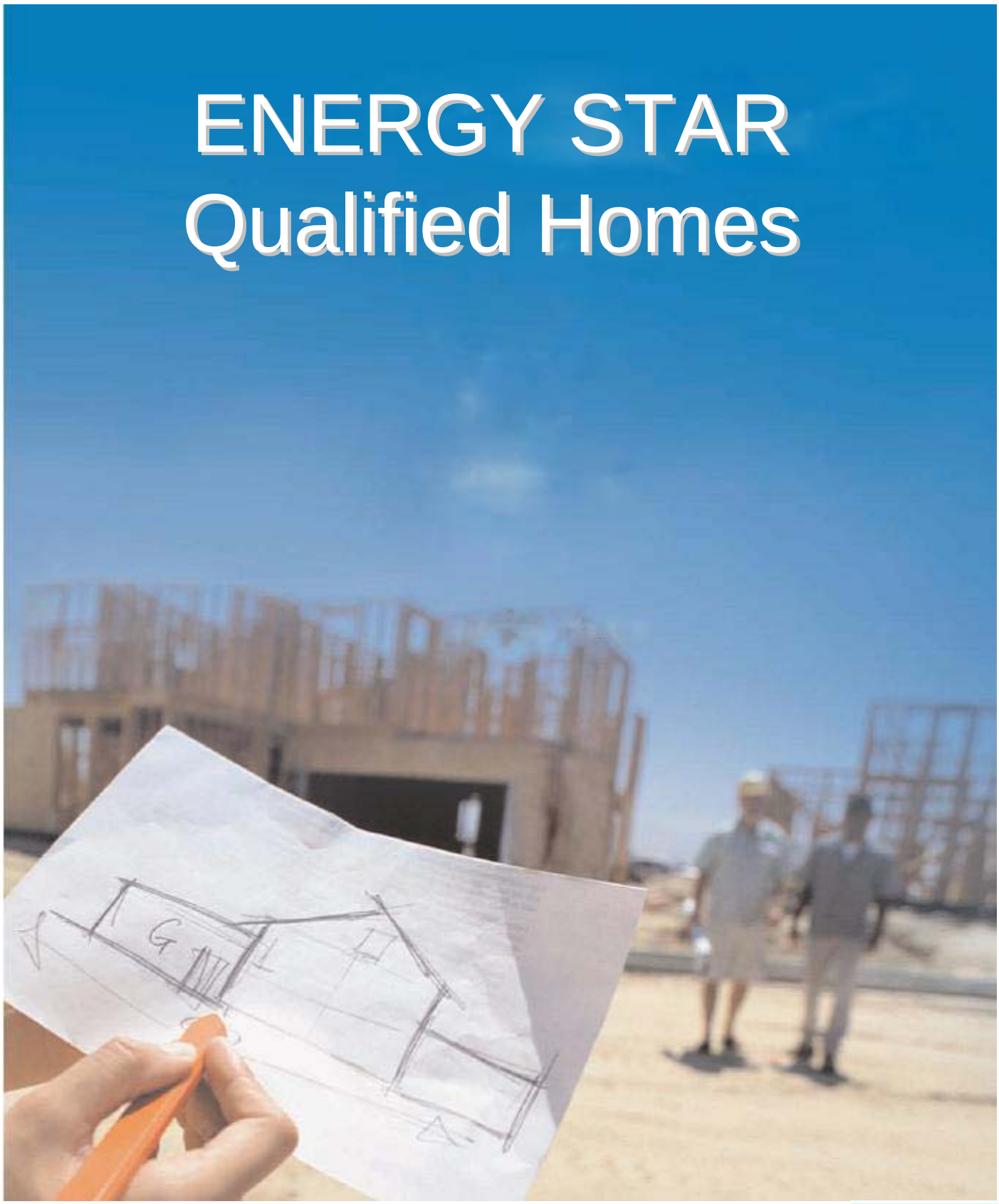
ENERGY STAR Qualified Homes



THERMAL BYPASS CHECKLIST GUIDE

ENERGY STAR

ENERGY STAR QUALIFIED HOMES

THERMAL BYPASS CHECKLIST INTRODUCTION

In response to significant changes in residential energy codes and standards, the United States Environmental Protection Agency (EPA) released a new set of guidelines for ENERGY STAR qualified homes, to be implemented in 2006. A major new requirement is the Thermal Bypass Checklist.

The Thermal Bypass Checklist is a 23-point list of building details where thermal bypass, or the movement of heat around or through insulation, frequently occurs due to missing air barriers or gaps between the air barrier and insulation. The Thermal Bypass Checklist must be completed by a certified home energy rater in order for a home to be qualified as ENERGY STAR, however, up to six items may be verified by the builder to minimize required field trips by the rater.

Below are key points regarding the implementation of the Thermal Bypass Checklist:

Key Points

1. If a state, local, or regional energy code contradicts the ENERGY STAR Thermal Bypass Checklist, precedence must be given to the state, local, or regional energy code. Precedence should also be given to guidelines set by regional ENERGY STAR programs.
2. Not every specific detail and field condition can be covered in these guidelines. EPA and the Residential Services Network (RESNET) rely on Home Energy Rating System (HERS) Providers and raters to employ their judgment when determining compliance with the general intent of the Thermal Bypass Checklist.
3. Builders may self-verify up to six items on the list; the remaining items, however, must be verified by a certified home energy rater.
4. Both the builder and the certified rater shall sign the Checklist, ensuring accountability on both sides.
5. Beginning 6 months after the implementation date for the new ENERGY STAR guidelines, any items found to be non-compliant with the Thermal Bypass Checklist must be corrected in order for the home to be qualified as ENERGY STAR.

A copy of the Thermal Bypass Checklist is provided at the end of this guide for reference.

ENERGY STAR QUALIFIED HOMES

GENERIC TIPS AND BEST PRACTICES

Infrared Images in Guide:

- Infrared images help reveal thermal bypass conditions by exposing hot and cold surface temperatures resulting from unintended thermal air flow. In infrared images, darker colors indicate cool temperatures, while lighter colors indicate warmer temperatures.

Builder:

- This guidance has been created to facilitate both contractor bidding and quality installation.
- Have architect or designer add to the construction drawings wall sections with outline of thermal barrier to define transition between conditioned and unconditioned space throughout the home, along with complete air barrier details.
- Provide drawings in multiple languages needed to accommodate likely field crews (e.g., English and Spanish).
- Typically, the installation measures to create a complete air and thermal barrier for cantilevered floors will be the responsibility of the framing and/or insulation contractors.
- Other trades must be informed to limit penetrations being cut into blocking during rough-in stage if blocking is installed by the framing contractor.
- Meet with framing, insulation, and air sealing subcontractors prior to construction to coordinate installation of all Thermal Bypass Checklist details.
- Consult with local building code officials regarding acceptable air barrier materials exposed to air spaces in attics, shafts, soffits, and dropped ceilings.

Contractor:

- Use photos for technical assistance and follow scope of work.
- Share new ideas for more effectively and economically providing required air barriers.

Field Superintendent:

- Review contractor performance by verifying installation meets objectives of the Thermal Bypass Checklist and the scope of work.
- Develop in-house procedures for inspection to ensure the air and thermal barriers are not compromised by other trade contractors.

Installation Criteria:

- The purpose of the thermal bypass inspection is to constructively work with builders to provide more effective thermal envelopes. If the general intent of an air barrier requirement is met, but not perfect, use good judgment before failing. Use field observations as an opportunity to help the builder be more successful in the future.

1.1 AIR BARRIER AND THERMAL BARRIER ALIGNMENT

"Insulation is installed in full contact with the air barrier to provide continuous alignment of the insulation with the air barrier."

An *air barrier* is any material that restricts the flow of air and can thereby serve to prevent air from leaking in and out of a building. In wall assemblies, the exterior air barrier is typically a combination of sheathing and either building paper, house wrap, or board insulation. The interior air barrier is often an interior finish, like gypsum board. A *thermal barrier* restricts or slows the flow of heat. This is accomplished through insulation including fiberglass batts, rock wool, blown cellulose, vermiculite, spray foam and rigid board insulation.

Regardless of which material is used, insulation is not fully effective unless it is installed properly – that is, continuously aligned with a contiguous air barrier. Insulation works because it is resistant to the flow of heat- that is, it slows the conduction of heat. This resistance to heat flow is measured by the R-value of the material. However, most insulation products (with the exception of closed foam insulation) do a poor job at stopping air flow (Figure 1.1.1).

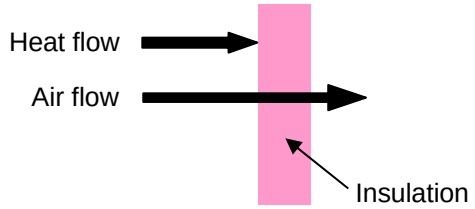


Figure 1.1.1 - Insulation does not stop the flow of air.

Thus, for insulation to be effective, a separate air barrier or skin is needed to stop the flow of air (Figure 1.1.2). For the air barrier itself to be effective, it must be contiguous and continuous across the entire building envelope, with all holes and cracks fully sealed, and it must be perfectly aligned with the insulation (Figure 1.1.3).

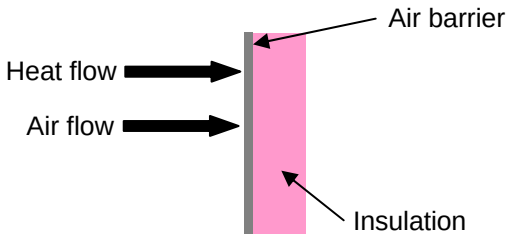


Figure 1.1.2 - Air barrier prevents the flow of air through insulation.

Generally, the Thermal Bypass Inspection Checklist requires a sealed air-barrier on all six sides of insulation (top, bottom, back, front, left, and right), however, there are a few exceptions as noted throughout the checklist. In climate zones 1 – 3, there is a general exemption for the internal air-barrier closest to conditioned space because the direction of air-flow is from the outside to the inside of the house. In climate zones 4 – 6, the direction of air-flow is primarily from the inside of the house to the outside, therefore requiring the internal air-barrier.

1.1 AIR BARRIER AND THERMAL BARRIER ALIGNMENT

“Insulation is installed in full contact with the air barrier to provide continuous alignment of the insulation with the air barrier.”

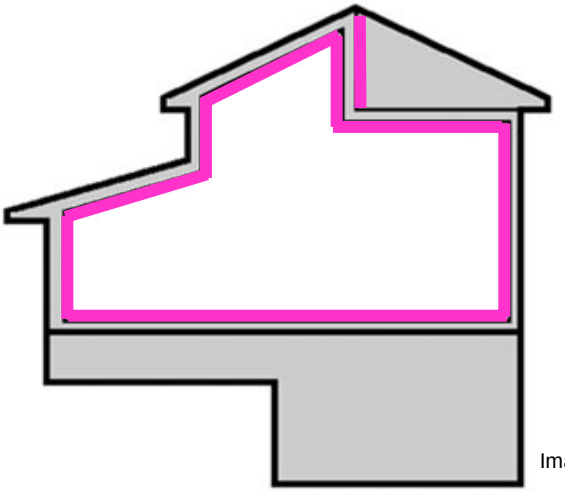


Image courtesy of Southface Energy Institute

Figure 1.1.3 - The air barrier should be contiguous and continuous over the entire building envelope. Insulation should be perfectly aligned with the air barrier.

In order for insulation to be aligned with the air barrier, it should be installed without any gaps, voids, compression, or wind intrusion. Gaps and voids allow air to flow through the insulation, decreasing its effectiveness (Figure 1.1.4). Compression reduces the effective R-value of the insulation.

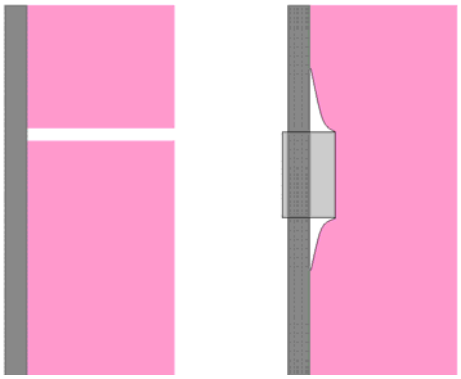


Figure 1.1.4 - Gaps (left) and voids (right) allow air to flow through insulation.

The following images depict real-life examples of misalignment between the air barrier and the home’s insulation.

1.1 AIR BARRIER AND THERMAL BARRIER ALIGNMENT

EXAMPLES

Figure 1.1.5 - Insulation installed with voids and compressions

Figure 1.1.5 shows a common practice insulation installation: inset stapling along the inside edges of wall framing. However, the large gap between the insulation and interior finish will allow air flow around the insulation and facilitate air leakage at any gaps or holes in the framing. In contrast, stapling the insulation to the face of the studs would have allowed the batts to fill the framing space and be aligned with the interior finish. Note also how the insulation is also compressed around piping and wiring, resulting in a reduced R-value.

Figure 1.1.6 - Insulation installed with gaps and voids

Similarly, in Figure 1.1.6, the large gap between the insulation and where the interior finish will be installed will allow air flow around the insulation.

1.1 AIR BARRIER AND THERMAL BARRIER ALIGNMENT

EXAMPLES

Image courtesy of Environments for Living

1.1.7 - Alignment of insulation and air barrier

In Figure 1.1.7, excellent insulation installation is shown with both faced and unfaced batts of fiberglass insulation. Note that the batts are not compressed, there are no gaps, voids or compression, and the insulation is fully aligned with the interior surface. Note also that the insulation is also carefully fit around piping and electrical wiring rather than being compressed in these areas, as was shown in Figure 1.1.5. Homes like this with carefully installed fiberglass insulation can be more comfortable and will have fewer moisture problems.

Image courtesy of Environments for Living

Figure 1.1.8 - Insulation is fit around piping and wiring

Figure 1.1.8 demonstrates one example of proper installation of fiberglass batts around piping and wiring.

1.1 AIR BARRIER AND THERMAL BARRIER ALIGNMENT

EXAMPLES

Figure 1.1.9 - Blown cellulose insulation

Several options outside of traditional fiberglass batts are available for insulation. Figure 1.1.9 shows wet-spray cellulose insulation, which is blown into wall assemblies with a mixture of water and glue that allows it to stay in place without falling out or settling. Since it goes in wet, it does need time to dry. But, the value of this product is that it inherently fills the entire wall cavity without any gaps, voids or compression. A house built with wet-spray cellulose carefully applied can be more comfortable and offers another insulation option that can avoid moisture problems.

