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Inspecting Floor Furnaces

by Skip Walker Aug. 2008

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Gas-fired floor furnaces are common in homes built through the early1950's. When properly installed and maintained, these provide a reasonably reliable and comfortable heat source. Their use is not restricted to small homes; larger homes sometimes have several floor furnaces. Floor furnaces are relatively simple, but inspecting these can be a challenge. Part of the inspection takes place in the interior and part in the crawlspace. The three main types of floor furnaces are flat, wall-register type, and double-sided wall-register type. Floor furnaces are only allowed over a raised, unoccupied, underfloor space. They derive their combustion air from below and cannot be installed in houses with slab foundations or installed such that they project into habitable spaces such as an occupied/finished basement.

Nearly all floor furnaces we will see installed are older and many are original to the dwelling. These units would be considered very energy inefficient when compared to current standards. Floor furnaces rely on convection to warm the dwelling; i.e. hot air rises/cold air falls. Because of this, the doors to a room must be left open for warm air to reach that area. The thermostat controlling the unit must be installed in the same area as the register. A thermostat installed either a long distance from the register or where intervening doors may prevent heated air from reaching the thermostat may cause the unit to run continuously and create an unsafe operating condition.

Location and Clearances: The first thing to observe with a floor furnace is the location and clearances. Flat floor furnaces require at least 6 inches clearance to walls. Wall-register floor furnaces should be at least 6 inches from inside wall corners. Replacement furnaces are allowed with lesser clearances ***provided*** no safety hazards exist. Inspectors must exercise good judgment in evaluating whether an installation with lesser clearances poses a safety hazard. Doors should not swing over or within twelve (12) inches of floor furnaces (see Photo 1), and carpeting should not cover the grills. Doorstops or closers cannot be used in lieu of proper clearances to prevent doors from swinging within twelve (12) inches of the furnace. Other furnishings, drapes, etc should maintain a minimum of twelve inches from the register. The floor registers should not be installed on stairs, aisles, landings, and door openings/exit paths from rooms. In areas such as a hallway, the register should be installed with at least eighteen (18) inches on one side to allow occupants to walk by the unit without stepping on the register.

Both listed and unlisted floor furnaces should have a temperature-limiting device at the register. In unlisted systems, this should shut the system gas flow off should the register temperature reach 350ºF. Older systems may not have this feature. The ignition temperature of wood is roughly 450ºF to 575ºF – depending on species and wood condition. However, wood damaged through pyrolysis (long-term low level heat exposure) may ignite at much lower temperatures. The intent of the temperature-limiting device is to prevent ignition and not to protect the occupants from contact burns. Even in normal operation, floor grills and registers can become very hot. Some sort of protective barrier is advisable if young children are present in the dwelling.

Photo 1 – Floor furnace next to door and within 6 inches of a corner

Floor furnaces become a collection point for dust, lint, pet hair, children's toys and the like. They can be difficult to clean. Proper cleaning/maintenance is important to the safe operation of the system. The inspector should be careful not to drop anything in the furnace. Before operating a floor furnace, check that nothing flammable has fallen inside. If the furnace has not been used in some time, heated dust and debris can create a noticeable smell during the inspection. If the client is present, this will graphically underscore the importance of routine furnace cleaning. A dirty floor furnace might even set off a smoke detector.

Heat Exchangers:

The grills above the furnace are removed to expose and inspect the heat exchanger. Double-sided wall-register furnaces may have dampers to control the amount of heat sent to each side. The mechanical workings of the dampers should be inspected. The main combustion chamber will typically have a cap with a sight-glass. Looking through the cap the homeowner can tell if the burners are lit. The cap or the transparent part of the cap is often missing, and other materials such as aluminum foil are a poor substitute. The cap must fit securely, or combustion fumes will escape from the opening and enter the room. Caps often have an asbestos pad where they rest on the hole at the top of the combustion chamber.

With the furnace off and the grills removed, the heat exchanger can be inspected from above. One method of finding cracks in a heat exchanger is to remove the sight-glass cap and shine a flashlight into the combustion chamber. Light may be visible through cracks and will shine onto the walls of adjacent (secondary) heat exchangers or the furnace enclosure. Cracks in floor furnaces are not uncommon, and usually are in straight horizontal or vertical lines. Heat exchangers are sometimes two-piece and held together in the center with a tension band, similar to a pool filter. The bolt that holds the band together can fail and the heat exchanger will open up like a cracked egg. If possible, examine the color of the flame, but be careful! If you remove the sight-glass to view the flame, a strong rush of hot gas combustion products will come out the opening.

