

Attic Knee Walls

Last Updated: 03/14/2016

Scope



Install an air barrier on the exterior of attic knee wall insulation and to block open floor joist cavities under attic knee walls

Install an air barrier on the exterior of attic knee wall insulation and to block open floor joist cavities under attic knee walls.

- Install a top and bottom plate or blocking at the top and bottom of all knee wall cavities.
- Install insulation without misalignments, compressions, gaps, or voids in all knee wall cavities.
- Install a continuous air barrier on the exterior side of the attic knee wall framing with a rigid air barrier or other supporting material to prevent the knee wall cavity insulation from sagging and to create a continuous thermal barrier. Rigid air barrier material could include rigid foam insulation, drywall, plywood, or OSB, among others.
- Seal all seams, gaps, and holes in the air barrier with caulk or foam.
- If spray foam insulation is used for the wall cavity insulation, the spray foam can serve as the air barrier if it is at least 5.5 inches thick if open-cell or at least 1.5 inches thick if closed-cell spray foam insulation.
- Install blocking in the joist bays below the knee walls to prevent air flow under the knee walls.

See the [Compliance Tab](#) for related codes and standards requirements, and criteria to meet national programs such as DOE's Zero Energy Ready Home program, ENERGY STAR Certified Homes, and Indoor airPLUS.

Description

Knee walls, the walls that separate conditioned from unconditioned space in an attic, can be a source of significant air leakage if a continuous air barrier is not provided to prevent unconditioned air from flowing under the knee wall and under the floor boards of the attic room. There are two ways to block off this air flow: 1) a continuous air barrier can be installed on the exterior of the kneewall framing from the top of the knee wall down to the attic floor, including the spaces between the attic floor joists from the bottom of the knee wall to the ceiling deck below, or 2) a continuous air barrier can be installed along the underside of the attic roofline from the top of the knee wall to the top plate of the home's exterior wall. With either method, the air barrier should be installed before installing attic floor insulation in the unconditioned portion of the attic.

An air barrier is defined as any durable, solid material that blocks air flow between conditioned space and unconditioned space, including necessary sealing to block excessive air flow at edges and seams and adequate support to resist positive and negative pressures without displacement or damage ([ENERGY STAR 2015](#)). Air barrier material can include thin sheet goods such as rigid insulation, dry wall, OSB, plywood, or rolled batt insulation that is covered with spray foam. These materials may be installed by insulators, framers, or drywallers. This task should be included in the contract for the appropriate trade depending on the workflow at the specific job site.

Air barrier effectiveness is measured at the whole-house level. High-performance branding programs and the 2009 IECC require that builders meet specified infiltration rates at the whole-house level. See the "compliance" tab for these specified infiltration rates.

How to Air Seal Knee Walls along the Roofline

1. Insulate and air seal the ceiling of the attic room.
2. Continue the insulation along the roofline to the roof edge (Figure 1).
3. Cover the insulation with a sheet material (drywall or rigid foam insulation) that is caulked where it meets the plywood floor sheathing, which is extended to the outside wall.

Figure 1 - One way to air seal and insulate kneewalls – add insulation and a rigid air barrier along roof line of unconditioned attic space outside kneewall 

How to Insulate and Air Seal Floor Joist Cavities under Knee Walls

Step 1a: Insert solid wood blocking or rigid foam board in the floor joist cavity openings under the kneewall (Figure 2). Seal the edges with a continuous bead of caulk or foam sealant.

Figure 2 - Air seal floor joist cavities under kneewalls with rigid foam, plywood, or OSB caulked in place 

-OR-

Step 1b: Stuff Floor joist cavities with rolls of fiberglass batt and cover them with spray foam to the edges (Figure 3).

Figure 3 - Stuff cavities under kneewalls with rolls of fiberglass batt and spray foam in place 

Step 2: Apply caulk to the exterior face of the framing of the top plate, bottom plate, and framing at each side of the kneewall. Install rigid foam or another solid air barrier over the knee wall framing (Figure 4). Seal any seams in the rigid barrier with tape or caulk.

Step 3: Fill the attic floor joist bays with insulation (batt, blown, or spray foam) to meet or exceed the code minimum R-value (Figure 4).