Figure 1.1.10 - Spray-in foam insulation

Figure 1.1.10 shows a wall being insulated with spray-in foam. Spray-in foams act as both an air barrier and a thermal barrier, so it is not critical that the foam be aligned with the interior finish. Properly installed, the foam application will fill holes and cracks for both a well insulated and air-tight wall assembly, making the home comfortable and reducing the likelihood of moisture problems. It should be noted that houses built to the 2006 IECC building code in climate zones 5 and higher must have insulation installed with a vapor barrier on the warm side to prevent moisture paths through the insulation. Therefore, it is suggested that closed-cell foam be used for climate zones 5 and higher since it is a vapor barrier.

1.1 AIR BARRIER AND THERMAL BARRIER ALIGNMENT

SCOPE OF WORK

Installation Criteria:

- Insulation shall be installed in full contact with the air barrier on all six sides to provide continuous alignment with the air barrier. For example, batt insulation shall be cut to fit around any wiring, pipes, or blocking and shall be correctly sized for wall width and height.

Tips and Best Practices:

- When choosing insulation, consider options that most readily achieve the proper installation requirements.
- Verify that insulation subcontractor installers are properly trained and/or certified in proper installation practices.

1.2 GARAGE BAND JOIST BARRIER

EXAMPLES

Sealing the garage completely from the conditioned areas of the house is important from an energy perspective because it can be a major source of heat gain and heat loss. It can also can be a health concern because the equipment stored there, such as cars and small-motor tools, release harmful fumes. When the garage is integrated with the house, the gaps created by joists spanning both conditioned space and the garage must be blocked off and sealed. See Figure 1.2.1 for an example of a house which blocked the joists from the garage but did not seal them.

Figure 1.2.1 – Gap between garage and conditioned space filled with barrier but not sealed

Making barriers for the gap between the garage and the conditioned space can become increasing difficult to construct as the joists become more irregular at their cross section. This is particularly true for I-joists and web-trusses. (Figure 1.2.2) In order to remedy this problem it might be possible to plan ahead and re-orient the joists for garages which are bounded by a single conditioned wall.

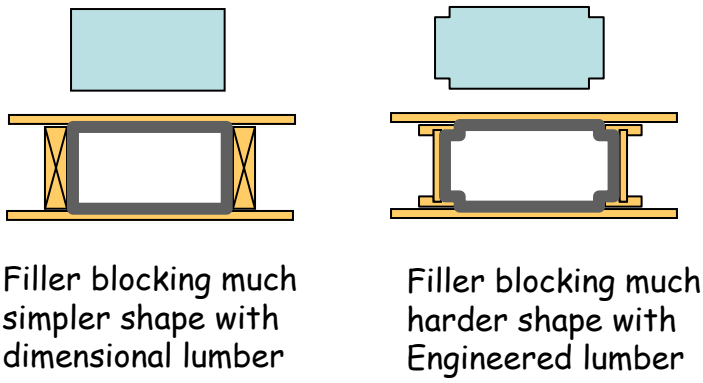


Figure 1.2.2 – Two types of joist-gaps created between garage and conditioned space

1.2 GARAGE BAND JOIST AIR BARRIER

SCOPE OF WORK

Installation Criteria:

- Insulation shall be installed in full contact with the air barrier on all six sides to provide continuous alignment with the air barrier. For example, batt insulation shall be cut to fit around any wiring, pipes, or blocking and shall be correctly sized for wall width and height.

Tips and Best Practices:

- When choosing insulation, consider options that most readily achieve the proper installation requirements.
- Verify that insulation subcontractor installers are properly trained and/or certified in proper installation practices.
- One best practice recommendation is to include an air barrier at band or rim joists. This is most effectively done using closed cell foam or SIP “header” panels which also avoid the labor-intensive process of cutting, installing, and caulking board products at each floor framing bay. As a least desirable option, paper-faced batts can work if carefully installed and taped to avoid air leakage.

1.3 ATTIC EAVES

“Solid baffles are provided at framing bays to avoid wind washing of attic insulation.”

Wind intrusion can occur at roof eaves with soffit vents. If the attic insulation is left exposed, the wind blowing through the soffit can flow through the insulation and in some cases blow it away from the edge. As a result, wind intrusion can undermine the effectiveness of the insulation and create opportunities for moisture problems.

Figure 1.3.1 - Wind intrusion around a soffit vent

In Figure 1.3.1 above, air flow coming through the soffit vent has completely pushed back the blown-in insulation originally installed over the entire attic floor.

1.3 ATTIC EAVES

EXAMPLES

One solution is to install a baffle between each rafter or truss to serve as an air barrier and prevent wind-washing. The baffles can be made of any number of materials specifically designed for this purpose including cardboard and foam sheathing.

Image courtesy of MaGrann Associates

Figure 1.3.2 - Cardboard baffles installed to protect insulation

In Figure 1.3.2 above, cardboard baffles have been installed to direct the flow of air over and above the insulation below.

One general exception to the required six sided alignment of the air-barrier with the thermal barrier is air barrier above ceiling insulation. Ceiling insulation must be in contact with the air-barrier below. e.g. the ceiling sheetrock; however, an air barrier above ceiling insulation (e.g. SIPs) is a performance advantage to those buildings without it. Due to cost effective reasons, the air-barrier above ceiling insulation is not required. Baffles, such as those pictured above, reduce the main effects of heat bypassing the ceiling insulation while being much more cost effective than covering the ceiling insulation with an air-barrier.

1.3 ATTIC EAVES

SCOPE OF WORK

Installation Criteria:

- Wind baffles shall be provided at all framing bays with soffit vents to prevent wind wash.

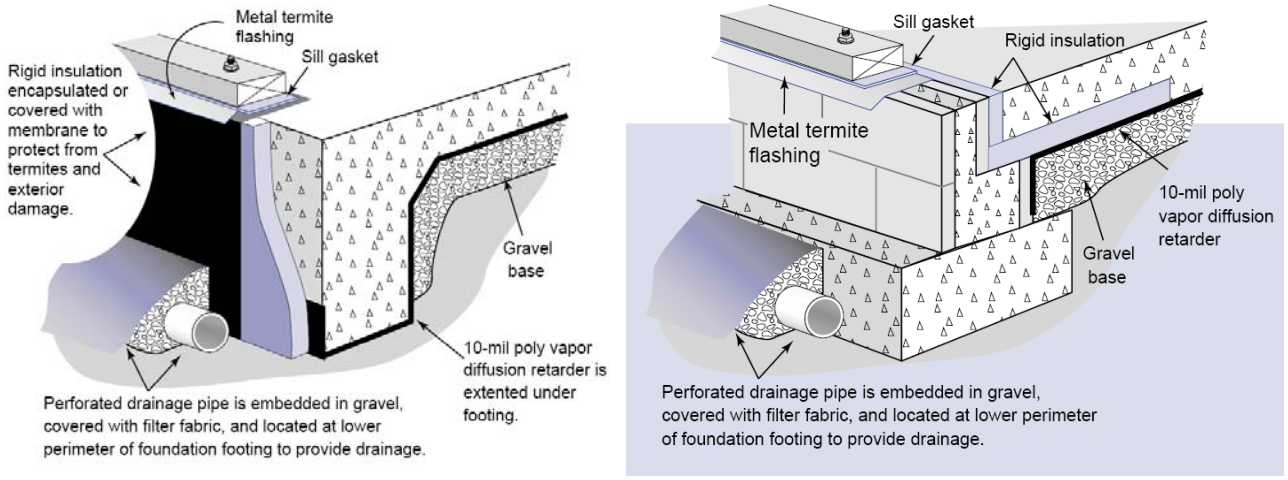
Tips and Best Practices:

- Even if soffit vents are not continuous, consider providing wind baffles at all framing bays since air gaps that commonly occur between roof sheathing and fascia board can allow wind intrusion along the entire roof edge.

1.4 SLAB-EDGE INSULATION

EXAMPLES

While the alignment of air and thermal barriers is important throughout the home, one specific detail merits further mention. Cold concrete slabs are a common source of discomfort in a home, and properly insulating the slab can dramatically reduce heat loss and decrease energy bills.



Diagrams courtesy of the US Department of Energy

Figure 1.4.1 - Options for slab insulation

There are two basic ways to insulate a slab. First, rigid insulation can be installed directly against the exterior of the slab, as shown in the detail at left in Figure 1.4.1. Note that in areas with high termite populations, builders should be careful to avoid installing foam insulation in contact with the ground. A second option is a “floating slab,” which can be constructed using interior insulation, as shown in the detail at right. In both cases, insulation should be continuously aligned with the air barrier.

1.4 SLAB-EDGE INSULATION

SCOPE OF WORK

Installation Criteria:

- In Climate Zones 4 and higher, slab insulation is required to avoid thermal bypass at exposed concrete slabs. An exemption applies to Climate Zones 4 and 5 where a maximum of 25% of the slab perimeter may be un-insulated.

Tips and Best Practices:

- When choosing insulation, consider options that most readily achieve the proper installation requirements.
- Verify that insulation subcontractor installers are properly trained and/or certified in proper installation practices.

1.5 AIR BARRIER AT ALL BAND JOISTS

BEST PRACTICES

One exception to the first requirement of the Thermal Bypass Inspection Checklist is air barrier/thermal barrier alignment at band joists for Climate Zones 4 and higher. While EPA highly encourages builders to complete this detail, it is not required except in homes with open web truss-joist floors and leaky duct systems.

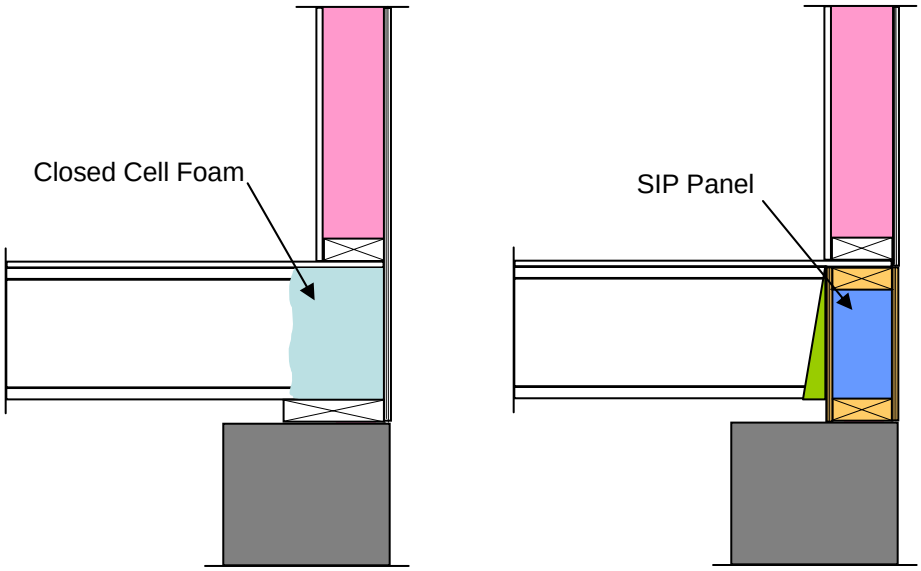


Figure 1.5.1 - Options for insulation/air barrier alignment at band joists

Figure 1.5.1 depicts two options for ensuring the alignment of an air barrier and thermal barrier at band joists. In the detail at left, closed cell foam is used to fill the entire joist area and acts as a thermal barrier and an air barrier. At right, a small structural insulated panel (SIP) is installed, also acting as both a thermal and air barrier.

1.6 MINIMIZING THERMAL BRIDGING

BEST PRACTICES

Figure 1.6.1 - Structural Insulated Panels

In addition to batts and blown-in insulation, there are factory-built insulated wall assemblies available today that, by virtue of how they are manufactured and assembled in the field, ensure full alignment of insulation with the integrated air barriers including no gaps, voids or compression. Structural Insulated Panels or SIPs (Figure 1.6.1) are whole wall panels composed of insulated foam board glued to both an internal and external layer of wood sheathing, typically OSB or plywood. This assembly will often be manufactured with precut window openings and chases.

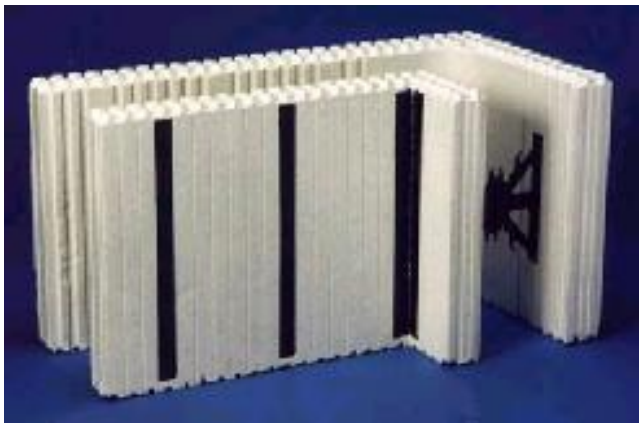


Figure 1.6.2 - Insulated Concrete Form

Another factory-built wall system shown in Figure 1.6.2 is Insulated Concrete Forms, or ICFs. ICFs are blocks made from extruded polystyrene insulation designed to be assembled like “Lego” blocks into a compete wall assembly. Steel reinforcing rods are added and concrete is poured into the voids, resulting in a very air-tight, well-insulated, and sturdy wall. The insulation is inherently aligned with the exterior and interior air barriers with no gaps, voids or compression.

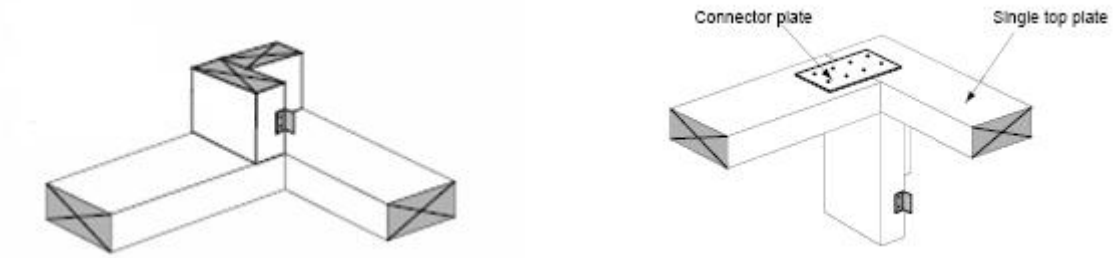
1.6 MINIMIZING THERMAL BRIDGING

BEST PRACTICES

Optimal Value Engineering (OVE) is another possible way to reduce the thermal bridging through walls, but unlike SIPs and ICFs, OVE uses standard building materials. In order to accomplish this, a framing plan is laid out as part of the architectural plans. By specifically placing each stud in the optimal location, it is possible to increase the spacing of 2x6s from 16" off-center to 24" off-center.

In addition, making "California Corners," or corners where studs are off-set, allows insulation to span the full length of the wall and prevents the unnecessary alignment of two studs side by side at the corners. It is also possible create a structurally sound, single stud top plate. For more information see http://www.eere.energy.gov/buildings/info/documents/pdfs/26449.pdf or www.pathnet.org. By adhering to these practices, it is possible to reduce the framing fraction from the standard 23% to around 15%. This 8% reduction in framing area would result in an 8% gain in insulation area.

In addition to energy savings associated with reduced framing area, is reduced capital costs associated with reduced framing.



Pictures from http://www.eere.energy.gov/buildings/info/documents/pdfs/26449.pdf

Figure 1.6.3 – Advanced Framing Techniques, Corners and Top Plates

2.1 SHOWER/TUB AT EXTERIOR WALL

“Exterior walls have been enclosed on all six sides.”
“Exterior walls have been fully insulated.”

In the construction process for many homes, tubs and showers are installed immediately after rough framing is complete, before insulation is installed (Figure 2.1.1). As a result, it is almost impossible to properly install insulation and complete air barriers at exterior walls adjoining tubs and showers. This can lead to air flow that circumvents insulation.

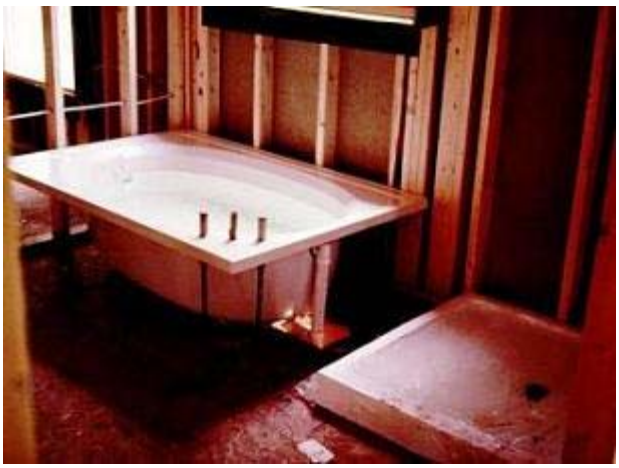
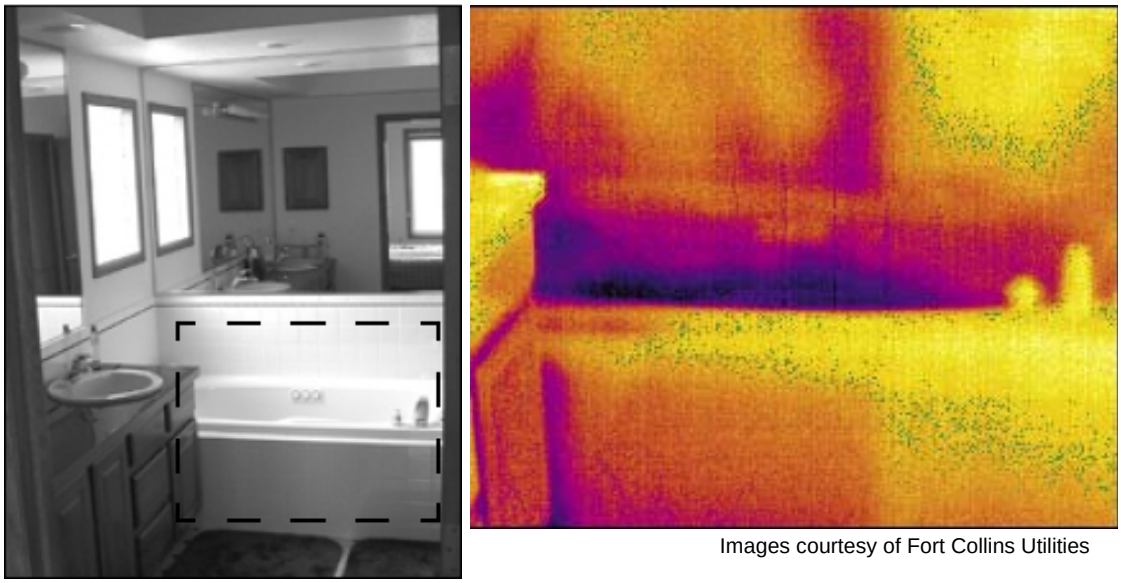


Image courtesy of Building Science Corp.

Figure 2.1.1 - Tub installed against exterior wall without air barrier or insulation



Images courtesy of Fort Collins Utilities

Figure 2.1.2 - Infrared image showing thermal bypass at tub with incomplete insulation and air barrier

The infrared image in Figure 2.1.2 shows a common problem where homeowners have tubs and showers that get cold in the winter. In this case, cool air from outside the home is decreasing the temperature of the tub inside the home. If an air barrier and insulation had been properly installed behind the tub against the exterior wall, the tub would be protected by an effectively insulated wall assembly, making the bathroom more comfortable for the homeowner.

2.1 SHOWER/TUB AT EXTERIOR WALL

EXAMPLES

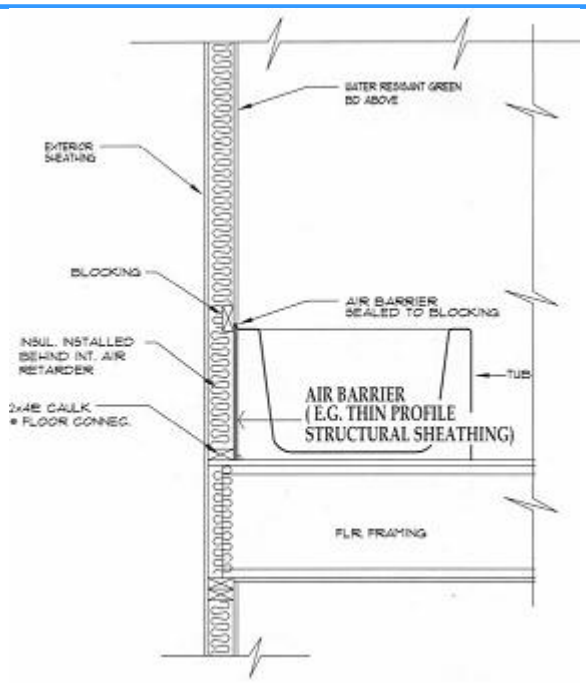


Diagram courtesy of MaGrann Associates

Figure 2.1.3 - Detail of tub installation with complete air and thermal barriers

Image courtesy of Energy Services Group

Image courtesy of Building Science Corp.

Figure 2.1.4 - Two options for air barriers where tubs adjoin exterior walls

The installation of air barriers and insulation behind tubs and showers at exterior walls can be achieved with proper planning (Figure 2.1.4). In the image at left, the builder left insulation batts and drywall for his framers and held them accountable for installing the materials where the tub was to be installed. In the home at right, the builder left a thin board sheathing product to be installed by the framer. Another option (not shown) would be to fill the cavity around the tub with spray-foam, which acts as both a thermal and air barrier. In any of these cases, the tubs will be much less likely to cause comfort or moisture problems. (Internal air-barriers for this detail are not required for climate zones 1 – 3, however, insulation behind the tub or shower is still necessary).

2.1 SHOWER/TUB AT EXTERIOR WALL

SCOPE OF WORK

Installation Criteria:

- Exterior walls shall be enclosed on all six sides, including a complete and continuous air barrier behind the tub. Except for Climate Zones 1 through 3, where houses may comply with the specification by adding a sealed and continuous air-barrier at the outside of the house and ensure alignment with the thermal barrier.
- Any gaps or cracks in this air barrier shall be appropriately air sealed with a compressible sealant, caulk, foam, tape, or mastic.
- Exterior walls shall be fully insulated with no gaps, voids, or compression.

Tips and Best Practices:

- Use a material that is readily available to ensure the air barrier is installed prior to setting the tub. Plywood, oriented strand board (OSB), sheathing boards, and drywall are good choices.
- Consider using spray foam at framing behind tubs to avoid labor installing both air barrier and insulation. However, it will need to be installed prior to setting the tub or shower.
- Insulation material and air barrier sheathing should be made available on site for installation prior to plumbing rough-ins, or the wall cavity behind the tub could be left accessible for installation of loose fill or blown in insulation by the insulation subcontractor.

2.2 FIREPLACE WALL

“Air barrier is fully aligned with insulated framing in framed shaft behind fireplace and any gaps are fully sealed with caulk, foam, or tape.”

Air barriers are also needed in wall chases, such as the furred out space behind fireplaces. Once framed in, they are very difficult to complete with insulation and air barriers.

Air barrier missing at framed exterior wall

Image courtesy of EnergyLogic

Figure 2.2.1 - Fireplace installed without air barrier

In Figure 2.2.1 above, the fireplace has been framed and installed without an obvious air barrier, making it difficult for insulation to be installed properly. The diagram in Figure 2.2.2 below shows a detail of how the air barrier behind the fireplace wall can be installed.

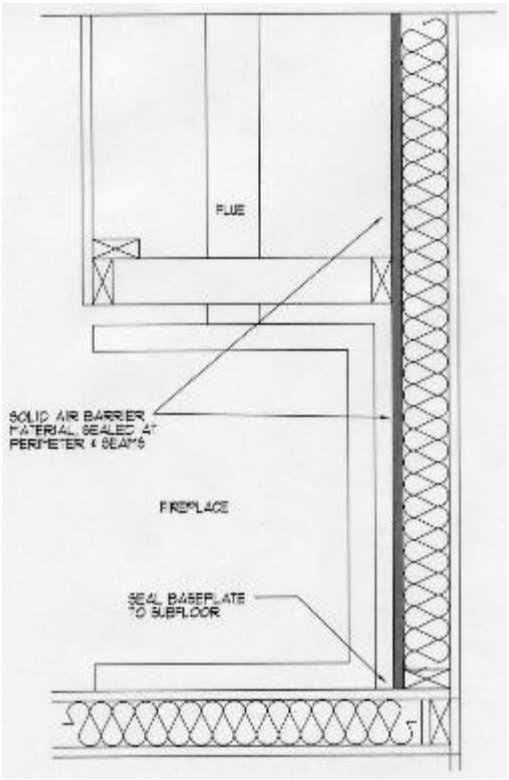


Diagram courtesy of MaGrann Associates

Figure 2.2.2 - Detail of fireplace air barrier installation

2.2 FIREPLACE WALL

EXAMPLES

One solution to this problem is for the builder to hold the framer responsible for installing the insulation and drywall at the fireplace shaft during the framing process when it is easily accessible.

Image courtesy of EnergyLogic

Image courtesy of Building Science Corp

Figure 2.2.3 - Fireplaces installed with air barrier

At left in Figure 2.2.3, the builder has used a thin board sheathing product to create an air barrier around the fireplace, bringing the furred out space into the conditioned space. At right, the builder has used drywall for the same purpose.

An exemption to this rule for Climate Zones 1 through 3 allows the air barrier to be installed on the outside of the wall because the general direction of pressure is from the outside inward.

2.2 FIREPLACE WALL

SCOPE OF WORK

Installation Criteria:

- Insulation must be installed without voids, gaps, or compressions prior to installation of the interior air barrier. Insulation should be cut to fit around any wiring, pipes, or blocking and correctly sized for wall cavities width and height.
- For Climate Zones 4 through 8, the air barrier shall be fully aligned with insulated framing in framed shaft behind fireplace, and any gaps shall be fully sealed with caulk, foam, or tape. For Climate Zones 1 through 3, houses may comply with the specification by adding a sealed and continuous air-barrier to the outside of the house and aligned with the thermal barrier.
- Fire-rated caulking along with flashing or UL-rated collars must be installed continuous around fireplace.
- Drywall, thermoply, or other air barrier materials may be used to create an interior air barrier on the exterior wall behind the fireplace.

Tips and Best Practices:

- Insulation must be installed prior to the installation of the air barrier and will likely be reliant on the builder to verify proper installation of insulation and therefore complete verification of this item on the Thermal Bypass Checklist.

2.3 INSULATED ATTIC SLOPES/ WALLS

EXAMPLES

The temperature differential between the attic space and conditioned space is large regardless of climate zone. Because this temperature differential creates a convection currents and a thermal bypass within insulation, an exterior and interior sealed air barrier are required for this location. (Houses in Climate Zones 1-3 may comply with this requirement if they provide a sealed air-barrier aligned with the insulation on the attic-side of the wall). Figure 2.3.1 shows an attic wall without an air-barrier, and Figure 2.3.2 shows the same wall with the location of the future, attic-side air-barrier.

Figure 2.3.1 – Attic knee wall with no exterior air barrier

Figure 2.3.2 – Attic knee wall with exterior air barrier

2.3 INSULATED ATTIC SLOPES/ WALLS

SCOPE OF WORK

Installation Criteria:

- Insulation shall be installed in full contact with the air barrier on all six sides to provide continuous alignment with the air barrier. For example, batt insulation shall be cut to fit around any wiring, pipes, or blocking and shall be correctly sized for wall width and height.
- For Climate Zones 1 through 3, houses may comply with the specification by adding a sealed and continuous air-barrier to the attic-side of the wall and aligned with the thermal barrier.

