Rigid Foam Insulation for Existing Exterior Walls

Last Updated: 12/11/2015

Scope

In this retrofit wall assembly, the air control layer is applied directly over the existing wall sheathing and then covered by at least two layers of insulating sheathing held in place by vertical furring strips. The vertical furring strips also provide the means of attachment for the exterior siding.

There are two possible locations for the water control layer for this retrofit wall assembly – at the outer face of the insulating sheathing or between the insulating sheathing and the existing exterior wall.

Insulate the walls of an existing home by removing the existing cladding and installing rigid foam insulating sheathing to upgrade the major building enclosure functions of the wall – water control, air control, vapor control, and thermal control, as follows:

- Remove existing wall cladding and trim.
- Prepare the wall sheathing for air/water control membrane.
- Remove windows and doors as needed to allow flashing of openings and air control transitions into openings.
- Install a continuous air/water control layer to the original sheathing or to the insulation sheathing.
- Transition the wall air/water control membrane to adjacent assemblies.
- Install flashings and air control transitions.
- Re-install windows and doors or install new windows and doors in properly flashed openings.
- Install insulating sheathing in accordance with code to satisfy the high R-value performance target for the assembly and for adequate condensation control.
- Install furring strips over insulating sheathing and attach to structure (structural sheathing and/or framing) through insulating sheathing. Install furring strips in a *vertical orientation only*.
- Install wall cladding and trim, by attaching to the furring strips.

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.
One method for increasing the insulation level of the walls in existing homes is to remove the exterior cladding and install rigid foam insulation, possibly new house wrap, and new exterior cladding over the walls. This step not only increases the wall R-value, it can also greatly improve the performance of the walls to control the movement of air, vapor, and water through the walls.

Some advantages to this retrofit approach include minimizing the impact of the wall retrofit on the interior finishes of the existing house, supporting continuity of the water and air control layers, reducing thermal bridging or heat transfer through wall framing, and lowering the risk of water damage and condensation within the existing wall structure.

In Figures 1 and 2, the wall siding is represented as lap siding, which could be wood, vinyl, or fiber cement lap siding. Other types of siding that can be attached using the vertical furring strips may be used as well, provided the weight of the siding is less than 10 lb/sf.

Taped insulating sheathing may serve as a layer to control water, air, and heat loss. However, house wrap or a paint-on membrane could also be applied to the original sheathing before the insulating sheathing is installed.

The insulating sheathing is held in place by vertical furring strips, along with other attachments per manufacturer’s instructions. The vertical furring strips also provide the means of attachment for the exterior siding and provide a ventilation gap under the siding.

The house wrap should be overlapped and taped at all seams and attached with fasteners per the manufacturer’s instructions. (See Figure 2.) If more than one layer of foam is used, the exterior layer of the foam is the water control layer and all seams in that layer should be taped with appropriate foam-compatible tape. The exterior foam layer should be foil-faced polyisocyanurate or XPS and the layer should be at least 1 inch thick. EPS should not be used as the outer layer but EPS Type II could be used as the inner layer. If the exterior of the rigid foam serves as the water control layer, the air control layer would still be house wrap or paint-on membrane that is installed between the existing house sheathing and the rigid foam.

The location of the water control layer has implications for how the water control function is handled at transitions and interruptions. For example, in window installations, if the water control layer is over the existing sheathing, the windows are installed within the existing wall framing. If the water control layer is at the face of the insulating sheathing, the windows are installed within the insulating sheathing layer of the wall, in order to integrate the window flashing into the water control layer.

When installing this retrofit wall assembly, it is recommended that multiple layers of insulating sheathing be applied to the exterior of the existing wall. For example, rather than installing one 2-inch layer of rigid foam, two 1-inch layers are installed. This creates a vapor impermeable layer on the exterior of the existing wall. If there is a wetting event (e.g., a plumbing leak) that causes the existing wall structure to become wet, it is important that the wall is able to dry to the inside. To allow drying to the inside, any new or existing application of closed-cell spray foam in the wall cavities should be limited to a thickness of no more than one inch. For other types of spray foam insulation, the vapor permeance of the installed thickness must be at least 1.0 perm. Open-cell spray foam insulation meets this criteria for typical framed wall cavity depths. This may not be the case for some medium-density spray foams.