Figure 4 - Cover insulated kneewall with rigid foam or other solid air barrier, caulked at edges. Add attic floor insulation 

Ensuring Success

Blower door testing, conducted as part of whole-house energy performance testing, may help indicate whether air leakage at knee walls has been successfully sealed. An infrared camera and/or visual inspection may also be used to determine locations of air leakage at the knee wall.

Climate

[ENERGY STAR Certified Homes](#)

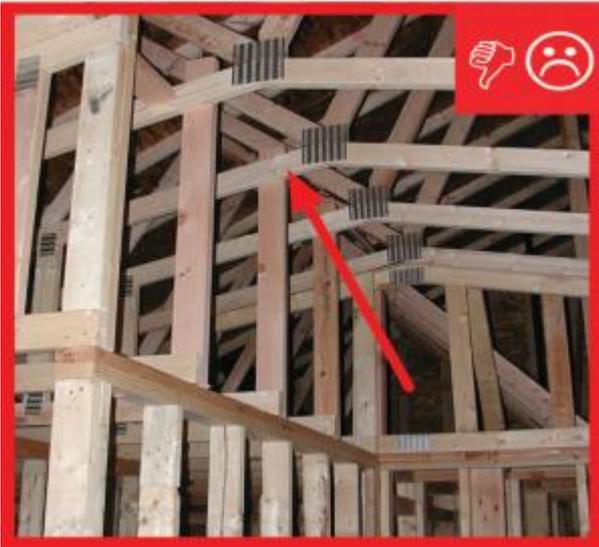
ENERGY STAR Certified Homes (Ver. 3/3.1 Ver 08) Rater Field Checklist. Fully-Aligned Air Barriers. A complete air barrier shall be provided that is fully aligned with the insulation at exterior surface of walls in all climate zones; and also at interior surface of walls for Climate Zones 4-8.

[DOE Zero Energy Ready Home](#)

DOE Zero Energy Ready Home (Rev 05) Exhibit 2: DOE Zero Energy Ready Home Target Home. Infiltration: Climate Zones 1-2: 3 ACH 50; Zones 3-4: 2.5 ACH50; Zones 5-7: 2 ACH50; Zone 8: 1.5 ACH50. Envelope leakage shall be determined by an approved verifier using a RESNET-approved testing protocol.

Training

Right and Wrong Images



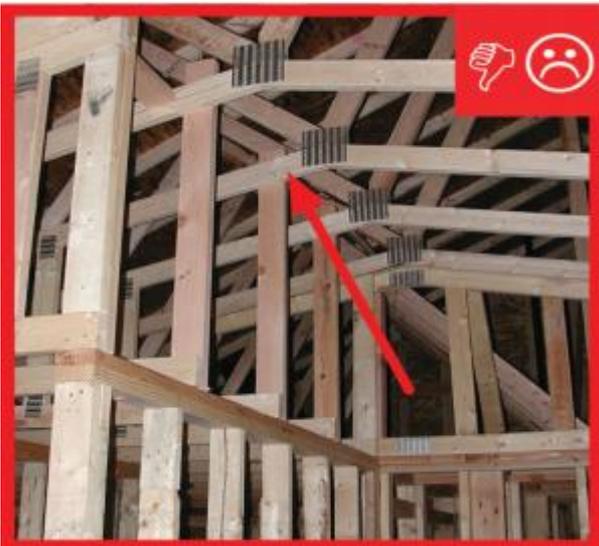
Display Image: [ES_TESRC_3.1.3_PG60_43b_102811_0.jpg](#)

Reference: [Thermal Enclosure System Rater Checklist Guidebook](#)

Author(s): EPA

Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.



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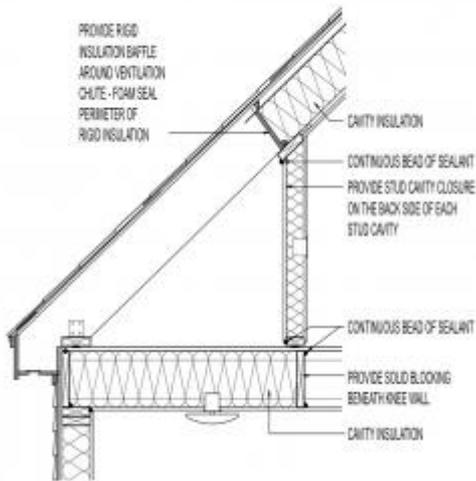
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CAD