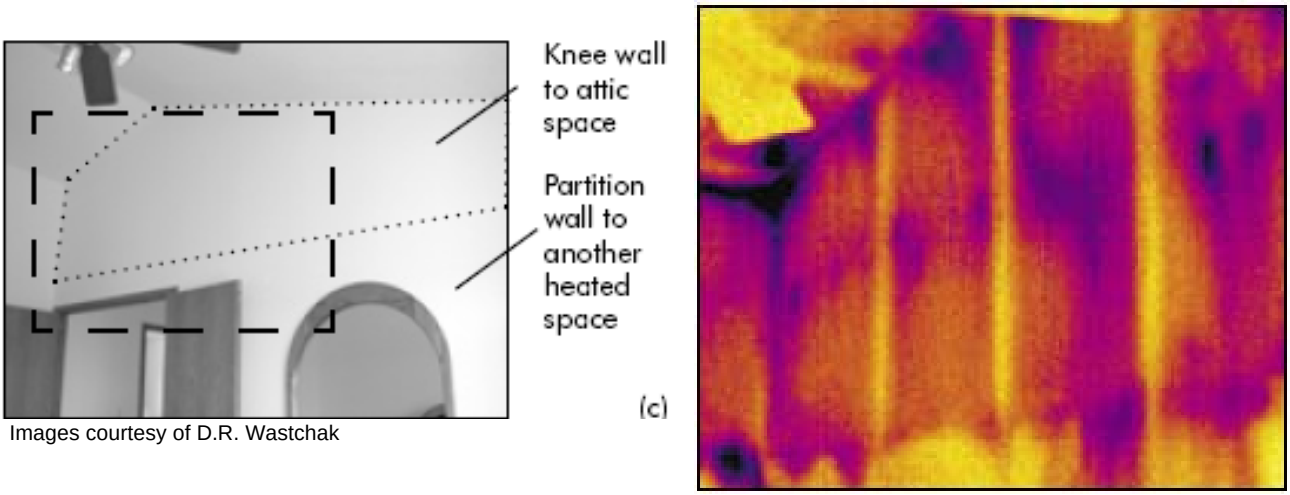
Tips and Best Practices:

- When choosing insulation, consider options that most readily achieve the proper installation requirements.
- Verify that insulation subcontractor installers are properly trained and/or certified in proper installation practices.

2.4 ATTIC KNEE WALLS

“Continuous top and bottom plates are installed with an air barrier on the attic side of insulated walls, including exposed edges of insulation at joists and rafters.”
“Insulation is in complete alignment with interior wall finish and the attic side air barrier.”

Where air barriers are not installed on the attic side of attic knee walls, very hot or very cold attic air can easily flow through and around the knee wall insulation. Figure 2.4.1. depicts hot surface temperatures at an attic knee wall in summer as a result of no attic-side air barrier.



Images courtesy of D.R. Wastchak

Figure 2.4.1 - Infrared image of attic knee wall detail

The darker colors in the infrared image in Figure 2.4.1 indicate excessive heat gain to the not attic through the knee wall insulation. The wood studs appear as much brighter vertical lines, indicating they are warmer than the insulated spaces between them. As expected, the wood studs are providing less effective thermal protection than the insulation itself, however, there are areas of the insulation which are approaching the same temperature as the studs due to convection currents in the insulation. The improperly installed insulation will not provide the rated R-value, and the resulting increase in energy bills can be significant.

The solution to this problem is providing an air barrier at the knee walls with sheathing or rigid insulation on the attic side. Figure 2.4.2 shows a knee wall constructed as a “six-sided wall,” with air barriers on all sides of the insulation, including top and bottom plates and blocking at floor framing.

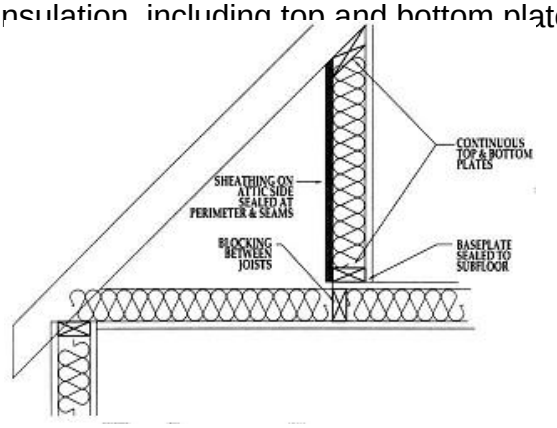


Diagram courtesy of MaGrann Associates

Figure 2.4.2 - Diagram of knee wall detail

2.4 ATTIC KNEE WALLS

EXAMPLES

Images courtesy of Energy Services Group

Figure 2.4.3 - Examples of properly blocked and air sealed attic knee walls

The images in Figure 2.4.3 above show examples of attic knee walls that have been fully blocked and air sealed. Once these walls are properly insulated, the rooms will be more comfortable and less likely to suffer from moisture problems.

2.4 ATTIC KNEE WALLS

SCOPE OF WORK

Installation Criteria:

- Continuous top and bottom plates shall be installed with an air barrier on the attic side of insulated walls, including exposed edges of insulation at joists and rafters.
- Where truss framing is used, blocking is required at the top and bottom of each wall/roof section.
- For Climate Zones 1 through 3, houses may comply with the specification by adding a sealed and continuous air-barrier to the attic-side of the wall and aligned with the thermal barrier.

Tips and Best Practices

- Recognize that attic knee wall barriers are only needed when adjoining an unconditioned attic.
- Acceptable materials for attic-side barriers vary significantly around the country. Be sure to confirm that the preferred material is acceptable to the local code official.
- FSK radiant barrier facing material typically meets code requirements for flame spreadability on attic-side materials. If FSK is a preferred air barrier material, verify that it is acceptable to the local code official.

2.5 SKYLIGHT SHAFT WALLS

EXAMPLES

Skylight shafts protruding through the ceiling and a unconditioned space need to be insulated since the shaft's walls are bounded by unconditioned space on either side of the wall. (Figure 2.5.1) Skylight shaft walls must be insulated to the same level as exterior walls and also must include a sealed air-barrier aligned with the insulation on both interior and exterior sides of the walls. Climate zones 1 through 3 are exempt from the sealed interior air-barrier, but must include the exterior air-barrier exposed to the attic or other unconditioned space.

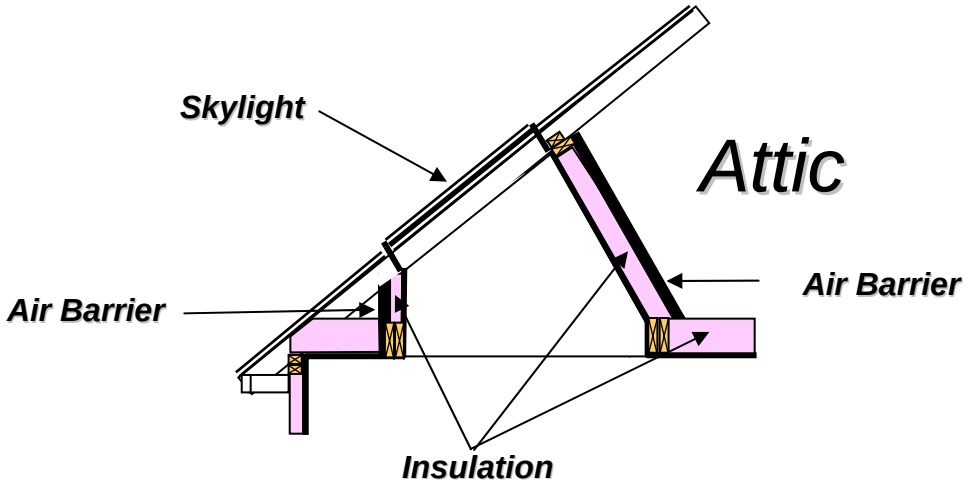


Figure 2.5.1 – Example of properly insulated skylight shaft

Light tubes such as the one pictured in Figure 2.5.2 should also be covered with insulation and an air-barrier. However, unlike skylight shafts, insulation for light tubes does not need to meet the levels of insulation associated exterior walls because the amount of exposed surface is much smaller. One acceptable method for insulating the light tube is duct insulation with an exterior air-barrier. The tube should be completely wrapped with insulation. Additionally, the penetration of the light tube through the ceiling must sealed between conditioned and unconditioned space. See Section 4.1 and 4.2 of this document.

Figure 2.5.2 – Example of an un-insulated light tube

2.5 SKYLIGHT SHAFT WALLS

SCOPE OF WORK

Installation Criteria:

- Insulation shall be installed in full contact with the air barrier on all six sides to provide continuous alignment with the air barrier. For example, batt insulation shall be cut to fit around any wiring, pipes, or blocking and shall be correctly sized for wall width and height.
- For Climate Zones 1 through 3, a sealed, continuous air-barrier is not required on the conditioned side of the wall. Instead, houses in these climate zones may comply with the specification by adding a sealed and continuous air-barrier to the attic-side of the wall and aligned with the thermal barrier.

Tips and Best Practices:

- When choosing insulation, consider options that most readily achieve the proper installation requirements.
- Verify that insulation subcontractor installers are properly trained and/or certified in proper installation practices.

2.6 PORCH ROOF

“Air barrier is installed at the intersection of the porch roof and exterior wall.”

Where blocking and air sealing are missing at the intersection between home interior and porch roof (as shown below in Figure 2.6.1), air can easily pass through the insulation, between the exterior and interior of the home, causing high utility bills along with potential comfort and moisture problems. An example of this problem is shown in the infrared image in Figure 2.6.2 where cold exterior walls occur at walls adjoining a porch roof without an air barrier.

Image courtesy of Energy Services Group

Figure 2.6.1 - Interior of the home is exposed to exterior air infiltration via the porch roof

Image courtesy of Energy Services Group

Figure 2.6.2 - Cold air infiltration into home via porch roof

2.6 PORCH ROOF

EXAMPLES

One solution to this problem is to install blocking or another solid air barrier between the porch roof and the conditioned space of the home, as shown Figures 2.6.3 and 2.6.4 below. Once the blocking is installed, the area can be easily insulated.

Image courtesy of Energy Services Group

Figure 2.6.3 - Conditioned space separated from exterior by blocking at intersection of porch roof and wall

Image courtesy of Environments for Living

Figure 2.6.4 - Exterior view of blocking between porch roof and wall

2.6 PORCH ROOF

SCOPE OF WORK

Installation Criteria:

- Air barrier shall be installed at the intersection of the porch roof and exterior wall.
- Where truss framing is used, blocking shall be provided at the top and bottom of each wall/roof section. Blocking shall be installed prior to insulation.

Tips and Best Practices:

- Acceptable materials for attic-side air barrier vary significantly around the country. Be sure to confirm that the preferred material is acceptable to the local code official.
- FSK radiant barrier facing material typically meets code requirements for flame spreadability on attic-side materials.

2.7 STAIRCASE FRAMING AT EXTERIOR WALL/ATTIC

“Air barrier is fully aligned with insulated framing and any gaps are fully sealed with caulk or foam.”

Staircases adjoining exterior walls, garages, or attics need complete air barriers to avoid thermal bypass between conditioned and unconditioned space (Figure 2.7.1). (Climate zones 1 – 3 are exempt from the internal air-barrier for this detail). A common area missing an air barrier on the interior wall is where staircases have small areas under enclosed landings or bottom stairs. Once framed, staircases can be difficult to complete with insulation and air barriers.

Image courtesy of Energy Services Group

Figure 2.7.1 - Staircase left open to attic

2.7 STAIRCASE FRAMING AT EXTERIOR WALL/ATTIC

EXAMPLES

An air barrier is needed at staircases where they come in contact with the exterior wall or attic above and below the stairs. This involves sealing any gaps with caulk or foam, and insulating the air barrier properly. This detail is depicted below in Figure 2.7.2.

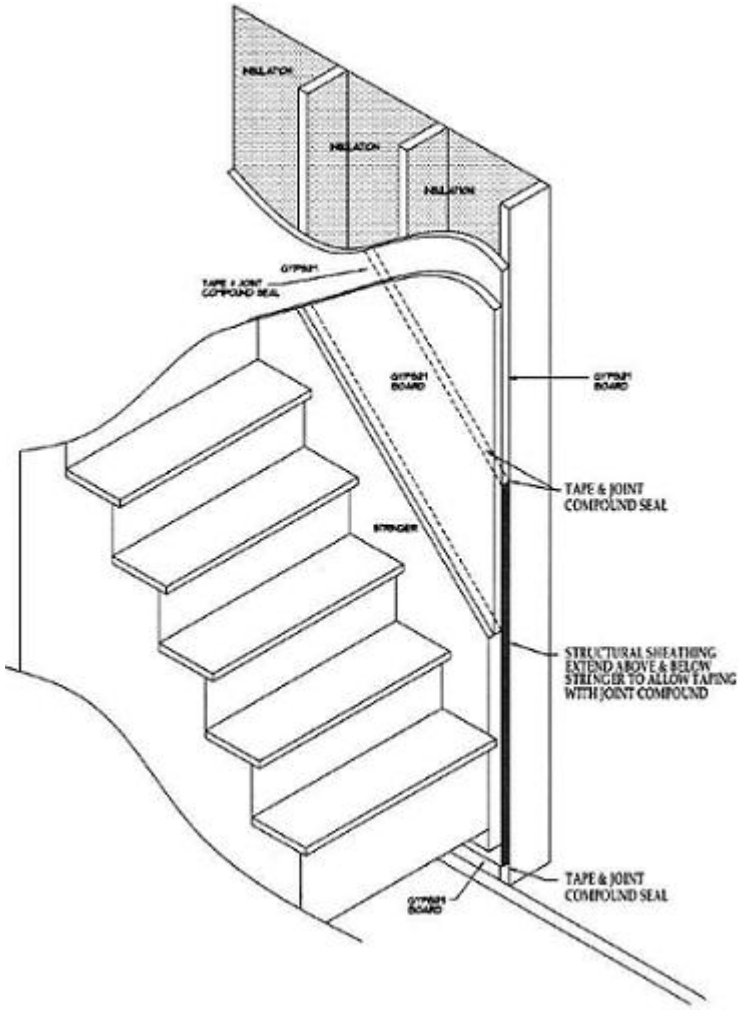


Diagram courtesy of MaGrann Associates

Figure 2.7.2 - Staircase air barrier detail

2.7 STAIRCASE FRAMING AT EXTERIOR WALL/ATTIC

SCOPE OF WORK

Installation Criteria:

- Structural sheathing can be used to extend above and below stringers to allow for taping with joint compound.
- Air barrier shall be fully aligned with insulated framing and any gaps are fully sealed with caulk or foam.

Tips and Best Practices:

- If stair air barrier is completely framed at inspection, builder verification may be needed for this item.

2.8 DOUBLE WALLS

EXAMPLES

Double walls are becoming increasing common in some markets where complicated architectural details are in demand such as curved walls or wall facings. Regardless of the type of double wall built, in order to pass the Thermal Bypass Checklist the insulation must be aligned with and enclosed by air barriers on all sides. There are multiple ways to accomplish this such as placing an air barrier on the exterior of the interior wall and insulating the remaining interior cavity. (Figure 2.8.1) However, this can be very difficult and it is suggested that the entire wall cavity be filled with blown-in insulation or spray foam. (Figure 2.8.2) If blown-in insulation is used, shelves located approximately every two feet of vertical distance up the wall should be installed to prevent excessive settling over time.

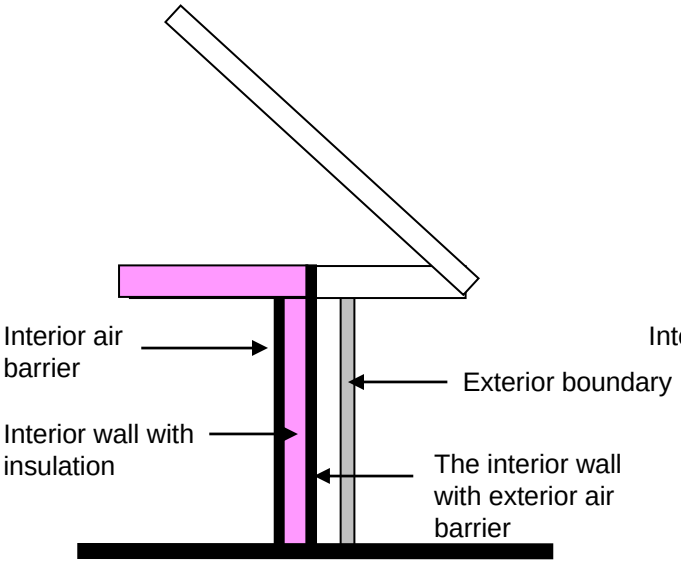


Figure 2.8.1 – Double wall with air barriers

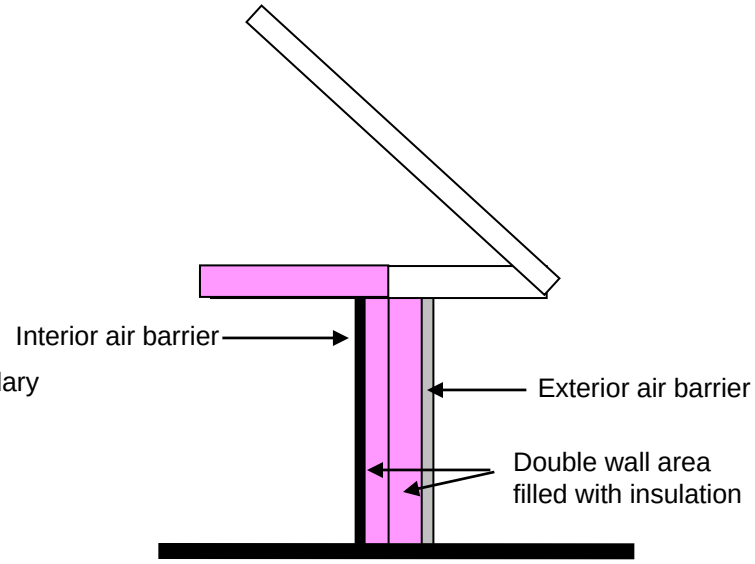


Figure 2.8.2 – Double wall with filled cavity

Figure 2.8.3 – Example of a double wall that would benefit from blown-in insulation

2.8 DOUBLE WALLS

SCOPE OF WORK

Installation Criteria:

- Insulation shall be installed in full contact with the air barrier on all six sides to provide continuous alignment with the air barrier. For example, batt insulation shall be cut to fit around any wiring, pipes, or blocking and shall be correctly sized for wall width and height.
- For Climate Zones 1 through 3, houses may comply with the specification by adding a sealed and continuous air-barrier to the outside of the pop-out or double wall and aligned with the thermal barrier.
- In Climate Zones 1 through 5, air gaps between insulation and outside sheathing at pop-out or double-wall exterior wall assemblies shall have air barriers installed that align with the exposed exterior face of the insulation.

Tips and Best Practices:

- When choosing insulation, consider options that most readily achieve the proper installation requirements.
- Verify that insulation subcontractor installers are properly trained and/or certified in proper installation practices.
- Use value-engineered framing that allows more wall insulation and reduces material costs.

3.1 INSULATED FLOOR ABOVE GARAGE

“Air barrier is installed at any exposed edges of insulation.”
“Insulation is installed to maintain permanent contact with the underside of the sub-floor decking.”

Cold and hot air from the garage can infiltrate conditioned space if insulation is not properly installed between the garage ceiling and the sub-floor above. This can lead to uncomfortable temperatures as well as poor air quality in rooms above the garage. In Figure 3.1.1, insulation has been installed in contact with the garage ceiling, but with voids and gaps between the insulation and the sub-floor above. In this detail, air can move underneath the sub-floor, greatly undermining the effectiveness of the floor insulation.

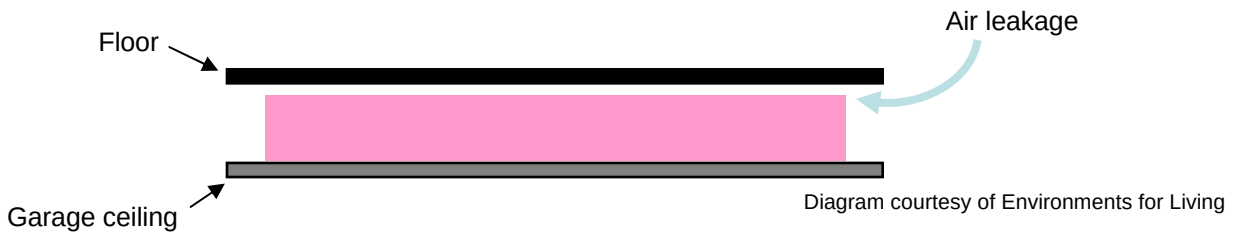


Figure 3.1.1 - Air leakage at garage ceiling

One solution for this problem is to completely fill the floor framing space with insulation so it is snug against the sub-floor and then provide an air barrier such as thin sheathing or rigid insulation where edges of the floor insulation are exposed between floor framing to stop air flow through the insulation.

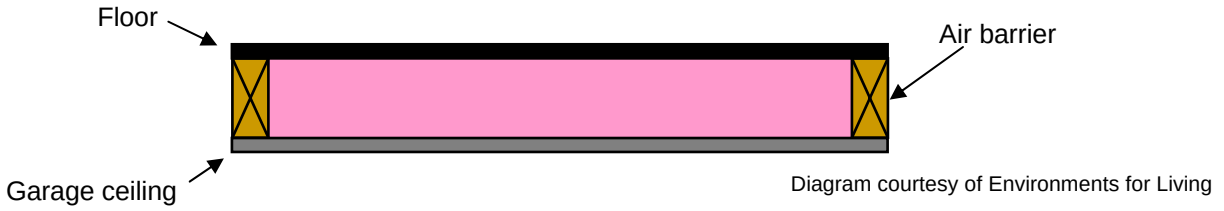


Figure 3.1.2 - Alignment of insulation and air barrier at garage ceiling

Another solution is to spray foam insulation snug against the sub-floor to desired thickness. Although much less desirable, faced batts with the facing towards the garage as the lower air barrier may also be used, but the facing will need to be fully taped and sealed, and an air barrier must be installed at the edges of the floor insulation to stop air flow through the insulation. The air barrier can be blocking, thin sheathing or rigid insulation.

Figure 3.1.3 - Alignment of insulation and air barrier at garage ceiling with spray foam or faced batt insulation

3.1 INSULATED FLOOR ABOVE GARAGE

EXAMPLES

Floors constructed of dimensional lumber are less susceptible to performance issues than those constructed with engineered framing members. With dimensional lumber, only the two open ends of the joist cavities need to be blocked and air sealed. The sub-floor and drywall ceilings below can be sealed to the framing members at the time of installation. Figure 3.1.4 illustrates blocking material locations.

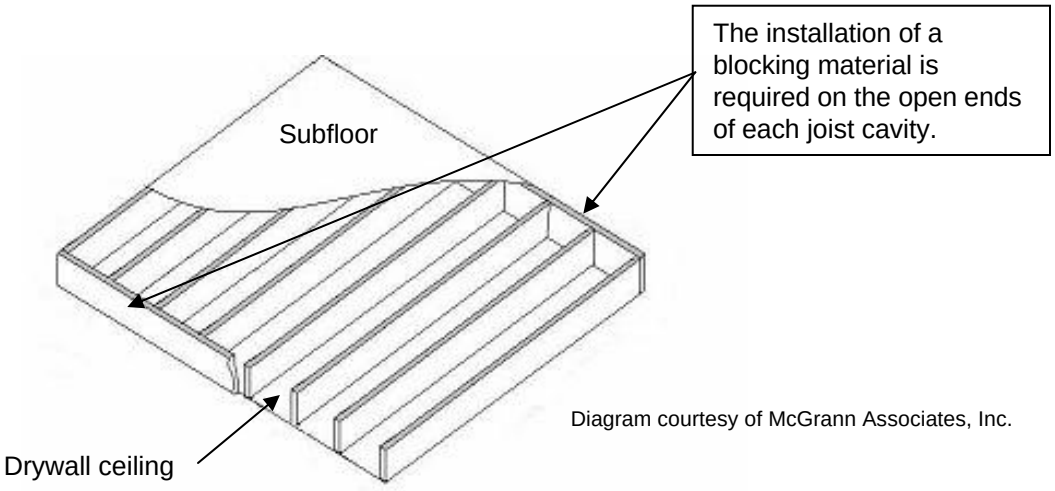


Figure 3.1.4 - Blocking for floor over garage

Floor assemblies constructed with open web trusses are difficult to effectively air seal. The web openings are labor-intensive to fill with batt or rigid insulation but can easily be filled with blown or spray insulation. All four edges of an open-web truss floor assembly require the installation of a sheathing material to enclose the entire floor cavity and then all joints and penetrations need to be air sealed. Figure 3.1.5 illustrates how to enclose the floor assembly on all four sides.

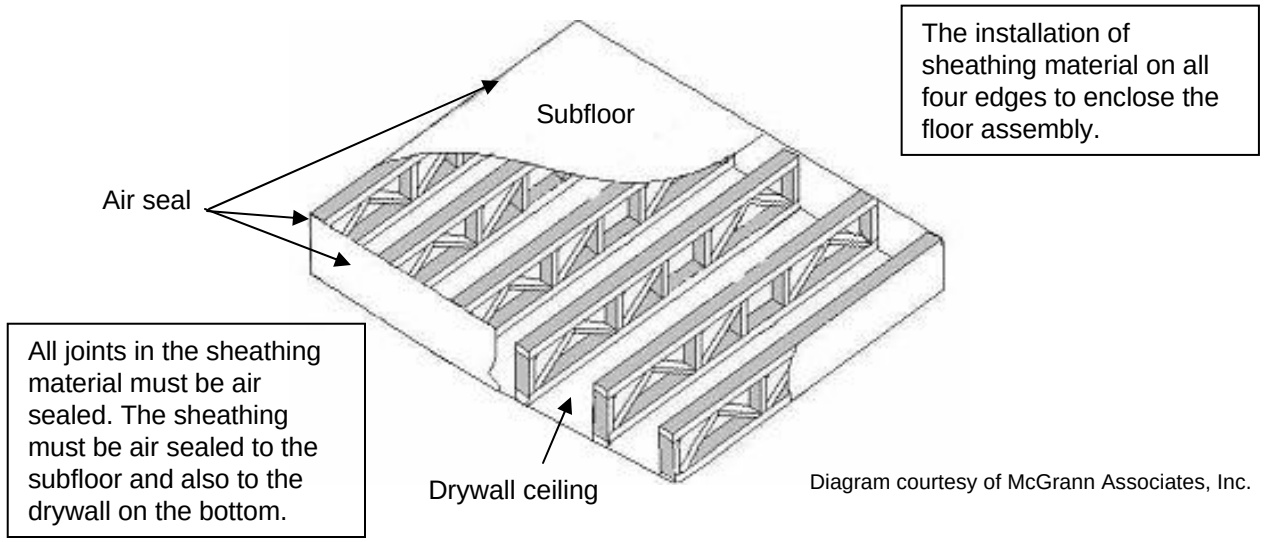


Figure 3.1.5 - Enclosing four edges of open web truss floor

3.1 INSULATED FLOOR ABOVE GARAGE

SCOPE OF WORK

Installation Criteria:

- Insulation shall be installed to maintain permanent contact with the underside of the sub-floor decking.
- Except where spray foam insulation is used, air barriers shall be provided at any exposed edges of insulation and on the bottom face of insulation not in contact with the garage ceiling.
- Blocking material must be installed on open ends of joist cavities at dimensional lumber.

Tips and Best Practices:

- Before choosing to completely fill the floor cavity (as in Figure 3.1.2), make sure that the weight of the insulation will not be excessive for the drywall ceiling, due to the depth of the floor framing. Check with the drywall manufacturer to determine whether netting installed for blown-in insulation effectively removes the extra weight from bearing on the drywall ceiling.
- If weight is not an issue, blown-in insulation completely filling the floor space may be the simplest and most cost-effective solution for assuring alignment with both sub-floor and ceiling.
- Consider using spray foam insulation to avoid completely filling thick framing space between garage and sub-floor with insulation and installing edge air barriers.
- Although less desirable, paper faced insulation batts can work if open-web trusses are not used and paper is carefully installed and taped at edges and seams to avoid air leakage.
- Fiberglass insulation may be installed with metal staves holding the insulation against the sub-floor above the garage. Any pipes in the floor system should have adequate insulation installed below them.

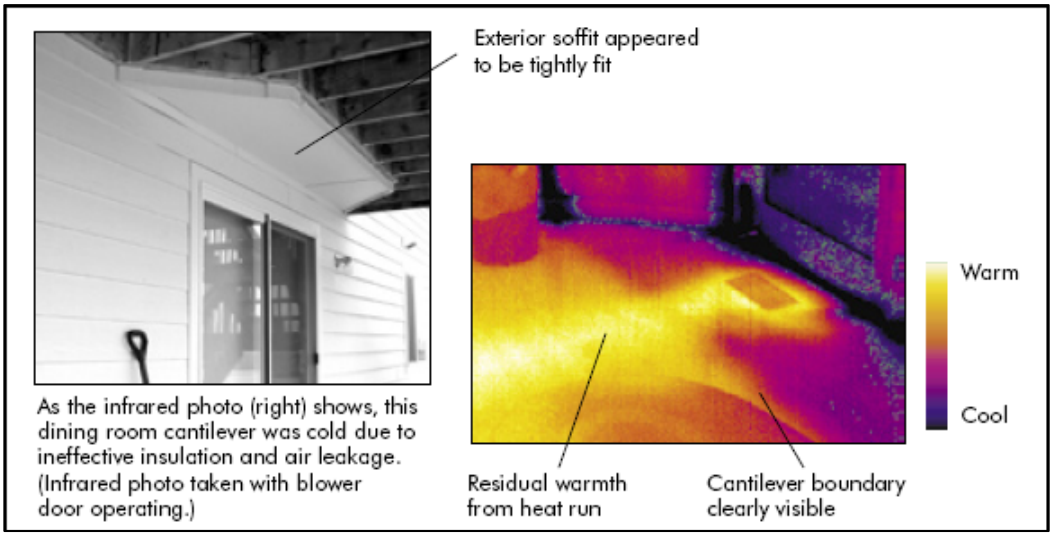
3.2 CANTILEVERED FLOOR

“Air barrier spans cantilever and any exposed edges of insulation.”
“Floor framing is completely filled with insulation or insulation is installed to maintain permanent contact with the sub-floor decking.”

Cantilevered floor assemblies are another location where air infiltration and insulation installation issues are common. Plywood or other soffit material is typically installed on the bottom of the joists of a cantilevered floor, but not air sealed at the intersections to exterior wall sheathing. Insulation is then installed by lying it upon exterior overhang in between the joists, resulting in an air gap between the insulation and the sub-floor above. Heat transfer can easily occur at the joist, making the floor too cold in winter and too warm in summer. Thermal bypass also occurs when there is no air barrier separating the cantilevered sub-floor from the conditioned space inside the home, allowing warm air to migrate out in the winter and in during the summer (Figure 3.2.1).

Image courtesy of Energy Services Group

Figure 3.2.1 - Visible daylight indicates that there is an incomplete air barrier separating the cantilevered floor from the outside



Images courtesy of Fort Collins Utilities

Figure 3.2.2 - Infrared image of a cantilevered floor without effective air barrier details

In Figure 3.2.2, the temperature differential on the cantilevered floor is clearly visible, as the floor over the cantilever is much cooler (darker colored) than the floor over conditioned space.

3.2 CANTILEVERED FLOOR

EXAMPLES

To eliminate thermal bypass at cantilevered floors, the framing space should be completely filled with insulation so that the insulation is in full contact with the sub-floor above. Also, an air barrier of thin sheathing, blocking, or rigid insulation should be added to the edge of the insulation, so that air flow is blocked between the exterior and interior of the home (Figure 3.2.3). Proper air sealing of the exterior sheathing on the bottom of the cantilevered floor is extremely important to stop air infiltration into the floor system. Not only will these proper insulation and air sealing details improve the energy efficiency, they will the improve comfort, air quality, and durability of the home.

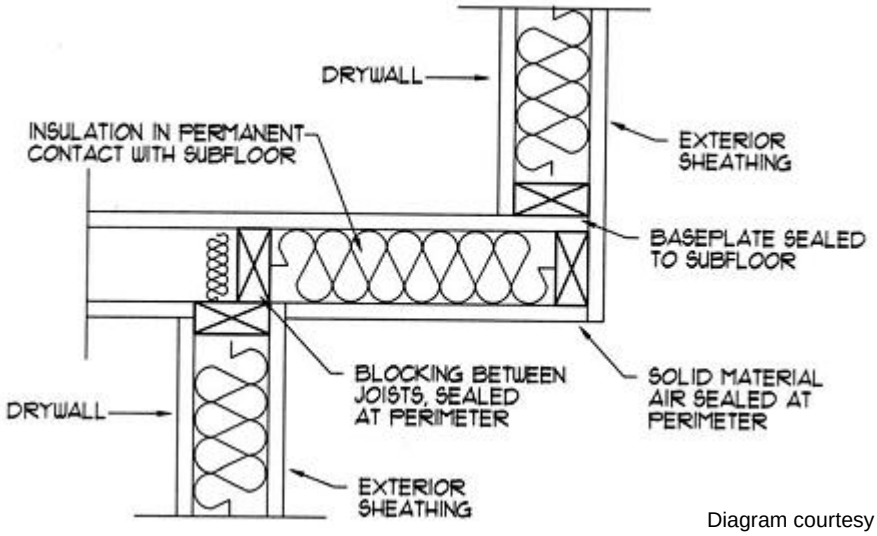


Diagram courtesy of MaGrann Associates

Figure 3.2.3 - Air barrier detail using blocking at cantilevered floor

Images courtesy of MaGrann Associates

Figure 3.2.4 - Proper installation of insulation under a cantilevered floor

The image at left in Figure 3.2.4 above shows insulation installed to fill the space underneath the sub-floor. In the image at right, the assembly has been blocked and air sealed below the conditioned floor above.

3.2 CANTILEVERED FLOOR

SCOPE OF WORK

Installation Criteria:

- Floor framing shall be completely filled with insulation or insulation is installed to maintain permanent contact with the sub-floor decking.
- Air barrier shall be fully air sealed and shall span cantilever and any exposed edges of insulation.
- Exterior bottom sheathing shall be installed to provide a complete and continuous air barrier for the cantilevered floor. Any intersections between sheathing, gaps, or cracks in the air barrier shall be fully air sealed with a compressible sealant, caulk, foam, or mastic.
- If spray foam is not used, blocking shall be installed on the inside edge of the wall top plate across the cantilever after insulation is installed, or prior to insulation if loose-fill insulation is used and holes cut into the blocking area are sealed after insulation is installed.
- If spray foam is used, blocking is not needed.

Tips and Best Practices:

- If the cantilever is completely framed at inspection, builder verification may be needed for this item since the insulation will not be exposed.
- Consider spray foam insulation installed to desired thickness because it can serve as both insulation and an air barrier.

4.1 – 4.2 DUCT SHAFT / PIPING SHAFT AND PENETRATIONS

“Openings to unconditioned space are sealed with solid blocking and any remaining gaps are sealed with caulk or foam.”

Penetrations in framing can be made by plumbers, electricians, or HVAC contractors who are not always careful cutting holes. Unfortunately, these holes can allow excessive air leakage. Sealing duct and plumbing penetrations involves fully sealing the holes with caulking or foam and providing flashing where needed for very large air spaces.

Image courtesy of Energy Services Group

Figure 4.1.1 - Blocking and foam air sealing in chase

In Figure 4.1.1 above, there is a very large hole for a duct requiring both blocking and foam to seal penetrations in the chase. In the image below, only caulking is needed because the plumber has neatly cut the hole around the plastic pipe penetration.

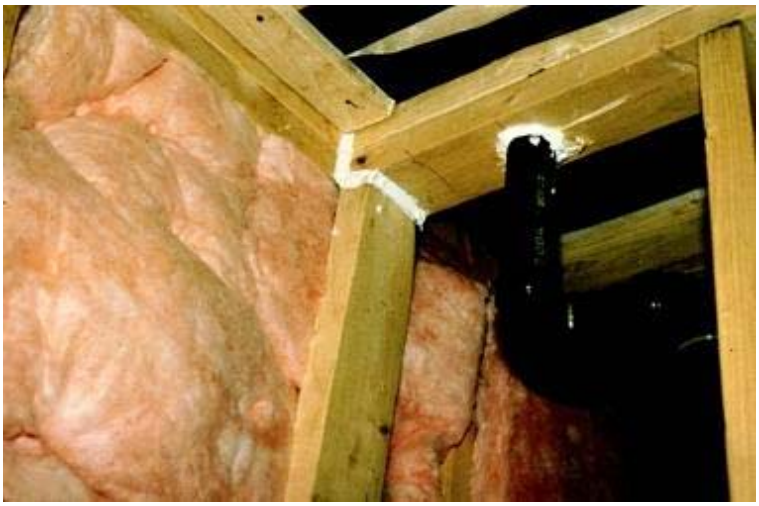


Image courtesy of Building Science Corp.

Figure 4.1.2 - Caulking around piping penetration

4.1 – 4.2 DUCT SHAFT / PIPING SHAFT AND PENETRATIONS

SCOPE OF WORK

Installation Criteria:

- Openings to unconditioned spaces shall be sealed with solid blocking as required and any remaining gaps shall be sealed with caulk or foam.

Tips and Best Practices:

- Since the flashing or framed caps at shafts and penetrations are typically installed by framers before the plumbing and HVAC trades do their work, make sure subcontractors understand their responsibilities to assure the integrity of the air barrier.
- Make sure air sealing crew has been trained to identify transitions between conditioned and unconditioned spaces, since workers not fully trained have been observed to unnecessarily seal blocking and framing in conditioned spaces.

4.3 FLUE SHAFT

"Opening around flue is fully sealed with flashing and any remaining gaps are sealed with fire-rated caulk or sealant."
"Combustion clearance between flue and combustible materials (e.g., OSB) are properly closed with UL-approved metal collars."

Effectively air-sealing shafts can be difficult due to large sizes and odd shapes. However, it is important because significant air infiltration can occur at unsealed openings. For example, the flue shaft shown in Figure 4.3.1 below has a very large air gap that must be sealed.

Image courtesy of Building Science Corp.

Figure 4.3.1 - Lack of air sealing around flue shaft

In Figure 4.3.2 below, insulation has been used to fill the space between the flue and the studs. However, this is a poor detail because insulation is not an effective air barrier.

Image courtesy of EnergyLogic

Figure 4.3.2 - Insulation improperly used for air sealing

4.3 FLUE SHAFT

EXAMPLES

Image courtesy of Building Science Corp.

Figure 4.3.3 - UL-rated metal collar installed around a flue shaft

Figure 4.3.3 above shows how a flue can be fully sealed in a large opening. In this case, an OSB panel was cut to fill the air space around the flue. The flue was then fitted with a metal collar, sealing the gap needed for combustion safety clearance between the OSB panel and flue. In Figure 4.3.4 below, fire-rated caulk, typically red in color, has been used to seal any gaps between the flue and metal collar.

Note that caution should always be used when installing insulation against potentially hot surfaces, for both combustible and non-combustible insulation may present a fire hazard if caused to overheat. Refer to local building codes for more information.

Image courtesy of EnergyLogic

Figure 4.3.4 - Fire-rated caulk around a flue shaft

4.3 FLUE SHAFT

SCOPE OF WORK

Installation Criteria:

- Flue openings shall be fully sealed with flashing as required and any remaining gaps sealed with fire-rated caulk or sealant.
- Combustion clearance between flue openings and combustible materials (e.g., OSB) shall be properly closed with UL-approved metal collars.

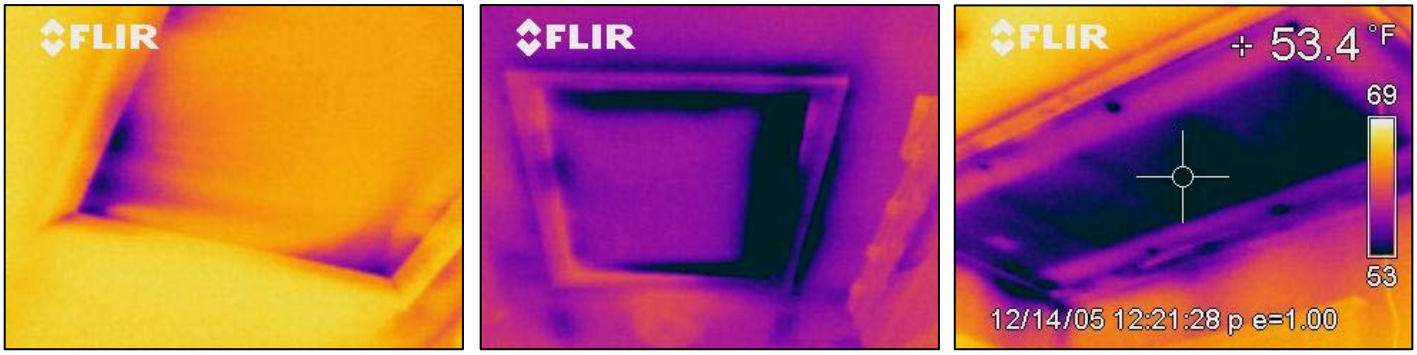
Tips and Best Practices:

- Trades should be informed to prevent degradation of the fire-rating during rough-in stage if blocking is installed by the framing contractor.
- Fire-rated foam with special color is now available for sealing difficult air gaps at flue openings.

5.1 – 5.2 ATTIC ACCESS PANEL / DROP DOWN STAIR

“Attic access panel or stair is fully gasketed for a snug fit.”
“Attic access panel or stair is covered with insulation that is attached and fits snugly in the framed opening.”

Attic access panels or drop-down stairs without insulation and gaskets are essentially large holes, allowing thermal flow and air leakage between the conditioned home and the unconditioned attic space.



Images courtesy of Energy Services Group

Figure 5.1.1 - Infrared images of thermal bypass at attic access panel

Dark colors in the infrared images in Figure 5.1.1 above indicate thermal bypass of cold attic air at access panels and drop-down stairs. The image at far left shows an insulated attic hatch with no gasket that allows air to leak in through the edges of the access panel. At center, the attic hatch is insulated, but the black area inside the frame indicates that the fiberglass batt used was too small to cover the entire panel. The resulting void allows cold air to come in contact with the attic hatch. The image at far right shows a drop-down stair installed with no insulation or gasket. The temperature of the stair is approximately ten degrees cooler than the rest of the room. It is often best to insulate drop-down stairs on the back side because insulation should not block the stairs themselves, as is shown in Figure 5.1.2.

