Observational Diagnostics, Section One

There are many Observational Diagnostic techniques and experiential knowledge that have been learned by many individuals through the time that they spend in buildings which, in general, may not have made its way into the typical building evaluation resource materials. This Observation Diagnostics, Section One document was created as a way of collecting and disseminating an initial set this useful knowledge for those interested in developing their building diagnostic skills. This document is also a beginning effort to bring some key pieces of information together in one place from a dispersed set of resources.

Combustion

Fan or building caused negative pressure can cause spillage of flue gases, accelerated introduction of carbon monoxide into the conditioned space, and flame roll out from atmospherically vented combustion appliances that are located within the negative pressure field.

For unvented heaters and gas ranges that have correct combustion adjustments the dominant concern is the amount of water vapor contained in the by-products of combustion which can be the equivalent of one gallon of water per 100,000 Btus burned.

The dominant safe combustion feature built into direct vent furnaces and water heaters is that they are atmospherically uncoupled from conditioned space.

HVAC Systems

When trying to determine if the air handler that is connect to a forced air duct system is a heat pump look for items that can indicate an alternative system. If gas piping for propane or natural gas, fuel lines connected to a fuel oil tank, or water piping connect to a water heater are attached to the air handler, it is not a heat pump. If there is a heating and cooling thermostat and an outside compressor unit connected to the air handler through a refrigerant line set you are close to your identification. The last item to confirm is that the compressor runs during the heat mode and thus you have confirmed that heating is not provided solely by electric strip heat.

For an air handler connected to a forced air duct system you can determine that it is an aerodynamically uncoupled, 90% plus efficient furnace system if there is a gas line connected to the air handler and there are two PVC pipes connecting the furnace with the outside environment.

To fully document a split system, furnace and air conditioner forced air heating and cooling system you need to find and record three model number plates, one on the furnace, one on the a/c coil, and one on the compressor.

A name plate on a gas furnace will include a variety of information including among other items the input Btu/hour, temperature rise range, type of gas, model number, manufacturer name, and manufacture date.

An 80% plus efficient natural gas furnace can be identified by observing that is has a fan on the furnace that draws a metered volume of combusted gases through the heat exchanger. It will not have a drain to remove combustion condensate, have an open draft diverter, or be connected to one or two PVC pipes.

A “package” gas furnace and air conditioning equipment unit is designed to be located outside the building and can be found placed on the ground or on the roof depending on local practices. It should not be located in a close crawl space, in a vented attic, or inside a mechanical room.

Ductwork

Incorporating building cavity air paths into a forced air duct system is most often associated with the largest amount of measured duct leakage.

In regions where air conditioning is used it is not uncommon to find insulated supply duct systems, which are located in unconditioned spaces, on which the exterior vapor retarder has not been completely sealed. The most damaging potential outcome is that water vapor can enter the duct insulation and condense on the surface of the supply duct and drain down to the inside surface of the vapor retarder where it cannot escape. Thus it saturates the duct insulation resulting in insulation with very little R-value.

The simplest method that can be used to identify the presence of condensed water vapor in duct insulation during the cooling season is to place the back of your hand against the vapor retarder at the bottom of the duct and feel both a cool temperature and the weight of water in the duct insulation.

The simplest method that can be used to identify the presence of duct liner insulation inside a sheet metal duct system is to thump on the metal duct and listen for a dull sound.

The four most common types of material used to convey supply air in duct systems for homes are flex duct, thin gauge metal, duct board and building cavities. Inflatable tubes are being used in some commercial establishments but are not in general use in homes.

The best indicator of previous duct sealing is that mastic is present for a representative sample of connection locations across the return ducts, air handler, and supply ducts. A customer showing a receipt for a new system, the fact that a service tech has been on site, or that there is mastic at the air handler will not give you the information that you need.

Foundation Types

Stairs leading from the home’s main floor to a below grade space indicate that the home is constructed on a basement foundation.

To determine if a home has a crawl space foundation look for the presence of a crawl space entry. Depending on the local construction practices, the entry may be a door in the exterior perimeter foundation wall which may be outside or from within the garage, an access built into the main level floor, or through an interior wall on some split level homes.

One way to determine if a home is constructed on a slab foundation is to determine that there is an absence of a crawl space entry or stairs to a below grade space.

For an existing home that has been determined to have been built on a crawl space foundation to be further classified as a properly closed crawl space it must include six design elements. It must include moisture management and drying mechanism(s) that meet the moisture load, safe combustion appliance operation, correct thermal performance, correct fire safety materials, radon management, and applicable pest management standards. Additional elements may be present.

The difference between a raised slab foundation system and a crawl space foundation system is that the slab is poured on top of fill that is inside a foundation wall that is one or more course of block above grade. There are suspended concrete slab floors built over crawl spaces which are a completely different type of construction.

Appliances

You will know that you are looking at a gas range that falls into the oldest category of gas ranges if you determine that the oven burner ignites using a standing pilot. New gas ranges use electronic ignition. Observing that there is a glass window in an oven door will not tell you whether it is standing pilot or electronic ignition. Open the burner drawer and look for a pilot flame. Electronic ignition is also indicated by a clicking sound just prior to oven burner ignition.

A variety of resources confirm that refrigerators with top freezers are the most energy efficient style. When you compare start with Energy Star units and to look at units that are the same size and have the same options.

A variety of resources including ACEEE confirm that a currently manufactured refrigerator will use ½ the amount of energy as a refrigerator of the same size, style, and set of options that was manufactured in 1990.

Horizontal-axis (usually front-loading) style clothes washers have been determined to have the best potential for efficient operation. This includes both water and energy efficiency. Plus the spin cycle performance of these units reduces the water retained in the clothes thus reducing the dryer run time.

One quick tip for identifying the age of an appliance is to look on the appliance name plate because the manufacture date is often listed.

The Energy Star appliance label indicates that an appliance meets a set of standards for using significantly less energy than standard products of the same type.

Visual Indications of Condensation

In homes where the owner has installed a vent free heater(s) and turned off the forced air heating system which has its ducts located in the attic there is the potential that water will drip out of some of the ceiling supply registers.

Spillage and or backdrafting of combustion by-products from atmospherically vented water heaters can be identified by the visual identifier of corrosion built-up on the water pipes at the top of the water heater, especially on the cold water line.

When mold growth is found only behind a chest of drawers located at an exterior wall it is an indication that the wall surface temperature has been or is at or below the dew point for the water vapor present in the interior air.

If in the basement of a home with a T-bar ceiling tile system the tiles are sagging down in the middle, there is the potential that during the cooling season warm, moist outside air is entering the space above the tiles, condensing, and being absorbed.

Moisture staining patterns can be observed in attic insulation around ceiling penetrations because during the heating season stack pressure is moving interior moist air from the home through the ceiling penetrations and into the attic where it condenses at the top of the insulation and is absorbed.

Warm, moist air circulating above the floor insulation in a vented crawl space foundation home can result in rust and rust balls on nail ends that are penetrating through the sup-floor into the space above the floor insulation when it is not properly installed next to the sub-floor.

Combustion Equipment

Soot markings or heat stressed metal near the gas burner location are evidence of previous flame rollout for atmospheric venting furnaces, water heaters or space heaters.

If air current smoke will not enter the draft diverter of atmospheric venting combustion equipment during operation it is an indication of a blocked chimney.

Space conditioning or water heating equipment is combustion based if a gas line and a vent pipe are present and connected to the unit.

A gas range is an unvented combustion source when no range hood exists, the hood is a recirculation type, or the hood is not turned on during range use.

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Sealed combustion appliances are recommended to replace unvented combustion appliances such as space heaters.

Expected Life

The expected life of a new gas furnace that is not located in climates with corrosive salt air coastal environments is 20 years. This assumes proper installation and reasonable maintenance during its service life.

Kitchen and Bathroom Exhaust Fans

Exhaust fans in the kitchen and bathroom serve the important purpose of removing moisture created in these areas. The concern with these fans is whether or not they are properly vented to the outside and exhaust the correct amount of cfm of air flow. The International Residential Code states that the bathroom exhaust should provide 50 cfm of air flow when in operation. The kitchen exhaust fan should provide 100 cfm of air flow. The issue is that often the fans do not exhaust to the outside. Bathroom fans are sometimes installed such that they are vented directly into the attic space above. Kitchen exhausts fans can be purchased that simply remove the moisture away from the cooking surface and exhaust it into the kitchen air. In order to determine whether the bathroom and kitchen exhaust fans are actually exhausting to the outside a number of items can be inspected. First, the presence of ductwork from the fan leading to the outside is a good clue that the fans are intended to exhaust to the outside of the building. Vent registers on the outside of the house [walls or roof] can also be a clue that the fans are ducted correctly. Confirm that the damper is not taped shut. When inspecting kitchen exhaust fans a person can turn on the fan and feel with their hand above the edge of the hood. If you feel air flow the hood is a recirculation type and does not exhaust to outside. Another approach is to access the ductwork for the exhaust fan in question and follow it to the point at which it exits the building. Or turn the fan on and off and observe if the exterior damper opens and closes. Remember, sound level does not necessarily equal cfm air flow. If you are not formally measuring air flow, a relative assessment of cfm air flow can be made by placing a material over the fan air intake and observing if the cfm air flow creates enough suction to hold it in place. Three different items, toilet paper, paper towel, wash cloth, have been used to indicate different cfm air flow amounts. If the lightest item, toilet paper, falls down you have noise but totally inadequate cfm air flow.