

January 4, 2019

Home Testing for Energy Efficiency using a Blower Door, and Thermal/ Infrared Imaging

Poorly insulated areas and inadequate air sealing can cause high energy bills and uncomfortable drafts over the life of a home. Once the walls, ceiling, and floors are finished it's hard to tell if a house has been properly insulated and air sealed. Fortunately, a house can be evaluated with a thermal imager – also called an infrared camera – and a blower door to determine whether it is well insulated and air sealed.

A blower door is a large fan assembly temporarily placed in an exterior doorway. In operation, the blower door draws air out of or into the house. Most blower door investigations are done by drawing air out of the house – depressurization. Instruments measure the amount of air flow and determine the air leakage rate of the house. Montana energy codes now require all new homes pass a blower door test. An infrared imaging investigation in conjunction with a blower door analysis can best detect air leakage in a home.

An infrared image shows the surface temperature of an object. Improperly insulated areas will appear colder than expected in winter and warmer than expected in the summer. The temperature difference between inside and outside plays a big part in image quality – there should be at least a 20-degree differential to get an acceptable image. The greater the temperature difference the better the infrared picture. Although if the temperature has been 40 degrees or colder outside the night before, and the house is heated to at least 65, an acceptable image scan can usually be performed before 10:00 a.m.

Most thermal imaging cameras can distinguish temperature differences to within one tenth of a degree and display the images in either a full color palate or in black and white. Most cameras are set up to show cold areas as dark and heat as lighter colors, and many will show the temperature range from coldest to warmest surface temperature. Certain areas are expected to appear colder in winter and warmer in summer, such as edges of windows and wall framing. Wall framing appears this way because wood has an R-value of about 1 per inch, while insulation, such as fiberglass, is about 3.5 per inch. It is the out-of-place hot or cold areas that are of concern.

Deciphering infrared images in the summer months can be difficult. Depending on how long the sun has heated certain areas, the infrared picture can be misleading. The only part of a house that can ordinarily be consistently evaluated is the attic. The attic is usually 20 degrees warmer in the late afternoon and early evening, and missing attic insulation and air leakage areas will appear warmer with the blower door depressurizing the house.

In new construction, the blower door and thermal imaging camera can be useful tools in ensuring the house is properly insulated and air sealed. In existing homes, the combination of these tools can often find areas of the home to be improved upon. Infrared investigations are usually conducted in two parts, the first before blower door operation, and the second with the blower door operating.

Before the blower door's operation, uninsulated and improperly insulated areas – as well as some moisture problems – can be detected by an infrared camera. After a few minutes of a blower door's depressurization, air leakage sites become exaggerated, which appears as dark or light streaks in the thermal image.

Some of the more common air leakage areas found in new houses are at the band/rim joist and the bottom plate, where exterior walls meet the foundation. Other common sites include exterior wall electrical boxes, the junction of the top plate at exterior and interior walls, and ceiling electrical boxes, including recessed light fixtures. Some of these areas are pictured below with accompanying methods of air sealing.

Note: Montana Department of Environmental Quality does not endorse any brand of product. If you have another type of air sealing product or technique you would like to share, please contact Montana DEQ at 406-444-0281.