It is advisable to avoid use of an interior vapor barrier and vapor impermeable wall coverings such as non-latex paint and vinyl wallpapers with this retrofit wall approach because these limit the drying potential to the interior. These types of wall coverings may contribute to problems if the interior space has high humidity, there is a history of water leakage in the wall, or the exterior wall has gotten wet during construction.
Figure 1. Insulating sheathing is installed on exterior of an existing framed wall with water control between existing sheathing and insulating sheathing.
Figure 2. Insulating sheathing is installed over existing wall sheathing in a wall retrofit to improve insulation, air, and water control. The water control layer is at face of insulating sheathing, which is foil faced and has taped seams.

How to Install Rigid Foam Board Insulation at Exterior Wall

1. Remove the existing wall cladding and trim, and inspect the structural integrity of the wall. Check the wall framing for any deficiencies, rot, insect damage, etc. Based on the findings of the inspection, revise the wall assembly plans and review specific detailing as needed. Proceed only after needed repairs are performed. Meet or exceed the minimum requirements of the current adopted building and energy codes.

2. Prepare the wall sheathing to receive the air/water control membrane or house wrap, if one is going to be used. Appropriate preparation of the wall sheathing will depend upon the nature of the existing sheathing and the air control strategy pursued. If using a sheet good (house wrap) as the air/water control layer, all protruding fasteners must be removed to avoid punctures or tears in the membrane. Gaps or voids in the sheathing layer may need to be filled in. Use a primer for self-adhered membranes if recommended by the membrane manufacturer if installing membrane.

3. Remove windows and doors and trim to allow for proper flashing of the window and door openings, and to permit the installation of air control transition membranes.

4. Install a continuous air control membrane (house wrap or paint-on membrane) over the existing sheathing as shown in Figure 1. Connect the air control membrane to the air control layer of adjacent assemblies in a tight and durable manner. Seal all penetrations against air and water leaks. This layer may also serve as the water control layer, or the surface of the rigid foam can serve as the water control layer if all seams are sealed, as shown in Figure 2.

5. Install flashings and air control transitions. Transition the air control at the top and bottom margins of the exterior wall into the window and door rough openings and air seal all penetrations through the wall. Flash window and door rough openings as well as all wall penetrations.

6. Re-install windows and doors or install new windows and doors in properly flashed openings. If the water control layer is over the existing sheathing, the windows are installed within the existing wall framing whereas if the water control layer is at the face of the insulating sheathing, the windows are installed within the insulating sheathing layer of the wall. This is to ensure the window flashing is properly integrated into the water control layer. Air seal the window and door units to the air control transition membranes at the interior perimeter of the window and door units.
7. Install insulating sheathing over the air/water control membrane. Butt joints tight. When installing multiple layers, offset seams in two directions. If the surface of the rigid foam will serve as the water control layer, then the exterior layer of rigid foam cannot be EPS, it must be foil-faced polyisocyanurate or XPS and all seams of the exterior foam layer must be taped. Until furring strips are installed, insulating sheathing pieces can be held in place with cap nails or screws with roofing washers.

8. Install furring strips over insulating sheathing and attach furring strips to the wall structure (structural sheathing and/or framing) through the insulating sheathing. Install furring strips in a vertical orientation only. It is important to install furring strips in a vertical, not horizontal, orientation to allow drainage behind the cladding/trim and to prevent water from dwelling within the system. 1x4 furring is recommended. The furring need not be preservative treated for moisture protection. The spacing of fasteners through the furring strips must be such that the cladding load is distributed to no more than 10 lb per fastener.

9. Attach cladding and trim to the vertical furring strips.
Ensuring Success

Refer to the current adopted building and energy codes for information on appropriate levels of insulation for the different climate zones as well as the proper ratios of vapor and air impermeable and permeable insulation.

Remediate any hazardous conditions that will be affected (e.g., exposed or aggravated) by the planned work. Follow applicable laws and industry procedures for mitigation of hazardous materials. Engage the services of a qualified professional when needed.

Given the increased airtightness associated with this retrofit, combustion safety testing and controlled mechanical ventilation upgrades are required to maintain acceptable indoor air quality.
Climate

The exterior wall assembly should be designed for a specific hygrothermal region, rain exposure zone, and interior climate. The climate zones are shown on the map below, which is taken from Figure C301.1 of the 2012 IECC.

IECC Climate Zone Map

The insulation levels should be based on the minimum requirements for vapor control in the current adopted building code and the minimum requirements for thermal control in the current energy code. Additional insulation can be added above these minimums to create high R-Value exterior wall assemblies. The table below provides the minimum thermal resistance (R-value) requirements for exterior walls specified in the 2009 IECC (ICC 2009b) and the 2012 IECC (ICC 2012b), based on climate zone.

