Blown Insulation for Cavities of Existing Exterior Walls

Last Updated: 03/15/2017

Scope

Upgrade existing exterior walls that are uninsulated or poorly insulated by adding blown-in insulation in the wall cavities.

- Determine if the insulation is to be installed from inside or outside the home.
- Access the existing walls to determine the location of existing framing and blocking.
- Drill or cut holes for insulation installation.
- Completely fill wall cavities with blown insulation to the manufacturer’s recommended density for “dense” installation.
- Verify that all of the wall cavities are filled.
- Patch walls. If installation was done from the exterior, repair or install a proper drainage plane and air barrier.

For more information on conditions that may be encountered when working with walls in existing homes, see the Pre-Retrofit Assessment of Walls, Windows, and Doors.

The U.S. Department of Energy’s Standard Work Specifications has additional information on dense packing blown insulation.

See the Compliance Tab for related codes and standards, and criteria to meet national programs such as ENERGY STAR, DOE’s Zero Energy Ready Home program, and EPA’s Indoor airPLUS.
When considering methods for insulating exterior walls in an existing home, one common and somewhat uninvasive method is known as drill and fill. In this method, small holes are made in the interior or exterior wall near the top of the wall at each wall cavity, then the wall cavities are filled with blown-in insulation. See Figure 1 and 2.) An ideal time to do an exterior installation is when a house is being re-sided. Re-siding offers the opportunity to check and install or re-install a drainage plane like house wrap if necessary. Re-siding also offers the opportunity to install exterior rigid foam insulation, in addition to or instead of cavity insulation. (See Rigid Foam Insulation for Existing Exterior Walls).

Figure 1: The siding has been removed so cellulose insulation can be dense-packed into the exterior walls of this home. (Photo courtesy of CARB, Steven Winter Associates).
Figure 2: Fiberglass insulation is dense packed into a wall cavity from the interior side of the exterior wall. (Photo courtesy of CARB, Steven Winter Associates).

If the blown-in insulation is to be installed from the exterior as part of a siding replacement, an ideal opportunity is presented to improve the airtightness of the wall assembly with minimal effort. Exposed structural panels (plywood or OSB) can be effectively air sealed with fluid-applied air barriers, low-expansion foam, caulk, or quality tapes. Board sheathing should be covered by a house wrap, with all laps sealed with appropriate tape. Continuous rigid foam sheathing can be applied over existing sheathing to provide additional R-value, air sealing, and a continuous drainage plane.

It is critical for water management and durability that the wall assembly’s drainage plane be maintained. When blown-in insulation is added from the exterior, the drainage plane (if existing) will be breached and it must be made whole by appropriate patching or full replacement. The chosen method will depend on the amount of access and the state of the existing drainage plane material. If the insulation is to be installed from the interior, the drainage plane will not be affected.

Depending on the level of disturbance to existing exterior walls (interior and exterior sides), be aware of lead safety rules for homes built prior to 1980. In addition, if a home has knob and tub wiring, the National Electrical Code (NEC) Article 394.1 scope does not allow insulation to be applied to or surround the wiring.

This guide primarily focuses on wood framing construction with exterior wood sheathing and interior gypsum wall board. For more information on drill and fill installation in wood-framed walls as well as in other exterior wall materials, see the [Drill & Fill Installation Guide](#).

For other approaches to insulating exterior walls in existing homes, see the guides [Spray Foam Insulation for Cavities of Existing Exterior Walls](#) and [Rigid Foam Insulation for Existing Exterior Walls](#).

**How to Blow In Insulation into Existing Exterior Walls**

1. Determine if the existing exterior wall cavities are insulated. Options for assessing insulation levels include making a small cut-out in the interior gypsum wall board, viewing cavity insulation from the side of an electrical junction box cutout (shut off power to electrical outlets to avoid potential safety hazards), or using an infrared thermal imaging camera to qualitatively assess insulation levels.
   a. If the wall cavities are empty proceed to step 2.
   b. If the wall cavities have some existing insulation:
      i. Existing blown insulation that has deteriorated can remain (or be vacuumed out) and additional blown insulation can be installed in the wall cavity to the desired fill and density.
      ii. Existing batt insulation that has deteriorated can block blown insulation, preventing it from completely filling the cavity. Cut out a 1-foot strip along the wall near the floor on either the interior or exterior side of the wall, then pull out the old batt insulation to allow proper installation of the blown insulation into the wall cavities. Alternatively, use an infrared camera to verify that the blown insulation has adequately filled the wall cavities around the existing batt insulation.