New & Existing Homes

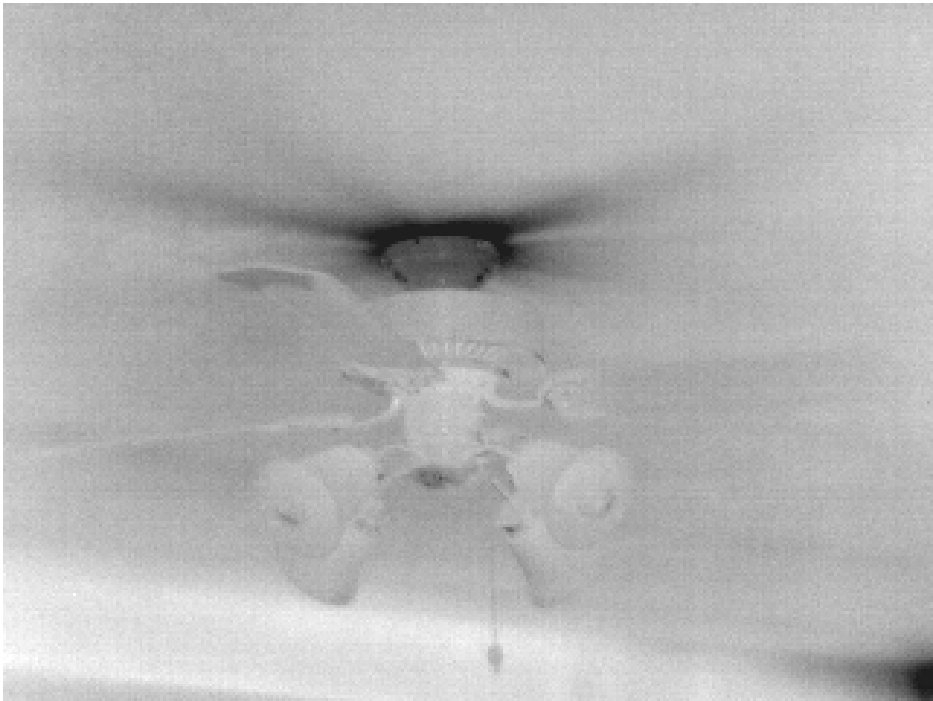
Along with detecting air leakage sites, thermal imaging can detect if a ceiling, wall, or floor has been properly insulated. In cold weather, a properly insulated house should not show any out of place dark (cold) areas. The picture below shows an under insulated section of wall. The insulated wall cavity should be warmer (lighter in color), and the wood framing should be darker. The wood should be darker because wood has an R-value of approximately 1 per inch while the insulated wall cavity would have an R-value of about 3.5 per inch. The wood stud (at arrow) indicates it is warmer than the insulated wall cavity, which is the opposite of what we should be viewing.



Air leakage at ceiling fan:



IR picture of air leakage taken with blower door operating:



Standard ceiling electrical box with openings at wires and gaps between box and sheetrock:



Fix: standard electrical box sealed with spray foam from the attic:

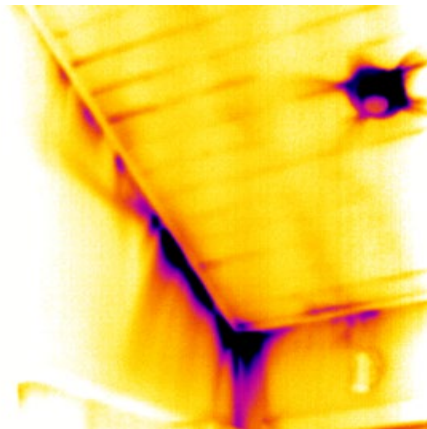


Fix: wide flange box with option to seal vapor barrier to box flange or use foam gasket on the flange.

Note: wire openings are sealed with foam:



Recessed lights and unsealed wall ceiling junction:

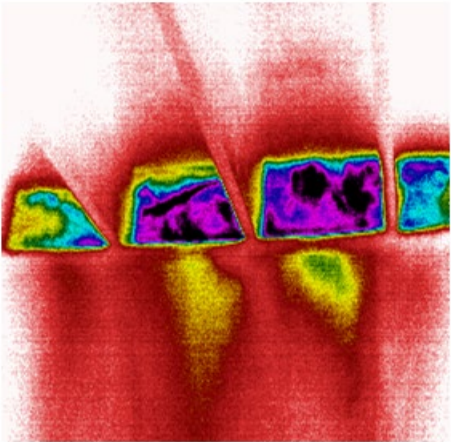


Fix: seal standard box from the attic or install air tight boxes and LED lights.

LED surface mounted light fixture with an air sealed electrical box:



Rim/band joist of crawl spaces, basements and between floor. Note: fiberglass is not an air barrier it does not stop air flow:



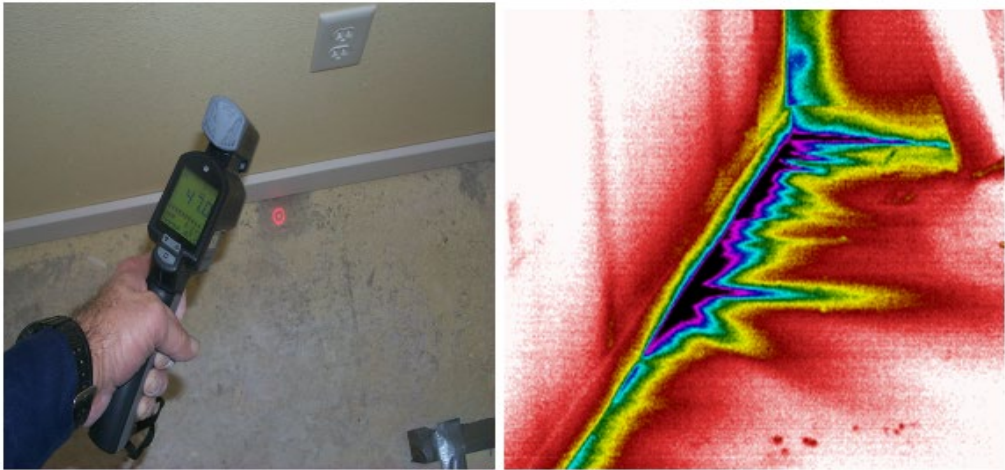
Fix: spray foam or foam block sealed in place. Note: the energy code requires rim/band joist must have an air barrier:



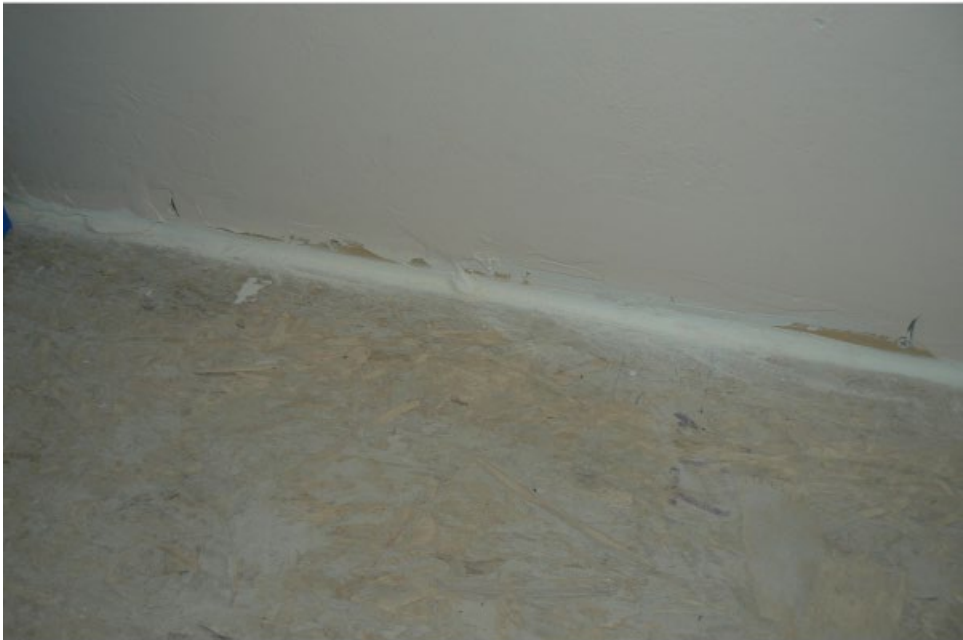
Exterior wall/junction – Gap between bottom plate and floor indicate inadequate caulking:



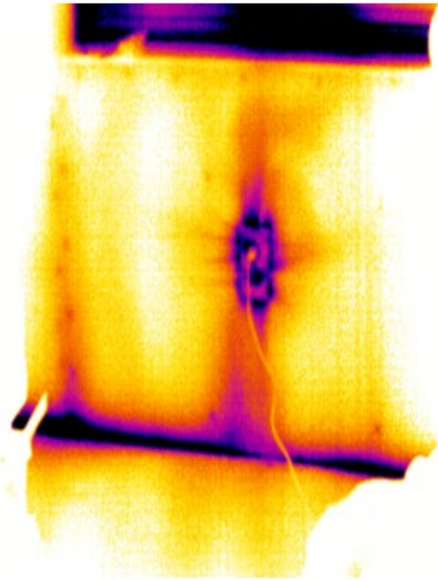
Air leakage at exterior wall floor junction:



Fix: seal the wallboard to the floor:



Air leakage at exterior wall electrical outlet:



Fix: seal openings in standard box:



Fix: seal (caulk) sides of electrical box to sheetrock



Fix: wide flange, with sealed (foamed in place) wiring opening boxes, compressed foam gasket seals box to wall board:



Fix: vapor retarder sealed to box flange:



Top plate air leakage (hot attic):



Fix: spray foam opening from the attic:



Fix: top plate gasket sealing gap between sheetrock and top plate:

