Insulating and Air Sealing Existing Floors above Unconditioned Spaces

Last Updated: 12/15/2015

Scope

Insulate a floor over unconditioned space with conditioned space above (such as a cantilevered floor, the second floor overhang of a garrison colonial house, the underside of a projecting bay, the ceiling of an inset porch, or the ceiling of a vented crawlspace) by adding insulation and air sealing as follows:

- Inspect the overhanging floor framing to verify existing conditions and develop specific detailing for insulating the overhanging area.
- Provide four control layers that are continuous between the overhanging floor and wall assemblies: water, air, vapor, and thermal.
- Install insulation to levels that meet or exceed the thermal requirements of the current adopted building and energy codes.

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

Cantilevered floors and floors over unconditioned space in existing homes are frequently found to be uninsulated and not air sealed, causing cold (or hot) areas in the rooms above these floors. Configurations where these overhangs occur include the second-floor overhang of a garrison colonial style house, the underside of a projecting bay, the ceiling of an inset porch, or the ceiling of a vented crawlspace with conditioned space above. There are several methods for air sealing and insulating these types of building configurations. Regardless of which method is used, any seams in the “ceiling” of the cantilever framing cavities should be air sealed before the cavities are insulated and any open floor joist bays that extend from the cantilever into the home must be blocked with some solid blocking material such as rigid foam or plywood and air sealed at the edges. For more information about air sealing cantilevered floors see the guide Cantilevered Floor.

Rigid Insulation below Framing and Cavity Insulation, Finish Material to Underside of Overhang

Figure 1 shows an assembly that is typical for a porch ceiling under a second-story room or the overhang of the second floor of a garrison colonial style home. Any existing finishing material such as plywood is removed from the underside of the overhang framing to minimize the change in elevation of the overhang. The framing cavities are then filled with batt or blown fibrous insulation and rigid foam is attached to the bottoms of the framing joists. Seams in the rigid foam are sealed with tape and a new finish material is installed to cover the rigid foam. This finish material might be fiber cement or engineered wood siding or painted plywood or OSB.

Figure 1. Rigid Insulation is installed below the framing and cavity insulation of a building overhang or cantilever then covered with finish material.

Closed-Cell Spray Foam Insulation in Cavities and Encapsulating Framing

The approach shown in Figure 2 is typical under a first-floor bay or for a vented crawlspace with conditioned space above. The framing is encapsulated with spray foam to decouple the framing from the ground or crawlspace thermal and moisture conditions. The standoffs may be replaced with 2x2 furring if needed for attaching the protection layer (e.g., cement board).
How to Insulate an Overhanging Floor Above Unconditioned Space

1. Inspect the structural integrity of the overhanging floor. Check the framing for any deficiencies, rot, insect damage, etc. Proceed only after needed repairs are performed. Based on the findings, revise the floor assembly and review specific detailing as needed. Follow the minimum requirements of the current adopted building and energy codes.

2. Air seal the joist cavities of the overhanging floor. Block any open bay that extend into the home’s conditioned space, for example that connect to the space between the first and second floors. Use a solid blocking material to block the bays and air seal around edges as described in the guide Cantilevered Floor.

3. Install either loose-fill, batt, or spray foam insulation in the ceiling cavities, then install polyisocyanurate or XPS insulating sheathing to the underside of the framing. Tape the seams of the insulating sheathing to create a robust air control layer, as shown in Figure 1 and Figure 3. ALTERNATELY, install closed-cell spray foam insulation in the cavities and encapsulate the framing, as shown in Figure 2 and Figure 4.

4. Install a protective layer of cement board or plywood over the insulating sheathing. ALTERNATELY, apply intumescent coating or other thermal ignition barrier over spray foam if required by code. To protect the spray foam from rodents and/or birds, attach blocking to the existing framing and attach a protective layer of cement board or plywood as shown in Figure 5.

Figure 2. The ceiling over an unconditioned space is insulated with closed-cell spray foam that fills the ceiling cavities and encapsulates the framing.

Figure 3. Foil-faced polyisocyanurate insulating rigid foam sheathing is installed below the floor framing of this house built on piers.
Figure 4. Spray foam insulation air seals the underside of the flooring of a home built on piers. (Image courtesy of Building Science Corporation)

Figure 5. Application of intumescent coating/ protection layer. (Image courtesy of Building Science Corporation)
Ensuring Success

No information at this time.
Climate

The floor 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 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. (See Table R601.3.1 Class III Vapor Retarders of the 2009 IRC (ICC 2009a) and Table R702.7.1 Class III Vapor Retarders of the 2012 IRC (ICC 2009b). Additional insulation can be added above these minimums to create high R-Value floor assemblies. The table below provides the minimum thermal resistance (R-value) requirements for framed floors 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>Framed Floor Minimum R-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2009 IECC</td>
</tr>
<tr>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>4 except Marine</td>
<td>19</td>
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<td>5 and Marine 4</td>
<td>30</td>
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<tr>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>7 and 8</td>
<td>38</td>
</tr>
</tbody>
</table>

Table 1. Framed Floor R-Value Requirements in the 2009 and 2012 IECC
Training

Right and Wrong Images

Display Image: 2018-Addison-7-CrawlEntry.jpg
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)

ENERGY STAR Certified Homes requires that ceiling, wall, floor, and slab insulation levels meet or exceed those specified in the 2009 International Energy Conservation Code (IECC) with some alternatives and exceptions, and achieve Grade 1 installation per RESNET Standards (see 2009 and 2012 IECC Code Level Insulation – ENERGY STAR Requirements and Insulation Installation (RESNET Grade 1). 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.