Figure 5.1.2 - Improperly installed insulation impedes use of drop-down attic access stair.

5.1 – 5.2 ATTIC ACCESS PANEL / DROP DOWN STAIR

EXAMPLES

Images courtesy of Energy Services Group

Figure 5.1.3 - Example of properly insulated attic hatch

There are several relatively simple solutions for stopping thermal bypass at attic hatches or drop-down stairs. In Figure 5.1.3 above, the image at left depicts an attic hatch insulated with a fiberglass batt that extends all the way to the edge of the hatch. At right, the frame around the hatch has been fitted with a gasket for effective air sealing.

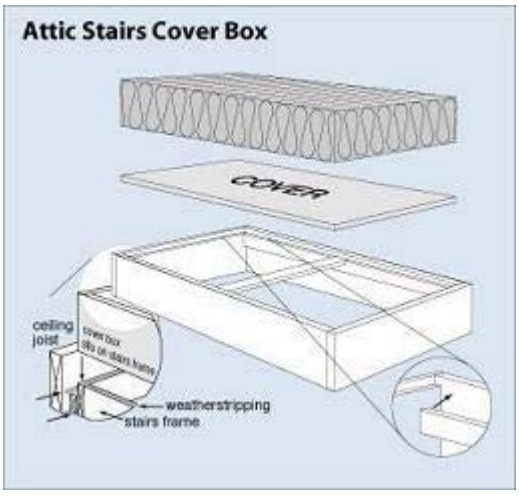


Diagram courtesy of the US Department of Energy

Figure 5.1.4 - Option for insulation of drop-down stair

One way to properly insulate attic drop-down stairs is to construct a simple cover box and cover it with insulation (Figure 5.1.4). Insulated boxes made specifically for this purpose are available from several manufacturers.

5.1 – 5.2 ATTIC ACCESS PANEL / DROP DOWN STAIR

SCOPE OF WORK

Installation Criteria:

- Attic access panel or stair shall be fully gasketed for a snug fit. However, gaps in weather-stripping to accommodate hinge hardware at drop-down stairs shall be acceptable.
- Attic access panel or stair shall be fitted with minimum R-5 insulation that fits snugly in the framed opening.

Tips and Best Practices:

- For drop-down stairs, rigid insulation can be installed in the space between the steps and solid panel. However, this may cause potential builder liability if the insulation limits use of the steps or covers manufacturer instructions on the hatch.

5.3 DROPPED CEILING/SOFFIT

“Air barrier is fully aligned with insulated framing and any gaps are fully sealed with caulk, foam, or tape.”

Another common air barrier problem in home construction occurs at dropped ceilings and soffits. Framing crews build them early in the construction process, often leaving very difficult conditions for the proper installation of insulation with a complete air barrier. Heat conducted through a dropped ceiling can flow through insulation and potentially reach cold surfaces, where it can condense and cause moisture and dry rot problems. In addition, where insulation sags or has gaps in the framing, cold attic air can migrate to the framed out space in the winter.

Image courtesy of Maryland Energy Administration

Figure 5.3.1 - Improperly installed insulation over a dropped ceiling

Figure 5.3.2 – Infrared image of poorly installed insulation over a dropped ceiling

The framed dropped ceiling in Figure 5.3.1 above is an example where the insulation has been installed with voids and compressions that decrease its effectiveness. Figure 5.3.2 above shows an example of the potential comfort problems that can result where cold air in the winter substantially migrates to the dropped ceiling due to the lack of an air barrier and insulation above the dropped ceiling.

5.3 DROPPED CEILING/SOFFIT

EXAMPLES

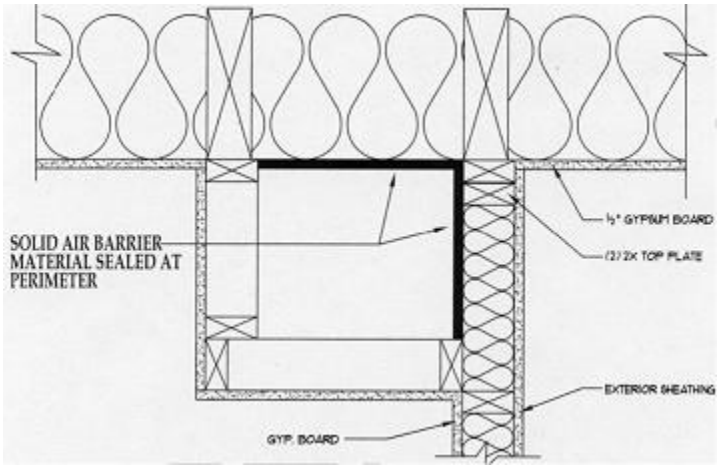


Diagram courtesy of MaGrann Associates

Figure 5.3.3 - Diagram of soffit capped by air barrier

The simplest option for a complete air barrier at dropped ceilings and soffits, shown in Figure 5.3.3, is to cap the soffit with an air barrier, making the proper installation of insulation much easier for the insulation subcontractor. Note, as also show in Figure 5.3.4, an air barrier must also be included where dropped ceilings or soffits adjoin exterior walls at exposed insulation.

Images courtesy of Energy Services Group

Figure 5.3.4 - Air sealed soffits

The homes shown in Figure 5.3.4 are good examples of a complete air barrier. At left, a soffit for ducts has been sealed with sheathing and foam. Likewise, on the right, a kitchen soffit has been similarly air sealed.

5.3 DROPPED CEILING/SOFFIT

SCOPE OF WORK

Installation Criteria:

- A complete sealed air barrier shall be provided at all attic framing above soffits and dropped ceilings fully aligned with the attic insulation.
- Where drop ceilings or soffits occur at exterior walls, air barriers shall be included at the wall as well as at the attic floor.

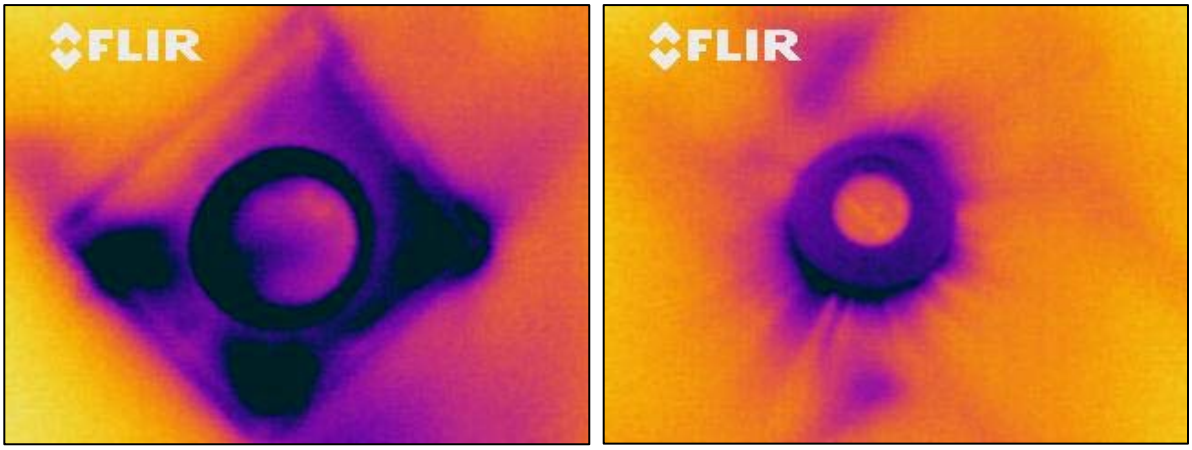
TIPS AND BEST PRACTICES

- Use of plywood, oriented strand board, Thermo-Ply®, or sheetrock as a rigid air barrier between the soffit and unconditioned space; seal any gaps with caulk, foam, or mastic.

5.4 RECESSED LIGHTING

“Airtight IC-rated recessed light fixtures are sealed to drywall with gasket, caulk, or foam.”

Recessed lighting into unconditioned attics can cause excessive air leakage and thermal bypass resulting in high utility bills and moisture problems. Each recessed light that is not insulated creates an almost two square foot thermal hole to the attic. Additionally, since lights get very hot, they create a natural draft, pulling air through them. While some recessed light fixtures are rated IC for “insulation contact,” meaning insulation can be placed over the top of the fixture, insulation stops thermal flow but not air flow. With the intense heat inside the fixture, there is a large driving force pushing air through the fixture and insulation above for large energy losses, even with IC fixtures.



Images courtesy of Energy Services Group

Figure 5.4.1 - Infrared images of thermal bypass at recessed lighting

The infrared images in Figure 5.4.1 show large thermal bypass at recessed light fixtures below an attic. At left, the can light has been poorly insulated, allowing cold air to enter the home from the attic. At right, air is leaking excessively through the gap between the can light and the drywall.

5.4 RECESSED LIGHTING

EXAMPLES

The best solution for energy efficient recessed lighting is to include the lights in the conditioned space of the home. This can be done directly below attics by using non-recessed light fixtures or locating recessed light fixtures in a dropped ceiling with an air barrier to the attic (Figure 5.4.2). However, where having a fixture below an unconditioned attic cannot be avoided, there are “insulation contact, air-tight” (ICAT) rated fixtures that seal tightly and can be covered with insulation. Note that some of these fixtures have sealed gaskets built-in (Figure 5.4.3), while others have to be carefully installed with a separate gasket.

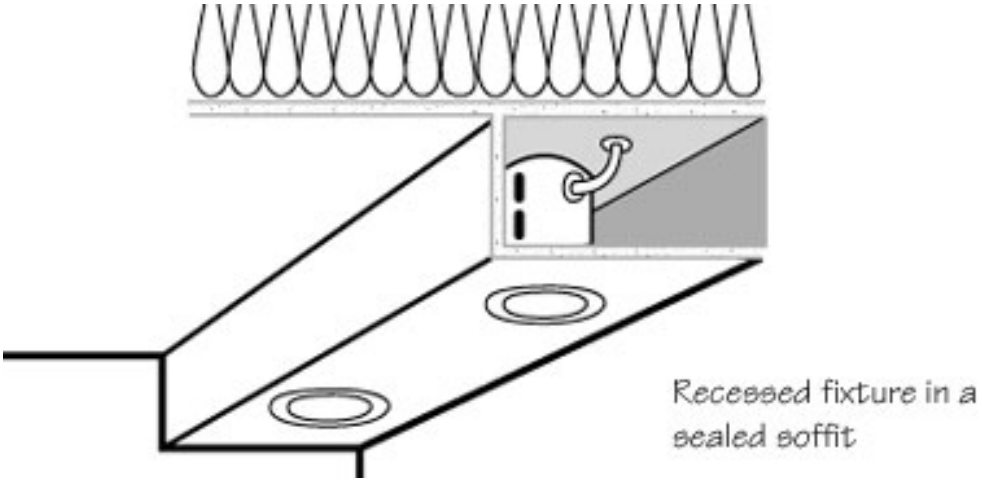


Figure 5.4.2 - Recessed light fixture in a sealed soffit

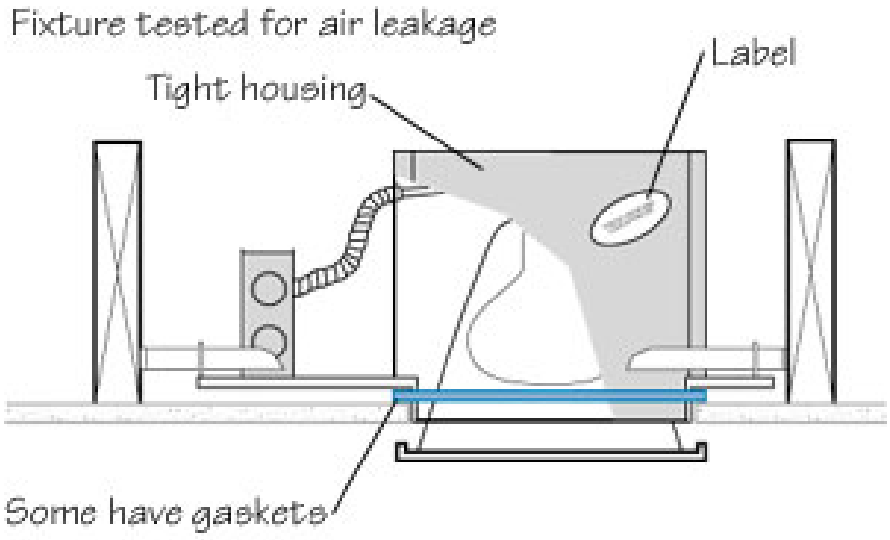


Figure 5.4.3 - ICAT-rated fixture installed with gasket

5.4 RECESSED LIGHTING

SCOPE OF WORK

Installation Criteria:

- All recessed lighting fixtures to unconditioned attics shall be airtight IC-rated (ICAT), and they shall be sealed to drywall with gasket, caulk, or foam.
- Blocking material must be installed on open ends of ceiling or soffit cavities.

Tips and Best Practices:

- Recognize that insulation contact, air-tight (ICAT) rated recessed light fixtures are only needed at ceilings adjoining unconditioned space.
- Develop a system for storing trim seal gaskets provided by manufacturer after initial installation of the recessed cans so they are available at the end of the job.
- Follow manufacturer recommendations for sealing since light fixtures get very hot.

5.5 WHOLE-HOUSE FAN PENETRATION AT ATTIC

“An insulated cover is provided that is gasketed or sealed to the opening from either the attic side or ceiling side of the fan.”

While whole-house fans are not frequently found in new construction in many parts of the country, they can provide quick night-time cooling in hot-dry climates with cool evenings. However, they represent an almost 10 square foot thermal hole to the attic because the large opening is not insulated and the metal louvers effectively transfer and leak heat between the home and unconditioned attic. This can cause comfort and moisture problems. This problem can be easily fixed with a simple insulated cover that can be constructed and gasketed to the fan to prevent the flow of heat from the attic into the conditioned space (Figure 5.5.1). However, this cover must lift automatically when the fan is switched on, or be able to be lifted without the homeowner climbing into the attic. Units that do require climbing into the attic are not allowed because they are highly unlikely to be used. Some whole-house fans come with built-in insulated covers that operate automatically and are fully sealed (Figure 5.5.2).