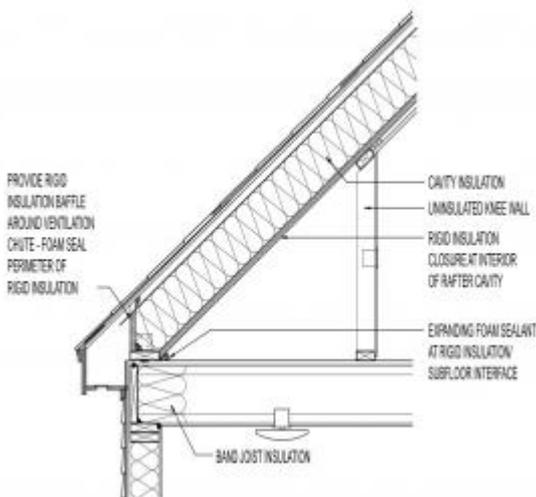
CAD FILE: [313 CAD 2-4 knee wall defines conditioned space 5-01013_GBA_1-31-12.dwg](#)
PDF: [313 CAD 2-4 knee wall defines conditioned space 5-01013_GBA_1-31-12.pdf](#)

Reference: [Building Plans for Advanced Framing](#)

Author(s): Green Building Advisor

Organization(s): Green Building Advisor

Website providing CAD files and drawings of advanced framing details.



CAD FILE: [313 CAD 2-4 Knee wall inside conditioned space 5-01014_GBA_1-31-12.dwg](#)
PDF: [313 CAD 2-4 Knee wall inside conditioned space 5-01014_GBA_1-31-12.pdf](#)

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Compliance

The Compliance tab contains both program and code information. Exact code language is copyrighted and may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our webmaster if you find broken links.

[ENERGY STAR Certified Homes](#)

ENERGY STAR Certified Homes (Version 3/3.1, Revision 08), Rater Field Checklist

Thermal Enclosure System:

2. Fully-Aligned Air Barriers.⁵ At each insulated location below, a complete air barrier is provided that is fully aligned as follows:

Walls: At exterior vertical surface of wall insulation in all climate zones; also at interior vertical surface of wall insulation in Climate Zones 4-8.⁷

2.3 Attic knee walls and skylight shaft walls.⁸

Footnotes:

(5) For purposes of this Checklist, an air barrier is defined as any durable solid material that blocks air flow between conditioned space and unconditioned space, including necessary sealing to block excessive air flow at edges and seams and adequate support to resist positive and negative pressures without displacement or damage. EPA recommends, but does not require, rigid air barriers. Open-cell or closed-cell foam shall have a finished thickness \geq 5.5 in. or 1.5 in., respectively, to qualify as an air barrier unless the manufacturer indicates otherwise. If flexible air barriers such as house wrap are used, they shall be fully sealed at all seams and edges and supported using fasteners with caps or heads \geq 1 in. diameter unless otherwise indicated by the manufacturer. Flexible air barriers shall not be made of kraft paper, paper-based products, or other materials that are easily torn. If polyethylene is used, its thickness shall be \geq 6 mil.

(7) All insulated vertical surfaces are considered walls (e.g., above and below grade exterior walls, knee walls) and must meet the air barrier requirements for walls. The following exceptions apply: air barriers recommended, but not required, in adiabatic walls in multifamily dwellings; and, in Climate Zones 4 through 8, an air barrier at the interior vertical surface of insulation is recommended but not required in basement walls or crawlspace walls. For the purpose of these exceptions, a basement or crawlspace is a space for which \geq 40% of the total gross wall area is below-grade.

(8) Exterior air barriers are not required for attic knee walls that are \geq 24 in. in height if an interior air barrier is provided and insulation extends in all directions from the top of this interior air barrier into unconditioned space at the following levels: CZ 1-5: \geq R-21; CZ 6-8: \geq R-30.

ENERGY STAR Revision 08 requirements are required for homes permitted starting 07/01/2016.