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Wood Frame Wall Minimum R-Value</th>
<th>2009 IECC</th>
<th>2012 IECC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13</td>
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<td>3</td>
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<td>20 or 13+5*</td>
<td>20 or 13+5*</td>
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<tr>
<td>4 except Marine</td>
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<td>20 or 13+5*</td>
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<tr>
<td>5 and Marine 4</td>
<td>20 or 13+5*</td>
<td>20 or 13+5*</td>
<td>20+5 or 13+10*</td>
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<tr>
<td>6</td>
<td>20 or 13+5*</td>
<td>20+5 or 13+10*</td>
<td>20+5 or 13+10*</td>
</tr>
<tr>
<td>7 and 8</td>
<td>21</td>
<td>20+5 or 13+10*</td>
<td>20+5 or 13+10*</td>
</tr>
</tbody>
</table>

* The first value is cavity insulation, the second value is continuous insulation or insulated siding. So “13+5” means R-13 cavity insulation plus R-5 continuous insulation or insulated siding. If structural sheathing covers 40% or less of the exterior, continuous insulation R-value shall be permitted to be reduced by no more than R-3 in the locations where structural sheathing is used to maintain a consistent total sheathing thickness.

Table 1. Minimum Wall R-Values Required by the 2009 and 2012 IECC
Training

Right and Wrong Images

Display Image: TE7223_RigidFoamWall-1R_BSC_06-29-2011.jpg

Display Image: TE7223_RigidFoamWall-2R_BSC_11-29-2012.JPG
CAD
None Available
The Compliance tab contains both program and code information. Code language is excerpted and summarized below. For exact code language, refer to the applicable code, which 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**

[Note: Guidance for Version 3.0, Revision 08 is coming soon.]

ENERGY STAR Certified Homes is a voluntary high-performance home labeling program for new homes operated by the U.S. Department of Energy and the U.S. Environmental Protection Agency. Builders and remodelers who are conducting retrofits are welcome to seek certification for existing homes through this voluntary program.

ENERGY STAR Certified Homes (Version 3.0, Revision 07) requires that ceiling, wall, floor, and slab insulation levels meet or exceed those specified in the 2009 International Energy Conservation Code (IECC).

If the state or local residential building energy code requires higher insulation levels than those specified in the 2009 IECC, you must meet or exceed the locally mandated requirements.

The ENERGY STAR Thermal Enclosure System Rater Checklist (Ver 3, Rev 07) specifies:

2.1 Ceiling, wall, floor and slab insulation levels shall comply with one of the following options:

2.1.1 Meet or exceed 2009 IECC levels, OR

2.1.2 Achieve <= 133% of the total UA resulting from the U-factors in 2009 IECC Table 402.1.3, excluding fenestration and per guidance in note “d” below, AND home shall achieve <= 50% of the infiltration rate in Exhibit 1 of the National Program Requirements.

2.2 All ceiling, wall, floor, and slab insulation shall achieve RESNET-defined Grade I installation or, alternatively, Grade II for surfaces that contain a layer of continuous, air impermeable insulation ? R-3 in Climate Zones 1 to 4, ? R-5 in Climate Zones 5 to 8.

3 Fully-Aligned Air Barriers. At each insulated location noted below, a complete air barrier shall be provided that is fully aligned with the insulation as follows:

- At interior or exterior surface of ceilings in Climate Zones 1-3; at interior surface of ceilings in Climate Zones 4-8. Also, include barrier at interior edge of attic eave in all climate zones using a wind baffle that extends to the full height of the insulation. Include a baffle in every bay or a tabbed baffle in each bay with a soffit vent that will also prevent wind washing of insulation in adjacent bays
- At exterior surface of walls in all climate zones; and also at interior surface of walls for Climate Zones 4-8
- At interior surface of floors in all climate zones, including supports to ensure permanent contact and blocking at exposed edge

3.1 Walls

(10) 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, with the exception of adiabatic walls in multifamily dwellings. All insulated ceiling surfaces, regardless of slope (e.g., cathedral ceilings, tray ceilings, conditioned attic roof decks, flat ceilings, sloped ceilings), must meet the requirements for ceilings.

4.4 Reduced thermal bridging at above-grade walls separating conditioned from unconditioned space (rim / band joists exempted) using one of the following options:

4.4.1 Continuous rigid insulation, insulated siding, or combination of the two; ? R-3 in Climate Zones 1 to 4, ? R-5 in Climate Zones 5 to 8, OR;

4.4.2 Structural Insulated Panels (SIPs), OR;

4.4.3 Insulated Concrete Forms (ICFs), OR;

4.4.4 Double-wall framing 16, OR;

4.4.5 Advanced framing, including all of the items below:

4.4.5a All corners insulated ? R-6 to edge 17, AND;

4.4.5b All headers above windows & doors insulated 18, AND;

4.4.5c Framing limited at all windows & doors 19, AND;

4.4.5d All interior / exterior wall intersections insulated to the same R-value as the rest of the exterior wall 20, AND;
4.4.5e Minimum stud spacing of 16 in. o.c. for 2x4 framing in all Climate Zones and, in Climate Zones 5 through 8, 24 in. o.c. for 2x6 framing.

5.2 Cracks in the building envelope fully sealed.

The ENERGY STAR Water Management System Builder Checklist specifies:

2 Water-Managed Wall Assembly

2.1 Flashing at bottom of exterior walls with weep holes included for masonry veneer and weep screed for stucco cladding systems, or equivalent drainage system.

2.2 Fully sealed continuous drainage plane behind exterior cladding that laps over flashing in Item 2.1. Additional bond-break drainage plane layer provided behind all stucco and non-structural masonry cladding wall assemblies.

2.3 Window and door openings fully flashed.

### DOE Zero Energy Ready Home

The DOE Zero Energy Ready Home Program is a voluntary high-performance home labeling program for new homes operated by the U.S. Department of Energy. Builders and remodelers who are conducting retrofits are welcome to seek certification for existing homes through this voluntary program.

The U.S. Department of Energy Zero Energy Ready Home National Program Requirements specify as a mandatory requirement (Exhibit 1, #2.2) that, for all labeled homes, whether prescriptive or performance path, ceiling, wall, floor, and slab insulation shall meet or exceed 2012 IECC levels. See the guide [2012 IECC Code Level Insulation – DOE Zero Energy Ready Home Requirements](#) for more details.

### 2009 - 2018 IECC and IRC Minimum Insulation Requirements:

The minimum insulation requirements for ceilings, walls, floors, and foundations in new homes, as listed in the 2009, 2012, 2015, and 2018 IECC and IRC, can be found in this table.

#### 2009 IECC

Section 401.3 Certificate

Section 402.1.1 Insulation and fenestration criteria

Table 402.1.1 Insulation and fenestration requirements by component

Table 402.1.3 Equivalent U-factors

Section 402.4 Air leakage (Mandatory)

Table 402.4.2 Air barrier and insulation inspection component criteria

#### 2012 IECC

Section R401.3 Certificate

Section R402.1.1 Insulation and fenestration criteria

Table R402.1.1 Insulation and fenestration requirements by component

Table R402.1.3 Equivalent U-factors

Section R402.4 Air leakage (Mandatory)

Table R402.4.1.1 Air barrier and insulation installation

#### 2015 and 2018 IECC

Section R401.3 Certificate

Section R402.1.2 Insulation and fenestration criteria

Table R402.1.2 Insulation and fenestration requirements by component

Table R402.1.4 Equivalent U-factors

Section R402.4 Air leakage (Mandatory)

Table R402.4.1.1 Air barrier and insulation installation


Section R101.4.3 (Section R501.1.1 in 2015 and 2018 IECC). Additions, alterations, renovations, or repairs shall conform to the provisions of this code, without requiring the unaltered portions of the existing building to comply with this code. (See code for additional requirements and exceptions.)
2009 IRC
Section R302.1 Exterior walls
Table R302.1 Exterior walls
Section R302.10 Flame spread index and smoke developed index for insulation
Section R316 Foam plastic
Section R403.3.4 Termite damage
Section R703 Exterior covering.
Section R703.11.2 Foam plastic sheathing
Section N1101.4 Building thermal envelope insulation
Section N1101.6 Insulation product rating
Section N1101.9 Certificate
Section N1102.1 Insulation and fenestration criteria
Table N1102.1 Insulation and fenestration requirements by component
Table N1102.1.2 Equivalent U-factors
Section N1102.4 Air leakage
Table N1102.4.2 Air barrier and insulation inspection

2012 IRC
Section R302.1 Exterior walls
Table R302.1 Exterior walls
Section R302.10 Flame spread index and smoke developed index for insulation
Section R316 Foam plastic
Section R403.3.4 Termite damage
Section R703 Exterior covering.
Section R703.11.2 Foam plastic sheathing
Section N1101.12.1 (R303.1.1) Building thermal envelope insulation
Section N1101.12.4 (R303.1.4) Insulation product rating
Section N1101.16 (R401.3) Certificate (Mandatory)
Section N1102.1.1 (R402.1.1) Insulation and fenestration criteria
Table N1102.1.1 (R402.1.1) Insulation and fenestration requirements by component
Table N1102.1.3 (R402.1.3) Equivalent U-factors
Section N1102.4 (R402.4) Air leakage (Mandatory)
Table N1102.4.1.1 (R402.4.1.1) Air barrier and insulation installation