Rater Design Review Checklist

3. High-Performance Insulation.
3.1 Specified ceiling, wall, floor, and slab insulation levels comply with one of the following options:
3.1.1 Meets or exceeds 2009 IECC levels OR;
3.1.2 Achieves \( \geq 133\% \) of the total UA resulting from the U-factors in 2009 IECC Table 402.1.3, per guidance in Footnote 4d, AND specified home infiltration does not exceed the following:
- 3 ACH50 in CZs 1, 2
- 2.5 ACH50 in CZs 3, 4
- 2 ACH50 in CZs 5, 6, 7
- 1.5 ACH50 in CZ 8

Footnote 4) Specified levels shall meet or exceed the component insulation levels in 2009 IECC Table 402.1.1. The following exceptions apply:
a. Steel-frame ceilings, walls, and floors shall meet the insulation levels of 2009 IECC Table 402.2.5. In CZ 1 and 2, the continuous insulation requirements in this table shall be permitted to be reduced to R-3 for steel-frame wall assemblies with studs spaced at 24 in. on center. This exception shall not apply if the alternative calculations in d) are used;
b. For ceilings with attic spaces, R-30 shall satisfy the requirement for R-38 and R-38 shall satisfy the requirement for R-49 wherever the full height of uncompressed insulation at the lower R-value extends over the wall top plate at the eaves. This exemption shall not apply if the alternative calculations in d) are used;
c. For ceilings without attic spaces, R-30 shall satisfy the requirement for any required value above R-30 if the design of the roof / ceiling assembly does not provide sufficient space for the required insulation value. This exemption shall be limited to 500 sq. ft. or 20% of the total insulated ceiling area, whichever is less. This exemption shall not apply if the alternative calculations in d) are used;
d. An alternative equivalent U-factor or total UA calculation may also be used to demonstrate compliance, as follows: An assembly with a U-factor equal or less than specified in 2009 IECC Table 402.1.3 complies. A total building thermal envelope UA that is less than or equal to the total UA resulting from the U-factors in Table 402.1.3 also complies. The performance of all components (i.e., ceilings, walls, floors, slabs, and fenestration) can be traded off using the UA approach. Note that Items 3.1 through 3.3 of the National Rater Field Checklist shall be met regardless of the UA tradeoffs calculated. The UA calculation shall be done using a method consistent with the ASHRAE Handbook of Fundamentals and shall include the thermal bridging effects of framing materials. The calculation for a steel-frame envelope assembly shall use the ASHRAE zone method or a method providing equivalent results, and not a series-parallel path calculation method.

Rater Field Checklist

1. High-Performance Fenestration & Insulation
1.3 All insulation achieves Grade 1 install. per ANSI / RESNET / ICC Std. 301. Alternatives in Footnote 4.

2. Fully-Aligned Air Barriers
2.6 Floors above garages, floors above unconditioned basements or crawlspaces, and cantilevered floors.

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)

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 performing retrofits on existing homes are welcome to seek certification for those homes through this voluntary program.

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 2, 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 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 International Energy Conservation Code (IECC)
Section R402 Building Thermal Envelope.
Table R402.1.1 Insulation and Fenestration Requirements by Component.
Section R402.2.6 Floors.
Section R402.4 Air leakage (Mandatory).
Section R402.4.1 Building thermal envelope.

2012, 2015, and 2018 IECC
Section 402 Building Thermal Envelope.
Table R402.1.1 (R402.1.2 in 2015 and 2018 IECC) Insulation and Fenestration Requirements by Component.
Section R402.2.7 (R402.2.8 in 2015 and 2018 IECC) Floors.
Section R402.4 Air leakage (Mandatory).
Section R402.4.1 Building thermal envelope.

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.)

Section R317 Protection of Wood and Wood Based Products Against Decay.
Section R317.1. Location Required.

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.
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. **New Whole-House Solutions Case Study: Project Home Again Phase I**
   - **Author(s):** BSC
   - **Organization(s):** BSC
   - **Publication Date:** February, 2009
   - Case study describing a building project in the hot-humid climate zone.

3. **New Whole-House Solutions Case Study: Project Home Again Phase II**
   - **Author(s):** BSC
   - **Organization(s):** BSC
   - **Publication Date:** January, 2010
   - Case study describing a building project in the hot-humid climate zone.

4. **Operation Helping Hands Green Dream 1 Home, New Orleans, Louisiana**
   - **Author(s):** BSC
   - **Organization(s):** BSC
   - **Publication Date:** April, 2009
   - Case study describing a building project in the hot-humid climate zone.

5. **Operation Helping Hands Green Dream 2 Prototype, New Orleans, Louisiana**
   - **Author(s):** BSC
   - **Organization(s):** BSC
   - **Publication Date:** July, 2010
   - Case study describing a building project in the hot-humid climate zone.

References and Resources*

1. **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](#)