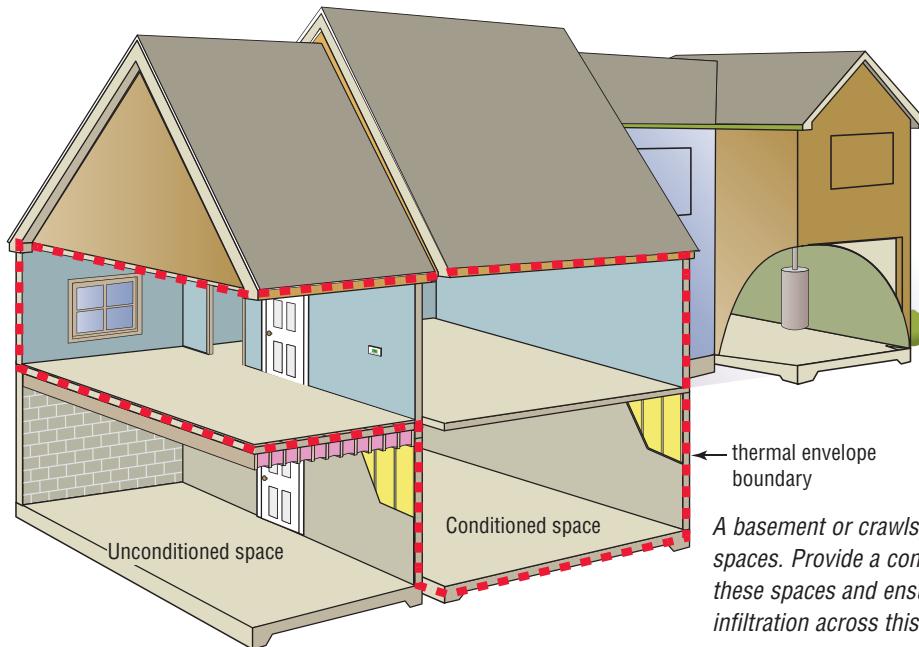


# Basement and Crawlspace

## Comfort, Health and Safety Strategies



**Comfort, health and safety** are all improved when design principles and construction methods are based on proven building science and physics. This is achieved by looking at the whole house as a system to understand that performance is interconnected by its components.

The foundation supports the home, so any part of the supporting structure that isn't designed, built and maintained properly can have a big impact on occupant comfort, health and safety. Occupant behavior (lifestyle, storage habits, quality of repairs, maintenance, etc...) is also an important consideration.

*A basement or crawlspace could have conditioned and unconditioned spaces. Provide a continuous thermal boundary (insulation) between these spaces and ensure they are properly air sealed to prevent air infiltration across this boundary.*

### Comfort, Health and Safety Considerations

- **Moisture** - Any bulk moisture (liquid) that enters the basement/crawlspace is harmful. High humidity (which can condense into water) is also bad. Both can lead to issues with mildew/mold, wood rot, termites, dust mites, etc... All bare dirt should be covered with a plastic vapor barrier to prevent ground moisture evaporating into the basement/crawlspace. Gutter downspouts should route water away from the foundation. The dirt and grade outside the home should be sloped away from the house. Sealing the basement/crawlspace from outside air and bringing the space inside the building enclosure, if done properly, will solve a multitude of potential issues.
- **Infiltration** - Air that leaks into the home through the floor can carry dust, dust mites, pollen, car exhaust fumes and other pollutants that contribute to poor indoor air quality. So, either isolate the space from the inside (by sealing on the basement side of the subfloor) or seal the walls and bring the space inside the building enclosure. Either approach can improve indoor air quality while having to dust less often.
- **Radon** - An odorless, colorless gas that is the second leading cause of lung cancer (behind smoking). The EPA has maps ([www.epa.gov/radon/wherelive.html](http://www.epa.gov/radon/wherelive.html)) that show if the house is in a high-risk area. Testing should be performed, and if necessary, preventative measures should be taken to minimize chances of radon infiltration (like plastic on bare ground, sealing the basement/crawl from the inside or installing a radon vent pipe)
- **Stored chemicals and equipment** - Do not store poisonous chemicals, fertilizers, gasoline, etc... inside the basement/crawlspace. If air can freely move into the living space, these pollutants are likely entering the living space.
- **Pests and critters** - Rodents, snakes, roaches, spiders, camel crickets and other pests obtain entry through unsealed leaks. Airsealing the floor will keep pests out of the living space. Airsealing the foundation walls will help keep them out as well.
- **Combustion safety**- All atmospherically vented combustion appliances should be located outside the building thermal envelope or isolated from the house to minimize the chances of carbon monoxide (CO) poisoning. If this is not feasible, combustion safety testing should be performed by a qualified professional to insure exhaust fans are not causing backdrafting of the water heater or furnace. It's also a great idea to install a CO monitor or detector on each floor if combustion appliances are present.



*Note: low-level CO monitors cost more and have greater accuracy than the cheaper ones found in many big box retailers. Some building codes and most above-code building programs require one on each floor, so a good strategy is to have one monitor and one or more detectors. The CO Experts Model 2014 and the NSI 3000 are popular products.*

## Electric Appliances

For homes with conditioned foundations and electric water heaters inside the basement/crawlspace, an excellent upgrade to consider is a heat pump water heater. Most heat pump water heaters are at least twice as efficient as standard electric tank water heaters and provide supplemental cooling and dehumidification as a byproduct of their operation – often a desirable benefit particularly in a basement location.