[DOE Zero Energy Ready Home](#)

DOE Zero Energy Ready Home (Rev 05) Exhibit 1: Mandatory Requirements: Item 1, Homes must be certified under ENERGY STAR Qualified Homes Version 3. Item 2, Ceiling, wall, floor, and slab insulation shall meet or exceed 2012 or 2015 IECC levels.

Exhibit 2: Design the home to meet the HERS index of the DOE Zero Energy Ready Home Target Home, for which insulation levels must meet the 2012 IECC and achieve Grade 1 installation, per RESNET standards.

Exhibit 2: Infiltration: Climate Zones 1-2: 3 ACH50; Zones 3-4: 2.5 ACH50; Zones 5-7: 2 ACH50; Zone 8: 1.5 ACH50. Envelope leakage shall be determined by an approved verifier using a RESNET-approved testing protocol. Building envelope assemblies, including exterior walls and unvented attic assemblies (where used), shall comply with the relevant vapor retarder provisions of the 2012 International Residential Code.

[ASTM E1677-11](#)

Standard Specification for Air Barrier (AB) Material or System for Low-Rise Framed Building Walls. This specification covers minimum performances and specification criteria for an air barrier material or system for framed, opaque walls of low-rise buildings. The provisions are intended to allow the user to design the wall performance criteria and increase air barrier specifications for a particular climate location, function, or design.

[ABAA 07261](#)

Self-Adhered Sheet Air Barrier. 2006. Air Barrier Association of America, Walpole, MA. This specification for self-adhered sheet air barriers is developed by a professional association, the Air Barrier Association of America, to provide guidance to the design professional.

[ABAA 07262](#)

Fluid-Applied Air and Vapor Barrier. 2012. Air Barrier Association of America, Walpole, MA. This specification for air barriers that are fluid-applied and also act as vapor barriers is developed by a professional association, the Air Barrier Association of America, to provide guidance to the design professional.

[ABAA 07263](#)

Closed Cell, Medium-Density Spray Polyurethane Foam Air Barrier. 2011. Air Barrier Association of America, Walpole, MA. This specification for closed cell, medium-density spray polyurethane foam air barriers is developed by a professional association, the Air Barrier Association of America, to provide guidance to the design professional.

[ABAA 07265](#)

Fluid-Applied Vapor Permeable Air Barrier. 2012. Air Barrier Association of America, Walpole, MA. This specification for fluid-applied vapor permeable air barriers is developed by a professional association, the Air Barrier Association of America, to provide guidance to the design professional.

[2009 IECC](#)

Table R402.1.1 Insulation and Fenestration Requirements – meet or exceed the insulation levels listed in this table.

Table 402.4.2 Air Barrier and Insulation Inspection Component Criteria. Walls: Insulation in exterior framed walls is in substantial contact and continuous alignment with the air barrier. Table 402.4.2, Air barrier and thermal barrier: Air permeable insulation is not used as a sealing material.

Section 402.4.1, Building thermal envelope. Knee walls to be sealed. Section R402.4.2 Air sealing and insulation is demonstrated by testing or visual inspection. Testing. The building should be tested for air leakage should have an air leakage rate of ? 7 at rough-in.

[2009 IRC](#)

Section N1102.4.1, Building thermal envelope. Knee walls to be sealed. Table N1102.4.2 Air Barrier and Insulation Inspection Component Criteria, Walls: Insulation in exterior framed walls is in substantial contact and continuous alignment with the air barrier. Table N1102.4.2, Air barrier and thermal barrier: Air-permeable insulation is not used as a sealing material.*

[2012 IECC](#)

Table R402.1.1 Insulation and Fenestration Requirements – meet or exceed the insulation levels listed in this table.

Table R402.4.1.1 Air Barrier and Insulation Installation. Walls: Insulation in exterior framed walls is in substantial contact and continuous alignment with the air barrier.* Table R402.4.1.1, Air barrier and thermal barrier: A continuous air barrier is installed in the building envelope. The exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier are sealed. Air permeable insulation is not used as a sealing material.*

Section R402.4.1.2 Testing. The building should be tested for air leakage and should have an air leakage rate of ? 5 in CZ 1 and 2 or ? 3 in CZ 3-8.