2015 and 2018 IRC
Section R302.1 Exterior walls
Table R302.1 Exterior walls
Section R302.10 Flame spread index and smoke developed index for insulation
Section R316 Foam plastic
Section R403.3.4 Termite protection
Section R703 Exterior covering.
Section R703.11.2 Foam plastic sheathing (Insulation over foam plastic sheathing in 2018 IRC)
Section N1101.10.1 (R303.1.1) Building thermal envelope insulation
Section N1101.10.4 (R303.1.4) Insulation product rating
Section N1101.14 (R401.3) Certificate (Mandatory)
Section N1102.1.2 (R402.1.1) Insulation and fenestration criteria
Table N1102.1.2 (R402.1.1) Insulation and fenestration requirements by component
Table N1102.1.4 (R402.1.4) Equivalent U-factors
Section N1102.4 (R402.4) Air leakage (Mandatory)
Table N1102.4.1.1 (R402.4.1.1) Air barrier and insulation installation


Section N1101.3 (Section N1107.1.1 in 2015 and 2018 IRC). Additions, alterations, renovations, or repairs shall conform to the provisions of this code, without requiring the unaltered portions of the existing building to comply with this code. (See code for additional requirements and exceptions.)

Appendix J regulates the repair, renovation, alteration, and reconstruction of existing buildings and is intended to encourage their continued safe use.

Sealing and Insulating Existing Exterior Walls - Code Compliance Brief

Overview:

The intent of this brief is to provide code-related information about sealing and insulating existing walls in existing residential buildings to help ensure that the measures will be accepted as being in compliance with the code. Providing notes for code officials on how to conduct plan reviews and field inspections can provide jurisdictional officials with information for acceptance. Providing the same information to builders, contractors, designers, and others is expected to result in increased compliance and fewer innovations being questioned at the time of plan review and/or field inspection.

From a model code perspective, submittal of construction documentation, permitting, plan review, and field inspection may be required depending upon specific details of renovating exterior walls of an existing home. Several different approaches can be taken to seal and insulate existing exterior walls during a renovation project. For example, insulation can be installed by filling the wall cavities with spray foam insulation from the outside/exterior side of the wall, while keeping the wall sheathing, house wrap, and cladding intact. Insulation can be installed from the interior where the renovation has exposed the interior wall down to the framing members (removal of gypsum board and/or sheathing). The following Plan Review section provides the code sections for alterations followed by the details of inspecting the alteration under the Field Inspection section regarding sealing and insulating existing exterior walls. Refer to the Technical Validation/Resource Materials section of this brief for the resources on technical validation on the different methods that exterior walls can be insulated, best practices, and measure guidelines on techniques to ensure sealed and insulated exterior walls.

Plan Review:

This section lists the applicable code requirements followed by details that will be helpful for plan review regarding the provisions associated with sealing and insulating existing exterior walls.

Per the 2015 International Energy Conservation Code (IECC)/International Residential Code (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.

Construction Documentation. Review the construction documents for details describing the renovation of the exterior walls, insulation and sealing materials, installation, and construction techniques.

- 2015 IECC/IRC, Section R103.2/N1101.5 Information on construction documents. Construction documents should include:
  - Details associated with the exterior wall(s) renovation (e.g., water/moisture damage, water control layer, and drainage)
  - Insulation material(s) and their R-values with the wall(s) and any openings in the walls
  - Details indicating how the insulation is to be installed to the existing wall(s) or the interior and/or exterior of the existing wall(s) and/or stud cavity
  - Air sealing details.

- 2015 IECC/IRC, Section R501.1.1/N1107.1.1 Alterations – General. Alterations to an existing building or portion of a building should comply with Sections R502/N1108, R503/N1109, or R504/N1110. Unaltered portions of the existing building are not required to comply.
R503.1/N1109.1 General. Alterations to any building or structure should comply with the requirements of the code for new construction. Alterations should not negatively impact conformance of a building or structure to the provisions of this code; that is, code conformance should be the same as existed for the building or structure prior to the alteration. Alterations should not create an unsafe or hazardous condition or overload existing building systems. Alterations should be such that the altered building or structure uses no more energy than the existing building or structure prior to the alteration.

R503.2/N1103.2 Change in space conditioning. Any non-conditioned or low-energy space that is altered to become conditioned space must be brought into full compliance with this code. (This means not only the altered assembly must be brought into compliance but the entire space or building would need to be brought into compliance.)

R503.1.1/N1109.1.1 Building Envelope. Building envelope assemblies that are part of the alteration must comply with Sections R402.1.2/N1102.1.2 (Insulation and Fenestration Table) or R402.1.4/N1102.1.4 (U-factor Alternative), and Sections R402.2.1/N1102.2.1 through R402.2.12/N1102.2.12, R402.3.1/N1102.3.1, R402.3.2/N1102.3.2, R402.4.3/N1102.4.3 and R402.4.4/N1102.4.4.

Exception: The following alterations need not comply with the requirements for new construction provided the energy use of the building is not increased:
- Existing wall cavities exposed during construction, provided that the cavities are filled with insulation.
- Construction where the existing wall cavity is not exposed.

2012 IECC/IRC, Section R101.4.3/N1101.3 and 2009 IECC/IRC, Section 101.4.3/N1101.4.3 Alterations – General. Alterations to an existing building or portion of a building should comply to the provisions of the code as they relate to new construction without requiring unaltered portion(s) of the existing building to comply with this code.

Exception: The following alterations need not comply with the requirements for new construction provided the energy use of the building is not increased:
- Existing wall cavities exposed during construction, provided that the cavities are filled with insulation.
- Construction where the existing wall cavity is not exposed.

2015 IECC/IRC, Section R402.1.2/N1102.1.2 Insulation Criteria. The building thermal envelope must meet the requirements of Table R402.1.2/N1102.1.2, based on the climate zone specified in Chapter 3 of the code and the building assemblies associated with the exterior wall(s) that are considered part of the building thermal envelope.

2015 IECC/IRC, Section R402.1.3/N1102.1.3 or 2012 IECC/IRC, Section R402.1.2/N1102.1.2 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. (2015 IECC/IRC new language added: “Where insulated siding is used for the purpose of complying with the continuous insulation requirements of Table R402.1.2/N1102.1.2, the manufacturer’s labeled R-value for insulated siding should be reduced by R-0.6.”)

An excerpt from the Insulation and Fenestration Requirements by Component Tables follows:

2015 IECC/IRC, Table R402.1.2/N1101.1.2 or 2012 IECC/IRC, Table R402.1.1/N1102.1.1

(R-values are the same for both versions, but, the footnotes have changed from 2012 to 2015 IECC/IRC)

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 Except Marine</th>
<th>5 and Marine 4</th>
<th>6</th>
<th>7, 8</th>
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<tbody>
<tr>
<td>Wood Frame Wall R-value</td>
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<td>13</td>
<td>20 or 13+5^a</td>
<td>20 or 13+5^a</td>
<td>20 or 13+5^a</td>
<td>20+5 or 13+10 a</td>
<td>20+5 or 13+10 a</td>
</tr>
</tbody>
</table>

^a2015 IECC/IRC footnote: The first value is cavity insulation, the second value is continuous insulation, so “13+5” means R-13 cavity insulation plus R-5 continuous insulation.

^a2012 IECC/IRC footnote: First value is cavity insulation, second is continuous insulation or insulated siding, so “13+5” means R-13 cavity insulation plus R-5 continuous insulation or insulated siding. If structural sheathing covers <= 40% of the exterior, continuous insulation R-value should be permitted to be reduced by no more than R-3 in the locations where structural sheathing is used to maintain a consistent total sheathing thickness.

2015 IECC/IRC, Section R402.1.4/N1102.1.4 or 2012 IECC/IRC Section R402.1.3/N1102.1.3 U-Factor Alternative. An assembly with a U-factor equal to or less than that specified in Equivalent U-factor Tables should be permitted as an alternative to the R-value in Insulation and Fenestration Requirements by Component Tables of the IECC/IRC.
### Equivalent U-factor Tables

**2015 IECC/IRC, Equivalent U-factor Table R402.1.4/N1101.1.4**

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<th>Climate Zone</th>
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<th>5 and Marine 4</th>
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<tbody>
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<td>Wood Frame Wall U-factor</td>
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<td>0.060</td>
<td>0.060</td>
<td>0.045</td>
<td>0.045</td>
</tr>
</tbody>
</table>

**2012 IECC/IRC, Equivalent U-factor Table R402.1.3/N1102.1.3**

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>1</th>
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<th>4 Except Marine</th>
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<tbody>
<tr>
<td>Wood Frame Wall U-factor</td>
<td>0.083</td>
<td>0.083</td>
<td>0.057</td>
<td>0.057</td>
<td>0.057</td>
<td>0.048</td>
<td>0.048</td>
</tr>
</tbody>
</table>

**2009 IECC/IRC Insulation and Fenestration Requirements by Component Table 402.1.1/N1102.1**

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Frame Wall R-value</td>
<td>R-13</td>
<td>R-13</td>
<td>R-13</td>
<td>R-13</td>
<td>R-20 or 13+5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>R-20 or 13+5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>R-21</td>
</tr>
</tbody>
</table>

<sup>a</sup>13+5<sup>a</sup> means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers &lt; 25% of the exterior, insulated sheathing is not required where structural sheathing is used. If structural sheathing covers &gt; 25% of exterior, structural sheathing should be supplemented with insulated sheathing of at least R-2.

### Air Sealing/Air Leakage Control

- **2015 IECC/IRC, R402.4.1/N1102.4 Air Leakage.** The building thermal envelope should be constructed to limit air leakage.
  - **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 General Requirements and components from the table that are applicable to insulating and sealing exterior walls.
  - **R402.4.1/N1102.4.1 Building Thermal Envelope.** Methods used to seal between dissimilar materials should allow for differential expansion and contraction.

- **2015 IRC/IECC, Air Barrier and Insulation Installation Table R402.4.1.1/N1102.4.1.1**
  - **Continuous air barrier.** Confirm that construction documents specify a continuous air barrier for the building components associated with the insulation of the exterior wall(s). Breaks or joints in the air barrier should be sealed. Air-permeable insulation should not be used as a sealing material.
  - **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 in substantial contact and continuous alignment with the air barrier.
  - **Rim joists.** Rim joists should include the air barrier and be insulated.

- **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.** Methods used to seal 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 walls.
  - **R402.4.1.1/N1102.4.1.1 Air Barrier and Insulation Installation Table**
    - **Air barrier and thermal barrier.** A continuous air barrier should be installed in the building envelope (wall). Breaks or joints in the air barrier should be sealed. Air-permeable insulation should not be used as a sealing method.
    - **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.
    - **Rim joists.** Similar language as the 2015 IECC/IRC.
2009 IECC/IRC, 402.4.1/N1102.4.1 Air leakage, Building Thermal Envelope

- The building thermal envelope should be constructed to limit air leakage. Methods used to seal between dissimilar materials should allow for differential expansion and contraction. Sources of infiltration (see listing below) should be caulked, gasketed, weather-stripped, or otherwise sealed with an air-barrier material, suitable film, or solid material:
  - All joints, seams, and penetrations
  - Rim joist junction
  - Other sources of infiltration.

Moisture Control

2015/2012 IRC, Section R702.7 Vapor retarders. Class I or II vapor retarders are required on the interior side of frame walls in Climate Zones 5, 6, 7, 8, and Marine 4.

- Class III vapor retarders are permitted where one of the conditions are met per the Class III Vapor Retarder Table R702.7.1

[1] The term “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.

[2] The term “continuous air barrier” is defined as a combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope.

Field Inspection:

Per the 2015 IECC, Section R104, Inspections, construction or work for which a permit is required is subject to inspection. Construction or work is to remain accessible and exposed for inspection purposes until approved (in some instances, inspections can be difficult to examine especially if the insulation is drilled and filled on the existing exterior side of the walls). Required inspections include footing and foundation, framing and rough-in work, plumbing rough-in, mechanical rough-in, and final inspection.

Per the 2015 IRC, Section R109, Inspections, for onsite construction, the building official, upon notification from the permit holder or his agent, can make or cause to be made any necessary inspections. Further details are provided for inspections regarding foundation, plumbing, mechanical, gas and electrical, floodplain, frame and masonry, and final inspection. Any additional inspections are at the discretion of the building official.

This section provides details for inspecting to the specific provisions for insulation and sealing of existing exterior walls where one or more specific types of inspection per the IECC or IRC may be necessary to confirm compliance. To confirm code compliance, framing and rough-in would be the typical type of inspection performed for new construction. However, since this document addresses existing residential exterior walls where framing already exists, the framing inspection would involve ensuring the wall(s) that have any sources of air leakage (exterior or interior) are sealed and the existing framing is acceptable (e.g., if load bearing is not compromised).

- Joints, seams, holes, and penetrations are caulked, gasketed, weather-stripped, or otherwise sealed.
- Ensure that the appearance of insulation of the interior/exterior wall, as appropriate, in the field matches what is on the approved construction documents.
- If the R-value or U-factor approach for compliance was used in the documentation, ensure that the insulation installed meets the minimum R-value or maximum U-factor required for the type of assembly and climate zone per the approved construction documents.
- Confirm that the continuous air barrier is properly installed. Confirm that the insulation for framed walls is installed in substantial contact and continuous alignment with the air barrier.
- If applicable, confirm that the vapor retarder is installed in accordance with approved construction documents.

Technical Validation(s):

This section provides additional related information and references to materials that are applicable to the provision.
Author(s): ICC
Organization(s): ICC
Publication Date: May 2014
This code establishes a baseline for energy efficiency by setting performance standards for the building envelope (defined as the boundary that separates heated/cooled air from unconditioned, outside air), mechanical systems, lighting systems, and service water heating systems in homes and commercial businesses.

2015 IRC—International Residential Code for One- and Two-Family Dwellings
Author(s): ICC
Organization(s): ICC
Publication Date: May 2014
This code for residential buildings creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

2012 IECC—International Energy Conservation Code
Author(s): ICC
Organization(s): ICC
Publication Date: January 2012
This code establishes a baseline for energy efficiency by setting performance standards for the building envelope (defined as the boundary that separates heated/cooled air from unconditioned, outside air), mechanical systems, lighting systems, and service water heating systems in homes and commercial businesses.

2012 IRC—International Residential Code for One- and Two-Family Dwellings
Author(s): ICC
Organization(s): ICC
Publication Date: January 2012
This code for residential buildings creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

Author(s): ICC
Organization(s): ICC
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Case Studies

1. **Existing Whole-House Solutions Case Study: Deep Energy Retrofit of 1910 House, Portland, Oregon**
   - **Author(s):** PNNL
   - **Organization(s):** PNNL
   - **Publication Date:** December, 2011
     - Case study about a deep energy renovation of a home in the marine climate.

2. **Technology Solutions Case Study: Cladding Attachment Over Thick Exterior Insulating Sheathing**
   - **Author(s):** BSC
   - **Organization(s):** BSC
   - **Publication Date:** November, 2013
     - Case study describing optimal design and limitations of cladding attachments over exterior sheathings.

3. **Technology Solutions Case Study: Moisture Durability of Vapor Permeable Insulating Sheathing**
   - **Author(s):** BSC
   - **Organization(s):** BSC
   - **Publication Date:** October, 2013
     - Case study describing research about using exterior, vapor permeable insulation of retrofit walls with vapor permeable cavity insulation.

References and Resources*

1. **2009 IECC - International Energy Conservation Code**
   - **Author(s):** International Code Council
   - **Organization(s):** ICC
   - **Publication Date:** January, 2009
     - Code establishing a baseline for energy efficiency by setting performance standards for the building envelope (defined as the boundary that separates heated/cooled air from unconditioned, outside air), mechanical systems, lighting systems and service water heating systems in homes and commercial businesses.

2. **2009 IRC - International Residential Code for One and Two Family Dwellings**
   - **Author(s):** International Code Council
   - **Organization(s):** ICC
   - **Publication Date:** January, 2009
     - Code for residential buildings that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

   - **Author(s):** International Code Council
   - **Organization(s):** ICC
   - **Publication Date:** January, 2012
     - Code establishing a baseline for energy efficiency by setting performance standards for the building envelope (defined as the boundary that separates heated/cooled air from unconditioned, outside air), mechanical systems, lighting systems and service water heating systems in homes and commercial businesses.

4. **2012 IRC - International Residential Code for One and Two Family Dwellings**
   - **Author(s):** International Code Council
   - **Organization(s):** ICC
   - **Publication Date:** January, 2012
     - Code for residential buildings that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences.

5.
**Mass Save Deep Energy Retrofit Builder Guide**

**Author(s):** Pettit, Neuhauser, Gates  
**Organization(s):** Building Science Corporation  
**Publication Date:** July, 2013

Guidebook providing useful examples of high performance retrofit techniques for the building enclosure of wood frame residential construction in a cold and somewhat wet climate.

*Publication dates are shown for formal documents. Dates are not shown for non-dated media. Access dates for referenced, non-dated media, such as web sites, are shown in the measure guide text.*

**Contributors to this Guide**
The following authors and organizations contributed to the content in this Guide.

- **Building Science Corporation**, lead for the Building Science Consortium (BSC), a **DOE Building America Research Team**