Underfloor Clearance:

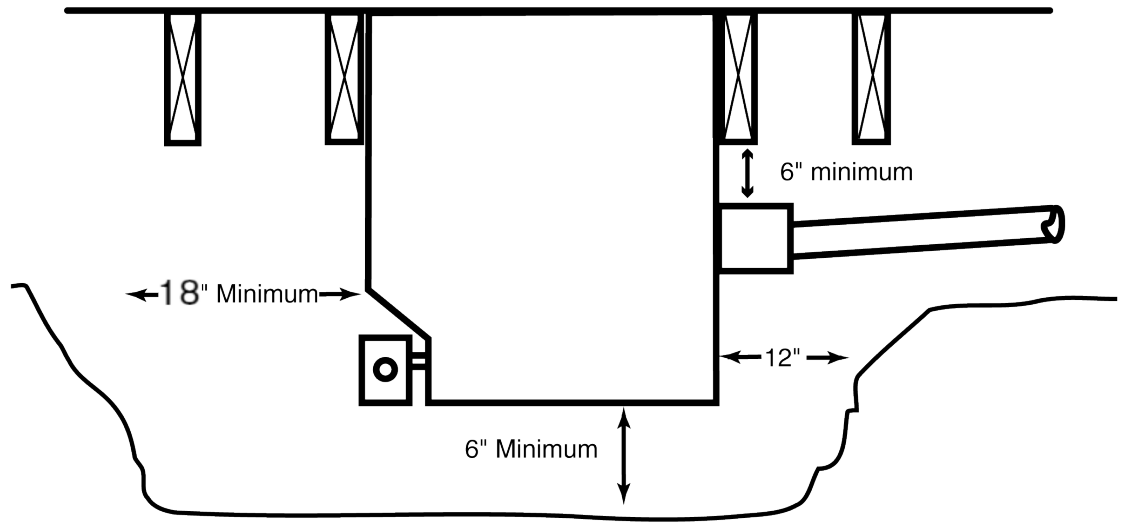
From beneath, check the soil clearances and framing around the furnace. Six (6) inches of clearance should be maintained between the soils and the furnace. A clearance of two (2) inches may be allowed if the lower six (6) inches of the floor furnace is sealed to prevent water entry. Sometimes a pit must be excavated to establish these clearances. Pits should extend to the area at least 12 inches horizontally from the edges of the furnace, with eighteen (18) inches clearance on the control side of the furnace (see Figure 1). Older codes also recommended sloping the edges of the pit 45 degrees to reduce the possibility of soils sloughing off the sides or recommend the pit be lined with concrete any time it is deeper than twelve (12) inches. The current CMC 2007 would require the installation of a watertight copper pan or “other suitable material” where the excavation exceeds twelve (12) inches and where adequate drainage has not been provided. The pan must be anchored to prevent floatation and extend four (4) inches above adjacent grade. The pan should provide six (6) inches of clearance on all sides, except the control side, which requires eighteen (18) inches. There are also general requirements in the CMC 2007 that require all appliances to be protected in areas subject to flooding. The floor furnace should also be protected in high-wind areas to prevent the loss of the pilot.

While required in the past, propane-fired appliances are no longer prohibited from being installed in pits under the CMC 2007. However, the new code did not alter the fact that propane is still heavier than air and could gather in explosive concentrations. The lack of proper ventilation or installation in a pit should still be raised as a safety concern.

The excavation of the pit may raise other structural issues. Does the excavation undermine any of the pier supports? Are the soils sloughing off the surface and toward the furnace? Are water lines or rust present, indicating past flooding/water intrusion issues? Any water lines, rust or indications of prior water on the burner assembly should be noted and deferred for further inspection. The framing around the furnace must also be inspected. Are the joists properly supported or headed off where they end at the furnace? Are any of the framing members charred? Are there sufficient clearances to the flue components?

Another point to note in the crawlspace is the size of the opening. Would it be possible to bring a new furnace into the crawlspace if the existing one must be replaced? Current standards require a minimum 24”x18” perimeter opening or a trapdoor of at least 24”x24” (CMC 2007 912.8). The passageway to the appliance should be a minimum of 24”x18”. In general, the access opening should be sufficient to allow for service and replacement of the system. Though lights are required for forced-air furnaces in underfloor spaces, lighting is not required for floor furnaces.

Figure 1 - Underfloor Clearance Requirements



Vent System/Draft Hood: Deteriorated vent connectors and draft hoods are among the most common defects with floor furnaces. On most models, the draft hood should be securely attached and tight across the top, with an opening at the bottom. A loose draft hood or vent connector can allow hot flue gases to escape next to the furnace, charring adjacent framing and causing fires (See Photo 2). Again, wood damaged through pyrolysis (long-term low level heat exposure) may ignite at much lower temperatures

Photo 2 - Loose Draft Hood and Charred Framing

than undamaged wood. The wood color/condition adjacent to the system and all vent components should be carefully examined for indications of heat transfer. In extreme cases, the wood may be obviously charred. In some cases, the heat transfer may be less obvious and the wood may only appear caramel in color. Any indications of heat transfer should be reported. Heat damaged wood may ignite at as little as 225^{o}F depending on the wood type, condition, oxygen availability, etc. The flue gases may also contain high concentrations of carbon monoxide due to poor drafting and incomplete combustion, and these gases can migrate into the living space.

The vent connector and possibly the entire flue pipe should be a double-wall (class B) pipe. In practice, older furnaces have single wall vent connectors that are rusted, particularly at the bottom. This rust may not be evident unless the inspector makes a close examination of the vent. Looking at the vent connector from the side and a few feet away may not be sufficient to spot damage or splits on the bottom of the vent connector. The cause of this damage is moisture in the flue gases condensing in the pipe due to inadequate draft or flue temperature. Since the surrounding space is cold and unconditioned, the cooling effect on the flue causes condensation. The requirement for a Type-B vent connector has been in place since the earliest editions of the Uniform Mechanical Code. Many furnaces installed before this code are still in service with

single-wall vents (photo 3). Occasionally the vent will be single-wall copper, designed to resist the corrosive effects of condensation.

Photo 3 - Rusted Draft Hood and Discarded Old Vent

The total developed horizontal length of a single wall vent connector should not exceed 75% of the total vertical length (the height difference between the draft hood and flue termination). Dual wall/Type B vent connectors are generally allowed to be 100% of the vertical height. Long horizontal runs allow the flue gases to cool, causing condensation and improper draft. Oversized vents also impede the flow of flue gases. A common example is floor furnaces venting into masonry or chimney or Transite flue. These older vent systems may require replacement on upgrade of the heating system.

Improper draft allows spillage of combustion products into the crawlspace and may affect the combustion process. While in the crawlspace, the inspector can test for spillage by holding a mirror just outside the opening at the bottom of the draft hood while the furnace is operating. If the mirror fogs, combustion products are spilling from the draft hood. This test should not be done immediately upon starting the furnace, as proper flow of flue gases often does not occur until the furnace has been operating for a few minutes.

Floor furnaces are often installed in tight spaces with minimal clearances. The draft hood requires at least 6 inches clearance from adjacent framing. Single-wall vents require at least six (6) inches of clearance to combustible materials. Dual wall/Type-B vents require at least a minimum one (1) inch clearance. There are newer flexible metal vent materials that carry a Type-B rating. Some of these flex B-vent products are not listed/approved for use in attics or crawlspaces. None appear listed for use in concealed

spaces. It is suggested that the inspector look at any labels visible on the installed vent materials. The vent connector must have a minimum ¼" per foot rise, which is often difficult to attain in a tight crawlspace. The vertical vent is sometimes entirely on the exterior of the building, with a vent connector penetrating an exterior cripple wall or rim joist. Again the vent is likely to be colder when it is outside, and this may create more condensation. Vent connectors and vents must be properly supported. The base of a vertical vent should be suspended from the framing, not supported on blocks or bricks on the soil. All vent openings should be sealed, including the bottom of the vertical vent.

When a floor furnace vent connects to a masonry chimney, check for a separate flue. Inspectors have reported seeing chimney repairs where a chimney was rebuilt without any opening for the floor furnace vent. Other older flue materials are often found. These include terra-cotta flues in metal liners. Over time, the mortar joints inside these flues may fail. Testing for spillage of gas combustion products at the draft diverter will usually detect a blocked flue. One of the most common repair recommendations for floor furnaces is to repair or upgrade the flue system.

Fuel Supply:

The gas connection to the furnace bears close examination. First, examine the rigid gas pipe. It should be adequately supported and end in a valve followed by a union or flexible connector. Is the valve a type that requires a tool or can it be operated by hand? Is its handle broken? If you carry a combustible gas detector, this is a good place to start checking for fuel gas leaks.

Keys sticking above the floor controlled older gas systems. These keys fit onto rods that controlled the pilot valve and the burner valve. Often such older furnaces had no thermocouple. If the pilot blew out, it was possible to fill the furnace with gas. Many of these old systems are still in use (Photo 4). There may be a pressure regulator with a breather tube run into the burner area. Do not mistake the breather tube for a thermocouple. In many older homes with these furnaces the long metal rod may have a slot at the end for holding the match used to light the pilot.

Photo 4 – Non-Safety Pilot system – Also note Condensation on Soils below Draft Hood

An improvement on the older gas systems is the "90% safety" type. These have a thermocouple linked to the valve controlling the burners, but not the pilot. With these systems there are usually separate “butterfly” valves for the pilot and burners. The pilot valve is ahead of the line controlled by the thermocouple, and gas to the pilot will continue to flow even after the pilot has blown out. Gas will not flow to the main burners when the pilot is out.

With either of the above gas systems, it is unlikely to find a thermostat in the system. If a thermostat has been added, there is usually a new one-piece gas valve that contains the thermocouple and a pilot tube. Even with these new valves, some of the older components may still be in the gas line, even though they are not essential to its use.

The connector for the gas valves should be a modern listed flexible connector, steel or teflon-coated. Copper tubing or uncoated/ribbed brass connectors are obsolete materials and should be replaced. The gas piping and connector materials should be adequately supported and should not be in contact with soil. Current standards require that a minimum six (6) inch clearance to grade be maintained unless the gas piping is factory wrapped. It is not unusual to find older installations where the gas piping or connector is on or below grade. Care should be taken around any such areas since disturbing the soil or piping may result in gas leaking from deteriorated connectors or pipes.

Should the inspector opt to carry a combustible gas detector or carbon monoxide detector, additional testing can be performed while the unit is in use.

Replacements:

The current California building code requires habitable spaces to have a heat source capable of maintaining a temperature of ***68°F*** three (3) feet above the floor level (CBC 2007 1204.1). It is important to advise your clients that this type of heating system may be inadequate in remote areas of the dwelling. Leaving bedroom doors open and using a small fan to assist heat exchange throughout the dwelling can make living with a floor furnace easier.

Floor furnace heating systems are old and should be considered obsolete. While the unit may have been functional at the time of inspection, the units are older may require repair or replacement at any time. Replacement floor furnaces are still available for flat floor furnace types. There appears to be no replacements for wall-register types.

Almost any floor furnace can be repaired given enough time and money. Most homeowners will opt to have a qualified mechanical contractor upgrade floor furnaces to central forced air units when the floor furnace requires repair or fails to provide adequate comfort. The floor furnace can be gutted and the outer box and grill modified for use as a return air opening for a forced air unit. Other replacement options are wall furnaces or direct vent units.

Older floor furnace systems are not energy efficient. Depending on individual usage patterns, replacing an old floor furnace with a modern forced air system may actually pay for itself in a fairly short time through reduced energy costs. Many local gas utilities offer rebates or incentives to upgrade older heating systems to modern energy efficient units. The inspector may wish to direct the client to the local gas utility's energy conservation website for further information on any available rebates or upgrade programs in place.

About the author:
Skip Walker lives in the SF Bay Area and has performed over 2,000 paid inspections since becoming a CREIA member in 2003. Skip is both a CREIA Master Inspector and an ASHI Certified Inspector. Skip is an ICC Certified Residential Combination Building Inspector and a F.I.R.E. Certified Inspector. Skip is the education chair for the Silicon Valley ASHI/CREIA Chapter. He also holds a California Real Estate Appraisal Trainee License. Skip may be reached at HomeInspection@sanbrunocable.com.