[2012 IRC](#)

Table N1102.4.1.1 Air Barrier and Insulation Installation, Walls: Knee walls to be sealed. Table N1102.4.1.1, Air barrier and thermal barrier: A continuous air barrier is installed in the building envelope including rim joists and exposed edges of insulation. Breaks or joints in the air barrier are sealed. Air permeable insulation is not used as a sealing material.*

[2015 IECC](#)

Table R402.1.2 Insulation and Fenestration Requirements – meet or exceed the insulation levels listed in this table.

Table R402.4.1.1 Air Barrier and Insulation Installation, Ceiling/attic: Access openings, drop down stairs, and knee wall doors to uncodnitioned attic spaces are sealed. Walls: Insulation in exterior framed walls is in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed. General requirements: A continuous air barrier is installed in the building envelope; breaks and joints in the air barrier are sealed. Air-permeable insulation is not used as an air-sealing material.*

Section R402.4.1.2 Testing. The building should be tested for air leakage in accordance with ASTM E 779 or E 1827 and should have an air leakage rate of ? 5 in CZ 1 and 2 or ? 3 in CZ 3-8.

[2015 IRC](#)

N1102.4.1.1 Air Barrier and Insulation Installation, Ceiling/attic: Air barrier in any dropped ceiling/soffit is substantially aligned with insulation and any gaps are sealed. Access openings, drop down stairs, and knee wall doors to uncodnitioned attic spaces are sealed. Walls: Insulation in exterior framed walls is in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed. General requirements: A continuous air barrier is installed in the building envelope; breaks and joints in the air barrier are sealed. Air-permeable insulation is not used as an air-sealing material.*

* Due to Copyright restrictions, exact code text is not provided. For specific code text, refer to the applicable code.

[Air Sealing and Insulating Attic Knee Walls - Code Compliance Brief](#)

Overview:

The intent of this brief is to provide code-related information about attic knee walls to help ensure that the measure will be accepted as being in compliance with the code. Providing notes for code officials on how to plan review and conduct field inspections can help builders or remodelers with proposed designs and provide jurisdictional officials with information for acceptance. Providing the same information to all interested parties (e.g., code officials, builders, designers, etc.) is expected to result in increased compliance and fewer innovations being questioned at the time of plan review and/or field inspection.

Attic knee walls are typically short, vertical walls approximately 2 to 3 feet high in an attic that separates attic space from conditioned space. Most common attic knee walls are associated with the creation of a bonus room that can have many uses. The walls screen out the unusable space where the rafters meet exterior wall top plates and/or the attic floor.

Unfortunately, the space on the unconditioned side of the knee wall often is not well sealed or insulated and the wall structure by itself does not provide enough of a thermal barrier to adequately maintain the temperature of the conditioned side of the knee wall in a vented non-conditioned attic. Furthermore, attic knee walls really need to thermally perform better than an exterior wall, especially in the summer months when the temperature difference between the unconditioned attic space and the conditioned space is likely to be much greater than to the temperatures that exterior walls are exposed to. During the summer, the temperature in an unconditioned attic can exceed 130°F.

Properly sealing and insulating attic knee walls can significantly reduce air leakage and heat loss between the conditioned space and the unfinished attic. It is important to choose an air-barrier and insulation material that will reduce the air leakage and heat loss as much as possible. For example, rigid foam board can act as both a thermal barrier and an air barrier across the unconditioned side of the knee wall. Some insulation options either do not provide air sealing or are difficult to install outside of the wall framing.

While the energy code does not specify any one type of material or how to air seal and insulate attic knee walls, Building America recommends best practices as to what materials perform better in specific situations and how the materials should be properly installed. Refer to the "description" tab of this guide (<https://basc.pnnl.gov/resource-guides/attic-knee-walls>) and the Technical Validation Section of this brief for additional resources on best practices on air sealing and installing insulation and recommended air-barrier and insulation materials.

This brief provides an overview of the energy provisions of the 2009 through 2015 International Energy Conservation Code (IECC) and International Residential Code (IRC) code for attic knee walls. While the IECC/IRC does not specifically define attic knee walls, they are included in the definition of the "*building thermal envelope*^[1]" as other building elements that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space.

^[1] "*Building Thermal Envelope*" is defined as the basement walls, exterior walls, floor, roof, and any other building elements that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space.

Plan Review:

Per the 2015 IECC/IRC, Section R103.3/R106.3, Examination of Documents. The code official/building official must examine, or cause to be examined, construction documents for code compliance.

This section lists the applicable code requirements followed by details helpful for plan review regarding the provisions to meet the requirements for "attic knee walls."

- **Construction Documentation.** Review the construction documents for details describing attic knee wall insulation, installation, air sealing, and construction techniques.

- — **2015 IECC/IRC, Section R103.2/N1101.5 (2012 IECC/IRC, Section R103.2/N1101.8), Information on Construction Documents.** Construction documents should include:
 - Insulation materials and their R-values
 - Air sealing details.
 - **NEW language** (section) in the **2015 IECC/IRC, Section R103.2.1/N1101.5.1, Thermal Envelope Depiction.** The building's thermal envelope should be represented on the construction drawings.
 - Insulation. All three versions of the IECC/IRC allow compliance to be demonstrated by the following three prescriptive approaches: 1) R-value computation, 2) U-factor alternative, or 3) total UA alternative. This brief provides the general prescriptive requirements per the R-value computation approach.
 - **2015 IECC/IRC, Section R402.1.2/N1102.1.2, Insulation and Fenestration Criteria.** The building thermal envelope should meet the requirements of Table R402.1.2/N1102.1.2, based on the climate zone specified in Chapter 3 of the IECC and Section N1101.10 in the IRC.
 - **2015 IECC/IRC, Section R402.1.3/N1102.1.3, R-Value Computation.** Insulation material used in layers, such as framing cavity insulation, or continuous insulation should be summed to compute the corresponding component R-value. The manufacturer's settled R-value should be used for blown insulation. Computed R-values should not include an R-value for other building materials or air films.
 - Excerpt from the Insulation and Fenestration Requirements by Component

2015 IECC/IRC Table R402.1.2/N1101.1.2, Table R402.1.1/N1102.1.1 (2012 IECC/IRC)
(R-values are the same for both versions)

 - **Air Sealing/Air Leakage Control**
 - **2015 IECC/IRC, R402.4./N1102.4, Air Leakage.** The *building thermal envelope* should be constructed to limit air leakage.
 - **R402.4.1/N1102.4.1, Building Thermal Envelope.** The sealing methods between dissimilar materials should allow for differential expansion and contraction.
 - **R402.4.1.1/N1102.4.1.1, Installation.** The components listed in the Air Barrier and Insulation Installation Table^[2] should be installed in accordance with the manufacturer's instructions and the criteria listed as the applicable method of construction. Below are the General Requirement and components from the table that are applicable to sealing and insulating attic knee walls.
 - **R402.4.1.1/N1102.4.1.1, Air Barrier and Insulation Installation Table**
 - **Air Barrier General Requirements.** A *continuous air barrier*^[3] should be installed in the building envelope. The exterior thermal envelope contains a *continuous air barrier*. Breaks or joints in the *air barrier*^[4] should be sealed.
 - **Air-Barrier Criteria:**
 - **Walls** – The junction of the top plate and top of exterior walls should be sealed.
 - **Insulation Installation:**
 - **Walls** – Cavities within corners and headers of frame walls should be insulated by completely filling the cavity with a material having a thermal resistance of R-3 per inch minimum. Exterior thermal envelope insulation for framed walls should be installed in substantial contact and continuous alignment with the air barrier.
 - **2012 IECC/IRC, R402.4/N1102.4, Air Leakage.** The building thermal envelope should be constructed to limit air leakage.
 - **R402.4.1/N1102.4.1, Building Thermal Envelope.** The sealing methods between dissimilar materials should allow for differential expansion and contraction.
 - **R402.4.1.1/N1102.4.1.1, Installation.** The components listed in the Air Barrier and Insulation Installation Table should be installed in accordance with the manufacturer's instructions and the criteria listed as the applicable method of construction. Below are the components from the table that are applicable to sealing and insulating attic knee walls.
 - **R402.4.1.1/N1102.4.1.1, Air Barrier and Insulation Installation Table**
 - **Walls** – The junction of the top plate and top of exterior walls should be sealed. Exterior thermal envelope insulation for framed walls should be installed in substantial contact and continuous alignment with the air barrier.
 - **2009 IECC/IRC, 402.4.1/N1102.4.1, Air leakage, Building Thermal Envelope**
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