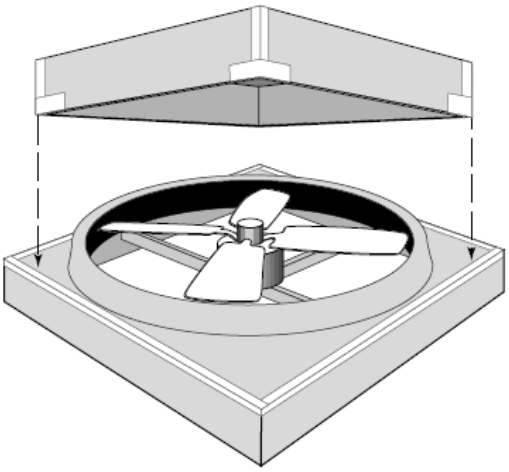


Figure 5.5.1 - Whole-house fan cover

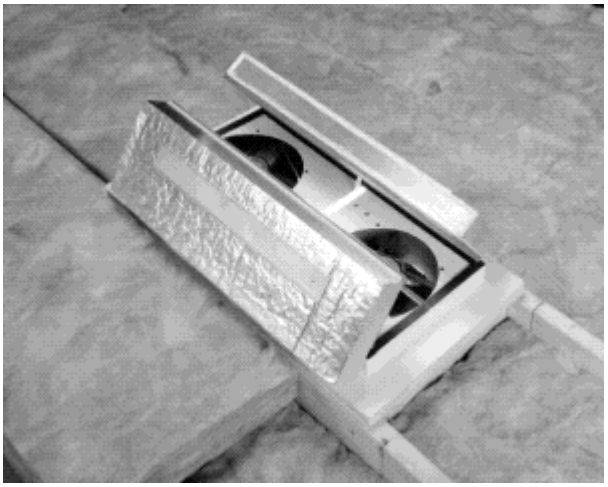


Figure 5.5.2 - Whole-house fan with built-in cover

5.5 WHOLE-HOUSE FAN PENETRATION AT ATTIC

SCOPE OF WORK

Installation Criteria:

- Whole-house fan shall include a minimum R-5 insulated cover that is fully gasketed to the framing assembly and opens automatically or with a simple mechanism that does not require the homeowner to climb into the attic.

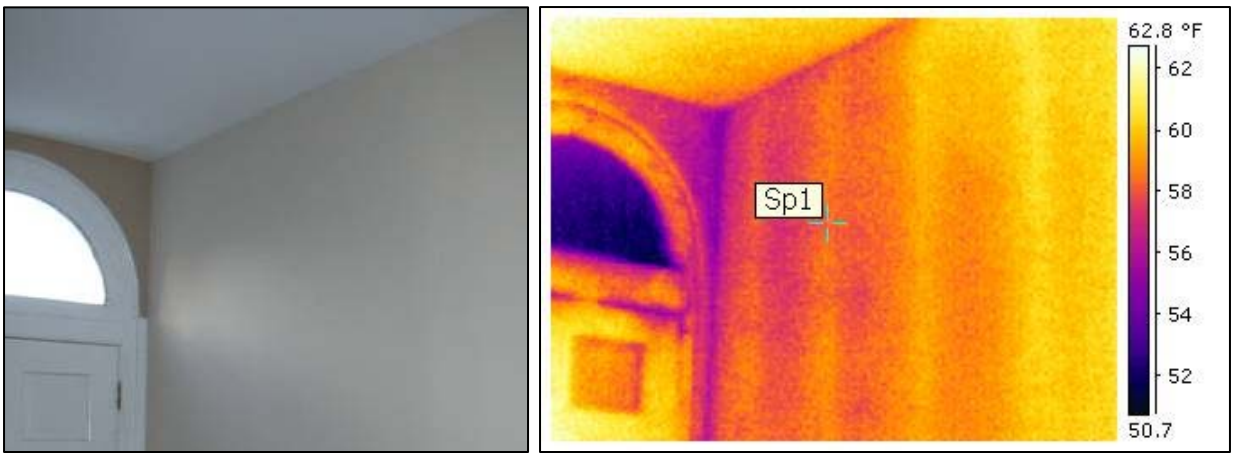
Tips and Best Practices:

- Whole-house fans are available with insulated covers that are fully gasketed and automatically lift when turned on.
- Make sure any modifications for an insulated cover to a whole-house fan do not conflict with manufacturer requirements.
- Make sure the homeowner understands how this product works and operates with an insulated cover.

6.1 COMMON WALLS BETWEEN DWELLING UNITS

“Air barrier is installed to seal the gap between a gypsum shaft wall (i.e., common wall) and the structural framing between units in duplex and townhouse construction.”

Common, or party, walls between units in attached housing can be significant sources of thermal bypass. For example, the infrared image in Figure 6.1.1 shows a gap between the common wall and the structural framing has not been sealed, resulting in cool air leaking into the home.



Images courtesy of Energy Services Group

Figure 6.1.1 - Infrared image of cool air infiltration at a common wall

Images courtesy of Energy Services Group

Figure 6.1.2 - Poorly sealed common wall

In Figure 6.1.2, an exterior view of a common wall/structural framing interface is shown on the left. While this corner will be covered by “J” channel siding, the corner will still leak. The large size of this leakage area can clearly be seen from the inside (at right), as daylight streams into the home.

EXAMPLES

A solution to this problem is to air seal the gaps between the drywall and framed wall using expanding foam (if allowed by code) or fire rated blocking or caulk (Figures 6.1.3 and 6.1.4).

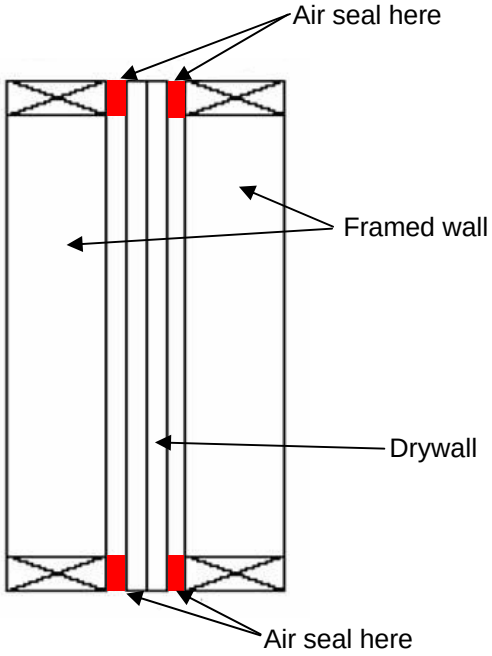


Diagram courtesy of EnergyLogic

Figure 6.1.3 - Diagram of common wall air sealing

Image courtesy of MaGrann Associates

Figure 6.1.4 - Example of properly air sealed common wall with fire-rated caulking (in red)

6.1 COMMON WALLS BETWEEN DWELLING UNITS

SCOPE OF WORK

Installation Criteria:

- Air barrier shall be installed to seal the gap between a gypsum shaft wall (i.e., common wall) and the structural framing between units in duplex and townhouse construction.

Tips and Best Practices:

- Acceptable materials for air-sealing party walls can vary significantly around the country. Be sure to confirm that the preferred material is acceptable to the local code official.
- Fireproof spray foam with a special color is now available as a possible solution for easily sealing large gaps between adjoining units.

ENERGY STAR Qualified Homes
Thermal Bypass Inspection Checklist

The Thermal Bypass Inspection Checklist must be completed for homes to earn the ENERGY STAR label. The Checklist requires visual inspection of framing areas where air barriers are commonly missed and inspection of insulation to ensure proper alignment with air barriers, thus serving as an extra check that the air and thermal barriers are continuous and complete. State, local, and regional codes, as well as regional ENERGY STAR program requirements, supersede the items specified in this Checklist.

Guidance on Completing the Thermal Bypass Inspection Checklist:

1. Accredited HERS Providers and certified home energy raters shall use their experience and discretion in verifying that each Inspection Checklist item is installed per the inspection guidelines (e.g., identifying minor defects that the Provider or rater deems acceptable versus identifying major defects that undermine the intent of the Checklist item).

2. Alternative methods of meeting the Checklist requirements may be used in completing the Checklist, if the Provider deems them to be equivalent, or more stringent, than the Inspection Checklist guidelines.

3. In the event an item on the Checklist cannot be verified by the rater, the home cannot be qualified as ENERGY STAR, unless the builder assumes responsibility for verifying that the item has met the requirements of the Checklist. This option is available at the discretion of the Provider or rater but may not be used to verify more than six (6) items on the Inspection Checklist. This responsibility will be formally acknowledged by the builder signing-off on the Checklist for the item(s) that they verified. The column titled "N/A" should be used when the checklist item is not present in the home or when local code requirements take precedent.

4. The Checklist may be completed for a batch of homes using a RESNET-approved sampling protocol when qualifying homes as ENERGY STAR. For example, if the approved sampling protocol requires rating one in seven homes, then the Checklist will be completed for the one home which was rated.

5. In the event that a Provider or rater finds an item that is inconsistent with the Checklist Inspection guidelines, the home cannot be qualified as ENERGY STAR until the item is corrected in a manner that meets the ENERGY STAR requirements. If correction of the item is not possible, the home cannot earn the ENERGY STAR label.

6. The Provider or rater is required to keep a hard copy record of the completed and signed Checklist. The signature of a builder employee is also required if the builder verified compliance with any item on the Checklist.

7. For purposes of this Checklist, an air barrier is defined as any solid material that blocks air flow between a conditioned space and an unconditioned space, including necessary sealing to block excessive air flow at edges and seams. Additional information on proper air sealing of thermal bypasses can be found on the Building America Web site (www.eere.energy.gov/buildings/building_america) and in the EEBA Builder's Guides (www.eeba.org). These references include guidance on identifying and sealing air barriers, as well as details on many of the items included in the Checklist.

ENERGY STAR Qualified Homes
Thermal Bypass Inspection Checklist

Home Address:_____ City:_____ State:_____

Thermal Bypass	Inspection Guidelines	Corrections Needed	Builder Verified	Rater Verified	N/A
1. Overall Air Barrier and Thermal Barrier Alignment	**Requirements:** Insulation shall be installed in full contact with sealed interior and exterior air barrier except for alternate to interior air barrier under item no. 2 *(Walls Adjoining Exterior Walls or Unconditioned Spaces)*				
	All Climate Zones:				
	1.1 Overall Alignment Throughout Home	☐	☐	☐	☐
	1.2 Garage Band Joist Air Barrier (at bays adjoining conditioned space)	☐	☐	☐	☐
	1.3 Attic Eave Baffles Where Vents/Leakage Exist	☐	☐	☐	☐
	Only at Climate Zones 4 and Higher:				
	1.4 Slab-edge Insulation (A maximum of 25% of the slab edge may be uninsulated in Climate Zones 4 and 5.)	☐	☐	☐	☐
	Best Practices Encouraged, Not Req'd.:				
	1.5 Air Barrier At All Band Joists (Climate Zones 4 and higher)	☐	☐	☐	☐
	1.6 Minimize Thermal Bridging (e.g., OVE framing, SIPs, ICFs)	☐	☐	☐	☐
2. Walls Adjoining Exterior Walls or Unconditioned Spaces	**Requirements:** • Fully insulated wall aligned with air barrier at both interior and exterior, **OR** • Alternate for **Climate Zones 1 thru 3**, sealed exterior air barrier aligned with RESNET Grade 1 insulation fully supported • Continuous top and bottom plates or sealed blocking				
	2.1 Wall Behind Shower/Tub	☐	☐	☐	☐
	2.2 Wall Behind Fireplace	☐	☐	☐	☐
	2.3 Insulated Attic Slopes/Walls	☐	☐	☐	☐
	2.4 Attic Knee Walls	☐	☐	☐	☐
	2.5 Skylight Shaft Walls	☐	☐	☐	☐
	2.6 Wall Adjoining Porch Roof	☐	☐	☐	☐
	2.7 Staircase Walls	☐	☐	☐	☐
	2.8 Double Walls	☐	☐	☐	☐
3. Floors between Conditioned and Exterior Spaces	**Requirements:** • Air barrier is installed at any exposed insulation edges • Insulation is installed to maintain permanent contact w/ sub-floor above and air barrier below - **Optional until July 1, 2008**				
	3.1 Insulated Floor Above Garage	☐	☐	☐	☐
	3.2 Cantilevered Floor	☐	☐	☐	☐
4. Shafts	**Requirements:** Openings to unconditioned space are fully sealed with solid blocking or flashing and any remaining gaps are sealed with caulk or foam (provide fire-rated collars and caulking where required)				
	4.1 Duct Shaft	☐	☐	☐	☐
	4.2 Piping Shaft/Penetrations	☐	☐	☐	☐
	4.3 Flue Shaft	☐	☐	☐	☐
5. Attic/ Ceiling Interface	**Requirements:** • All attic penetrations and dropped ceilings include a full interior air barrier aligned with insulation with any gaps fully sealed with caulk, foam or tape • Movable insulation fits snugly in opening and air barrier is fully gasketed				
	5.1 Attic Access Panel (fully gasketed and insulated)	☐	☐	☐	☐
	5.2 Attic Drop-down Stair (fully gasketed and insulated)	☐	☐	☐	☐
	5.3 Dropped Ceiling/Soffit (full air barrier aligned with insulation)	☐	☐	☐	☐
	5.4 Recessed Lighting Fixtures (ICAT labeled and sealed to drywall)	☐	☐	☐	☐
	5.5 Whole-house Fan (insulated cover gasketed to the opening)	☐	☐	☐	☐
6. Common Walls Between Dwelling Units	**Requirements:** Gap btwn drywall shaft wall (common wall) and structural framing btwn units is sealed at all exterior boundary conditions				
	6.1 Common Wall Between Dwelling Units	☐	☐	☐	☐

Rater Inspection Date: _____ Builder Inspection Date: _____

Home Energy Rating Provider: _____ Builder Company Name: _____

Home Energy Rater Company Name: _____ Builder Division Name: _____

Home Energy Rater Signature: Builder Employee Signature: