

Home Performance Remodeling Protocol

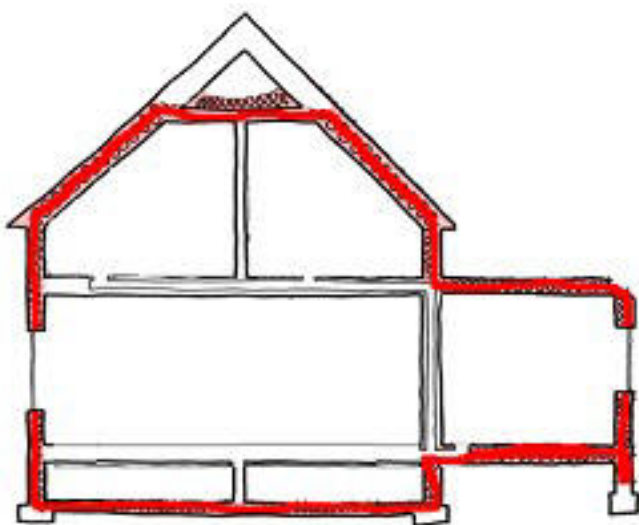
Level 2 Protocol: Air Sealing Home Improvement

In *Level 1 Protocol: Air Sealing Home Improvement*, the reasons for air sealing, factors causing houses to leak air, tools used for diagnoses, and strategies used for addressing air leaks were introduced. This protocol will describe some of the locations where air leaks occur and methods used to fix these leaks.

1.0 Air Sealing Strategy

The Level 1 Air Sealing Protocol introduced the strategy suggested to obtain the most benefit from air sealing investments. In general, a contractor should tackle the largest holes and least-expensive fixes first. As for the building, a good strategy is to start at the top and work down. Third in the list of priorities is to concentrate efforts in rooms where people spend the most time and will benefit most from improved comfort.

In order to determine areas of leakage, a contractor must determine areas of the house that are intentionally conditioned (heated or cooled) and components that aren't



conditioned. The interface between these two areas is called the pressure or thermal boundary. A thermal boundary consists of an air barrier (keeps air from moving from conditioned space to unconditioned space and vice versa) and an insulation layer (keeps thermal transmission from occurring from conditioned to unconditioned space and vice versa). The figure on the left illustrates a thermal boundary as a red line surrounding a house. Air leak pathways are

found in penetrations or voids in this pressure boundary. As most of these penetrations or voids can be obscured from view, a list of common locations for these leak pathways is presented below:

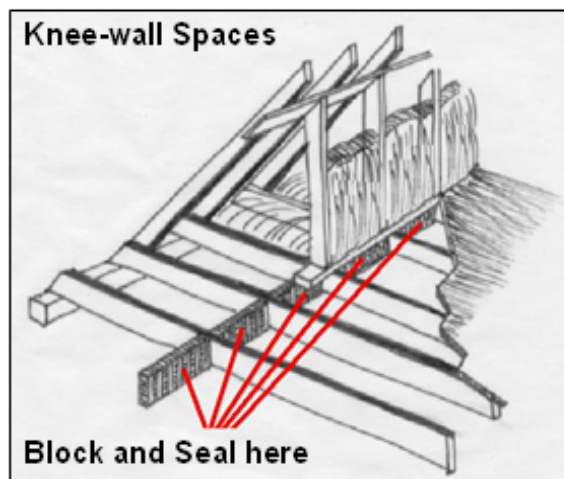
2.0 Common Locations for Leaks

2.1.1 Examine the top of the living space, and the floor of the attic.

- a. Note any breaches between the living space and the attic. These can include gaps for the passage of plumbing, electrical, and HVAC elements through framing or drywall/plaster. Interior partition walls often are open to the attic and should be sealed.
- b. Check the upper insides of closets for air leakage.

Home Performance Remodeling Protocol

- c. If there are attic knee-wall spaces, check to make sure they are sealed off from the attic floor. Doorways or hatches into the attic should also be sealed.
- d. If there are ceiling panels (suspended ceilings), get up above them and check for holes resulting from missing or damaged plaster.
- e. Check for venting in the attic. A little ventilation is absolutely necessary and attic ventilation requirements are found in the local building code. Be sure there are existing vents, and that they are free of any blockages such as insulation obscuring these openings.



2.1.2 Look around the inside of the living space.

- a. Check for air cavities that might not be obvious. For example, look for closets that are not as deep as the walls outside the closet on either side. You may want to seal the point at which these walls connect with the attic. Insulation board and caulk can be used in the attic floor to stop air exchange.
- b. Look for uneven ceiling heights, changes in floor height, and any previous remodeling efforts. This condition can signify potential areas of air movement.
- c. Look for openings between the house and garage or porches if present.
- d. Check doors and windows for presence and condition of weatherstripping.

2.1.3 Look at the floor of the living space, and the ceiling of the basement (or crawl space).

- a. Check for holes and leaks in the floor, especially around the perimeter of the living space.
- b. Look for gaps surrounding pipes and ducts coming up through the living space.

Several sources provide more exhaustive lists describing areas where air leakage commonly occurs.¹²³

3.0 Tools for Investigation and Sealing

A tool useful for identifying air leaks and evaluating the effectiveness of sealing work is a blower door. As described in Level 1 Protocol, a blower door induces a pressure

¹ http://southface.org/web/resources&services/publications/factsheets/8_airsealing.pdf

² <http://www.homeenergy.org/archive/hem.dis.anl.gov/eehem/95/951111.html>

³ http://www.energystar.gov/ia/home_improvement/home_sealing/DIY_COLOR_100_dpi.pdf

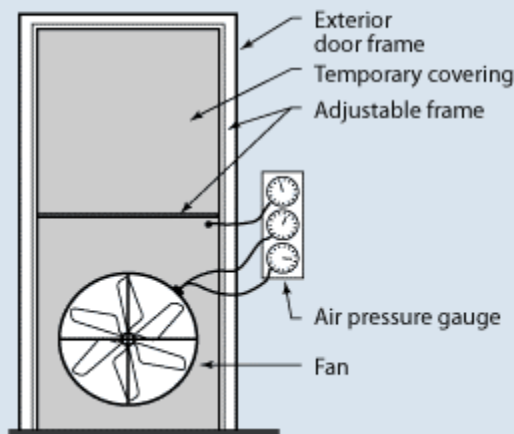
Home Performance Remodeling Protocol

difference between the house interior and exterior. Most often blower door tests are done by lowering the pressure inside the house by “sucking” air out of the house with the blower door fan. Typically, a vacuum of 50 Pascal’s is drawn upon the house and an air leakage level is determined in either air exchanges per hour (how many times does a home completely exchange its volume of air in an hour) or cubic feet per minute. During this time, a contractor might use chemical smoke to look for spots where air is crossing the pressure boundary. Chemical smoke is commonly created with titanium tetrachloride in order to create a smoke that is highly sensitive to air movement. Suppliers of blower door equipment also carry other associated items such as chemical smoke, auxiliary supplies for pressure testing, and user manuals.⁴⁵



Diagnostic Tools

Testing the airtightness of a home using a special fan called a blower door can help to ensure that air sealing work is effective. Often, energy efficiency incentive programs, such as the DOE/ EPA ENERGY STAR Program, require a blower door test (usually performed in less than an hour) to confirm the tightness of the house.



(Source: U.S. Department of Energy, Energy Efficiency and Renewable Energy)

Drafts induced by the blower door may also be felt by hand or seen by observing blowing and shifting insulation or moving window curtains or plants. Insulation with dark coloration is indicative of air movement due to the dirt collected by the insulation as air passes through it.

Once identified, air leaks need to be sealed. A variety of materials are available for this purpose including caulk, foam, and sheet goods. These materials can be found at most building supply outlets or specialized energy efficiency suppliers.⁶

Caulk is used to form a flexible seal in small gaps (up to ½” wide) between building materials. It comes in a variety of forms and delivery methods. Most caulk comes in disposable tubes and is dispensed through the use of a caulk gun. Other kinds come in

⁴ <http://www.energyconservatory.com/>

⁵ <http://www.infiltec.com/inf-catb.htm>

⁶ <http://www.sheltersupply.com/shelter/default.aspx>

Home Performance Remodeling Protocol

coils of formed ribbons which are placed into gaps by hand. The chemical composition of caulk determines whether it is paintable, easily cleaned, its flexibility and durability, etc. Acrylic latex caulk is often paintable and is easy to clean. Silicone-based caulks are flexible and durable by nature, but often can't be painted and present problems during clean up.⁷ In general, a consumer will get what they pay for so economizing on caulk that may cost more to apply than the price of the material is not a good strategy.

Specialized caulks are made for contact with surfaces that experience high heat such as flues and chimneys. Surfaces with high heat should only be sealed with materials designed for such an application. As with all materials, caulk should be applied in accordance to manufacturer's instructions.

Foams used for sealing also come in a variety of forms. Foams can span gaps up to three inches in width. Expanding foam generally comes in latex and urethane-based formulations. Latex foams are typically used indoors and urethane foams are common for areas exposed to water and outdoor environments. Typical areas for application include gaps between electrical outlets or lines located on or running through exterior walls, gaps between foundation and sill elements or rim joists, holes created through framing to accommodate plumbing, etc. Foam is not recommended for situations where flammability is an issue such as flues, and chimneys.



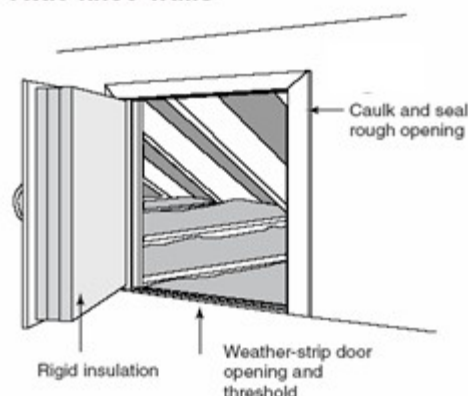
For large holes where the pressure boundary is damaged or missing, rigid foam insulation, drywall, duct board, and other board material can be fashioned into a pressure boundary. Joints created from these materials must be sealed with caulk, foam, or mastic in order to complete the seal. Care must be taken to ensure sealing measures derived from sheet goods will not present a flammability hazard.



⁷ http://www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11270

Home Performance Remodeling Protocol

Attic knee-walls



Weatherstripping on doors and windows should be checked and replaced if damaged or missing. Attic hatches often don't have any weatherstripping or gaskets so adding a seal at these locations will greatly reduce air flow as a result of stack effect. Other access hatches benefiting from the addition of gaskets or weatherstripping include doors entering unconditioned space behind knee walls in attics.

4.0 Follow-up Procedures

After performing air sealing procedures, the effectiveness of the activities should be checked. Again, the use of a blower door is recommended to determine the tightness of the shell and to monitor the air leaks previously identified.

If the house has any fuel-burning appliances, determine if combustion products are exiting the structure through their venting systems as designed. Sometimes air-tightening strategies can alter the operation of a fuel-burning device such as a water heater or fireplace by altering pressures within the house causing combustion products (including carbon monoxide) to enter the house rather than vent from it through flues or combustion vents. This phenomenon is called backdrafting and is a potentially fatal condition. Your blower door contractor can test for backdrafting.^{8 9 10}

⁸ <http://www.homeenergy.org/archive/hem.dis.anl.gov/eehem/94/940110.html>

⁹ http://www.healthhouse.org/tipsheets/TS_backdrafting.pdf

¹⁰ <http://www.weatherization.org/gasappliances.htm>