2. Decide if insulation is to be blown from the interior or from the exterior.

3. Verify that the exterior wall framing is not balloon framing. If the walls are balloon framed, blocking will need to be installed at the top and bottom of the walls to provide a barrier between the wall cavities and the basement below and attic above to allow for dense packing of the cavities.
4. Identify the wall studs and use painter’s masking tape to mark them.

5. Using a hole saw, drill 1-inch or 2-inch holes (depending on the size of the blower nozzle) in the center of each stud cavity, roughly 6 inches below the ceiling (see Figure 3). It may be necessary to also drill a lower hole to ensure the full cavity is packed with insulation. If there is blocking or other obstacles in the wall cavity (identified using infrared camera), make an additional hole below the blocking (see Figures 4 and 5). Remember to drill in to any cavities above door headers and above and below windows, as well as wall cavities behind cabinets on exterior walls. Also if a bathroom is on an exterior wall, bathroom tiles may need to be “popped” off prior to drilling a hole through the wall board.

6. Blow in new insulation to the desired density. Confirm manufacturer’s lbs/ft$^3$ recommendations to achieve “dense” packing. The common insulation type is a dense-packed blown cellulose or fiberglass insulation. For information on blowing machines and nozzles, see the Drill & Fill Installation Guide.

7. Fill all exterior wall cavities then re-verify with an infrared camera to ensure that all cavities are completely filled before patching.

8. Once verified, patch the holes. For interior penetrations, patch the holes with gypsum board or rigid foam plugs and joint compound. When dry, sand smooth then paint. For exterior penetrations, patch requirements will differ depending on whether siding was removed or remained in place. Repair the drainage plane and air barrier as needed before installing siding.

Figure 3: Fiberglass insulation is dense-packed into exterior walls through holes cut into the interior side of the exterior walls a few inches from the ceiling. An inspection band was cut out of the gypsum wall board to verify installation for this demonstration project. (Photo courtesy of CARB, Steven Winter Associates).
Figure 4: Infrared image shows that insulation is missing above the window header and that cross bracing in an exterior wall has blocked blown-in insulation from the upper corner of a wall cavity. (Photo courtesy of NREL)

Figure 5: Infrared image shows cross bracing in an exterior wall has blocked blown-in insulation, resulting in a void in the wall cavity. (Photo courtesy of NREL).
Ensuring Success

Infrared imaging is a recommended tool to help identify framing and blocking in existing walls and to determine the thoroughness of insulation coverage. Voids will be most visible when there is a significant temperature difference between the outside and the conditioned space of the house.
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.

The appropriate vapor permeance and location of vapor control is dependent on the climate zone and the overall configuration of the insulated wall assembly. There are many factors to consider when installing blown-in insulation from either the interior or exterior. Understanding Vapor Barriers is a good primer on what needs to be considered regarding vapor retarders.

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>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13 2009 IECC 13 2012 IECC</td>
</tr>
<tr>
<td>2</td>
<td>13 2009 IECC 13 2012 IECC</td>
</tr>
<tr>
<td>3</td>
<td>13 2009 IECC 20 or 13+5* 2012 IECC 20 or 13+5*</td>
</tr>
<tr>
<td>4 except Marine</td>
<td>13 2009 IECC 20 or 13+5* 2012 IECC 20 or 13+5*</td>
</tr>
<tr>
<td>5 and Marine 4</td>
<td>20 or 13+5* 2009 IECC 20 or 13+5* 2012 IECC 20 or 13+10*</td>
</tr>
<tr>
<td>6</td>
<td>20 or 13+5* 2009 IECC 20 or 13+10* 2012 IECC 20 or 13+10*</td>
</tr>
<tr>
<td>7 and 8</td>
<td>21 2009 IECC 20 or 13+10* 2012 IECC 20 or 13+10*</td>
</tr>
</tbody>
</table>

* 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 percent 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. Wall Insulation Requirements per the 2009 and 2012 IECC.
Training

Right and Wrong Images

None Available
CAD
None Available
Compliance

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, Version 3/3.1 (Rev. 09)

National Rater Field Checklist

Thermal Enclosure System.

2. Fully-Aligned Air Barriers. 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 4-8.8

Footnote 6) 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 of 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 of 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 6 mil.

Footnote 8) 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 40% of the total gross wall area is below-grade.

Please see the ENERGY STAR Certified Homes Implementation Timeline for the program version and revision currently applicable in your state.

DOE Zero Energy Ready Home (Revision 07)

Exhibit 1 Mandatory Requirements.

Exhibit 1, Item 1) Certified under the ENERGY STAR Qualified Homes Program or the ENERGY STAR Multifamily New Construction Program.

Exhibit 1, Item 2) Ceiling, wall, floor, and slab insulation shall meet or exceed 2015 IECC levels and achieve Grade 1 installation, per RESNET standards. See the guide 2015 IECC Code Level Insulation – DOE Zero Energy Ready Home Requirements for more details.

Exhibit 2 DOE Zero Energy Ready Home Target Home.

The U.S. Department of Energy’s Zero Energy Ready Home program allows builders to choose a prescriptive or performance path. The DOE Zero Energy Ready Home prescriptive path requires builders to meet or exceed the minimum HVAC efficiencies listed in Exhibit 2 of the National Program Requirements (Rev 07), as shown below. The DOE Zero Energy Ready Home performance path allows builders to select a custom combination of measures for each home that is equivalent in performance to the minimum HERS index of a modeled target home that meets the requirements of Exhibit 2 as well as the mandatory requirements of Zero Energy Ready Home Exhibit 1.

Exhibit 2, Insulation and Infiltration) Whole house leakage must be tested and meet the following infiltration limits:

- Zones 1-2: ≤ 3 ACH50;
- Zones 3-4: ≤ 2.5 ACH50;
- Zones 5-7: ≤ 2 ACH50;
- Zone 8: ≤ 1.5 ACH50;
- Attached dwellings: ≤ 3 ACH50.

Footnote 12) Building envelope assemblies, including exterior walls and unvented attic assemblies (where used), shall comply with the relevant vapor retarder provisions of the 2015 International Residential Code (IRC).

Footnote 23) Envelope leakage shall be determined by an approved verifier using a RESNET-approved testing protocol.

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.
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

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

2012 IECC

Exterior insulation for framed walls is in substantial contact and continuous alignment with the air barrier. Table R402.4.1.1 Air Barrier and Insulation Installation, 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 and 2018 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. Walls: Insulation in exterior framed walls is in substantial contact and continuous alignment with the air barrier. 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 (or RESNET/ICC 380 in 2018 IECC) and should have an air leakage rate of ≤ 5 in CZ 1 and 2 or ≤ 3 in CZ 3-8.


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

Table N1102.4.2 Air Barrier and Insulation Inspection Component Criteria, Air barrier and thermal barrier: Exterior wall insulation is installed in substantial contact and continuous alignment with the air barrier. Air permeable insulation is not used as a sealing material.

2012 IRC

Exterior insulation for framed walls is in substantial contact and continuous alignment with the air barrier. Table N1102.4.1.1 Air Barrier and Insulation Installation, 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 and 2018 IRC

N1102.4.1.1 Air Barrier and Insulation Installation. Walls: Insulation in exterior framed walls is in substantial contact and continuous alignment with the air barrier. 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 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.

National Electrical Code (NEC)

Article 394.1: If a home has knob and tub wiring, insulation should not be applied to touch or surround the wiring.

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>
<td>13</td>
<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>

\(^a\)2015 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.

\(^a\)2012 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.

An excerpt from the Equivalent U-factor Tables follows:

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

<table>
<thead>
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<th>Climate Zone</th>
<th>1</th>
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<th>4 Except Marine</th>
<th>5 and Marine 4</th>
<th>6</th>
<th>7, 8</th>
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<td>Wood Frame Wall U-factor</td>
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<td>0.045</td>
</tr>
</tbody>
</table>

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

<table>
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<tr>
<th>Climate Zone</th>
<th>1</th>
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<th>3</th>
<th>4 Except Marine</th>
<th>5 and Marine 4</th>
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<th>7, 8</th>
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<td>Wood Frame Wall U-factor</td>
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<td>0.057</td>
<td>0.057</td>
<td>0.048</td>
<td>0.048</td>
</tr>
</tbody>
</table>

An excerpt from the 2009 IECC/IRC Insulation and Fenestration Requirements by Component Table 402.1.1/N1102.1 follows:

<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>
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<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(^a)</td>
<td>R-20 or 13+5(^a)</td>
<td>R-21</td>
</tr>
</tbody>
</table>

\(^a\)“13+5” means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers <= 25% of the exterior, insulated sheathing is not required where structural sheathing is used. If structural sheathing covers > 25% of exterior, structural sheathing should be supplemented with insulated sheathing of at least R-2.

Air Sealing/Air Leakage Control

2015 IECC/IRC, R402.4.4/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.

- **2015 IRC/IECC, Air Barrier and Insulation Installation Table R402.4.1.1/N1102.4.1.1**
  - **Continuous air barrier.[2]** 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.

- **2015 IECC—International Energy Conservation Code**
  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
Publication Date: January 2009
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.

2009 IRC—International Residential Code for One- and Two-Family Dwellings
Author(s): ICC
Organization(s): ICC
Publication Date: January 2009
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.

Related Building America Solution Center Guides
Case Studies

1. **Existing Whole-House Solutions Case Study: Retrofitting a 1960s Split-Level Cold-Climate Home**
   
   **Publication Date:** September, 2015
   
   Case study on the retrofit of a 1960s split-level home.

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. **2015 IECC - International Energy Conservation Code**
   
   **Author(s):** International Code Council
   
   **Organization(s):** ICC
   
   **Publication Date:** May, 2014
   
   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.

6. **2015 IRC - International Residential Code for One and Two Family Dwellings**
   
   **Author(s):** International Code Council
   
   **Organization(s):** ICC
   
   **Publication Date:** May, 2014
   
   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.
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.

8. **2018 IRC - International Residential Code for One and Two Family Dwellings**
   - Author(s): International Code Council
   - Organization(s): ICC
   - Publication Date: August, 2017
   - 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): Johns Manville
   - Organization(s): Johns Manville
   - Publication Date: February, 2010
   - The purpose for this document is to provide basic guidance on the use of proven installation techniques that can be used by installers to help ensure correct “dense pack” application of JM Spider® in drill & fill applications.

10. **Retrofitting a 1960s Split-Level, Cold-Climate Home**
    - Author(s): Puttagunta
    - Organization(s): CARB, Steven Winter Associates, SWA
    - Report on air-sealing programs for energy-efficiency retrofits.

11. **Retrofitting the Southeast: The Cool Energy House**
    - Author(s): Zoeller, Shapiro, Vijayakumar, Puttagunta
    - Organization(s): CARB, Steven Winter Associates, SWA
    - Publication Date: February, 2013
    - Report about a deep energy retrofit Cool Energy House.

12. **Sidewall Blowing Tips and Tricks**
    - Author(s): Wisconsin Focus on Energy
    - Organization(s): Wisconsin Focus on Energy
    - Publication Date: March, 2003
    - High-density sidewall cavity insulation can be a major comfort and savings boost. It saves energy by slowing both conductive and convective losses, but only if the right things are done and done right. This always requires site-specific thinking.

    - Author(s): National Renewable Energy Laboratory
    - Organization(s): NREL
    - Publication Date: March, 2017
    - Standard Work Specification for dense packing blown insulation in existing homes.

*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.

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