## Combustion Safety

If a home is not total electric or has combustion appliances, always follow two simple rules for safe combustion:

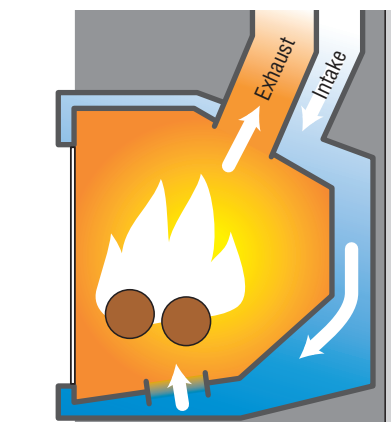
1. Each appliance should have its own source of combustion air that is separate from the breathing air of the occupants
2. Each appliance should have its own flue pipe to expel the combustion by-products to the outside

If the crawlspace is vented and the subfloor is well-sealed and insulated, the combustion air comes from the outside. If a basement is unconditioned and the subfloor is well-sealed and insulated, combustion air is often provided by counting the volume of the basement as the combustion air.

**Calculate make-up air.** The rule is that 50 cubic feet of volume is required for every 1,000 Btu/hr of appliance gas input. For example, a 100,000 Btu/hr (input) gas furnace would require  $50 \times 100 = 5,000$  cubic feet of volume to satisfy code – a 20' x 40' room with 8' ceilings (6,400 c.f.) would be more than adequate. A tightly sealed home may have special requirements, in this case - consult a professional to determine the correct make-up air

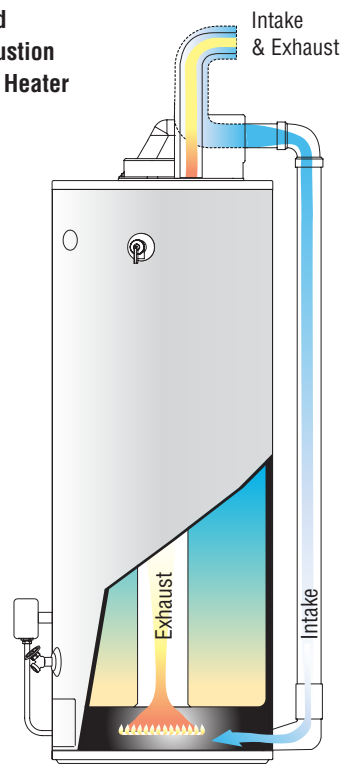
If the crawlspace or basement is brought inside the thermal envelope by insulating and air sealing the foundation walls, the combustion appliances should be isolated inside a contained “combustion closet” that has its own combustion air provided by outside air ducts, sometimes known as high/low vents. Check with the manufacturer for make-up combustion air specifications.

### Sealed Combustion Fireplace



Gas log fireplaces should be a sealed combustion design because ventless gas fireplaces are unsafe.

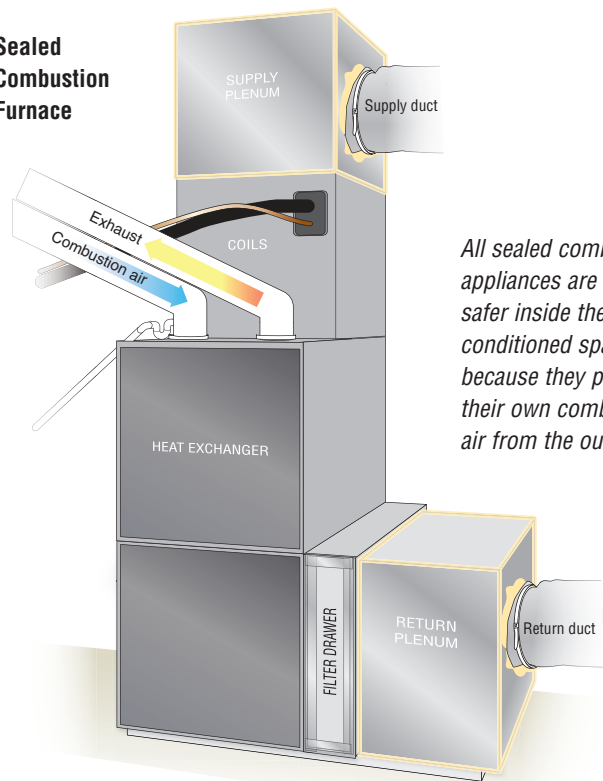
### Sealed Combustion Water Heater



### Sealed Combustion Appliances

**Appliance upgrades can address combustion issues.** An alternative to building a combustion closet around a natural draft furnace would be to upgrade the HVAC system to a high efficiency (90+% AFUE) furnace which can be installed to bring its own outside combustion air directly to the furnace. Gas water heaters could also be sealed combustion or direct vent.

### Sealed Combustion Furnace



*All sealed combustion appliances are much safer inside the conditioned space because they provide their own combustion air from the outside.*

High-efficiency gas furnaces are vented with PVC piping that can extend horizontally with a slow rise to an exterior wall for venting.