Spray Foam Interior Insulation for Existing Foundation Walls

Last Updated: 12/14/2015

Scope

Insulate a foundation wall by adding spray foam insulation to the interior side as follows:

- Inspect the existing foundation wall for any deficiencies and make any necessary corrections including fixing any water intrusion or moisture issues in the basement, crawlspace or along the foundation wall, prior to commencing the retrofit work.
- Install closed-cell spray foam insulation along the inside of the foundation wall and sill beam to the minimum thermal levels specified in the current adopted building code.
- Apply thermal/ignition barrier as required by the current adopted building code.

For more on slab foundations, see the U.S. Department of Energy’s Standard Work Specifications.

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

In most existing houses, the basement or crawlspace walls are uninsulated. One method for insulating the walls is to cover the interior surface with spray foam.

Most homes have foundation walls made of concrete (cast concrete or concrete block) or constructed of irregular discrete pieces, such as fieldstone, brick, or rubble. The primary distinctions between these foundation types is the character of the surface of the wall – either a flat surface or an irregular surface – and the water permeability of the wall, which is quite high for walls built of irregular discrete pieces. The use of spray foam interior insulation is appropriate for either type.

Measures should be taken to protect foundation walls from bulk water (even if they are not being insulated). If the grade around the perimeter does not slope away from the house, make grading adjustments so that it slopes away at 5% grade for at least the first 3 feet and if possible, 10 feet. If gutters are installed, the downspouts must direct water away from the perimeter of the house and the gutter system must be regularly maintained to prevent overflowing, leaks, or breaks in the system because these can concentrate water along the building foundation. Another protective measure is to provide a trench of gravel around the perimeter that extends out at least as far as the roof drip edge. This helps disperse bulk water that comes from the roof so that the top of the foundation wall is not continually splashed. It is especially important to keep bulk water away from the exposed part of stone or brick foundation walls to reduce the impacts of freeze-thaw cycles.

If necessary, a perimeter drainage system can be installed around the building’s exterior or interior (see Figure 2). For additional guidance on foundation drainage and moisture management see the guides “Drain or Sump Pump Installed in Basements or Crawlspaces”, “Exterior Surface of Below-Grade Walls”, “Final Grade”, “Water Management of Existing Crawlspace Floor”

Before proceeding with the foundation wall retrofit, an assessment should be made of the condition of the sill plate or sill beam, which sits on top of the foundation wall. If there is no capillary break under the sill and/or if the sill is within 12 inches of the ground, it is possible that it has suffered water damage. If so, the damaged pieces should be replaced and at the same time, a capillary break should be installed under the new pieces. If there is no capillary break under the sill and/or the sill is within 12 inches of the ground, but there is no indication of damage, then it is likely that the sill has been able to dry. However, covering the sill, rim joist, and wall with spray foam will limit the ability of the sill to dry to the interior, so special treatment may be required at the base of the exterior wall. (See the guide “Flashing at Bottom of Exterior Walls” for additional information.)

It is recommended that the seams in the sill plate framing be caulked prior to insulating. For more guidance, see Sill Plates.

Figure 1. Closed-cell spray foam is used to retrofit an existing rubble basement foundation wall. The spray foam also insulates the sill beam, fills the floor joist cavity at the rim joist, and fills the base of the wall cavity because the wall is balloon framed.
Figure 2. Spray foam extends down the inside of the foundation wall to the uninsulated slab. Because the wall lacked exterior perimeter drainage, the slab was cut and an interior footing drain was installed.

Figure 3. Spray foam extends down the foundation wall to the slab, which has been retrofitted by adding dimple plastic drainage mat and rigid foam insulation.
Figure 4. Spray foam insulation extends down the foundation wall to the slab, which has been retrofitted by cutting the slab to install drainage mat against the wall and a new perimeter footing drain, along with rigid foam plastic above the slab.

How to Install Spray Foam Insulation at Foundation Wall

1. Inspect the existing foundation wall for any deficiencies. Make any necessary repairs prior to beginning the retrofit work. For stone or brick walls, take measures to protect the exposed part of the foundation wall from bulk water if necessary, such as grading the soil surface away from the structure, installing gutters and downspouts, and installing a footing drain.

2. Install closed-cell spray foam insulation at the foundation wall to at least the minimum levels specified in the local building code. Extend the spray foam over the sill beam. If the house has balloon framing, use spray foam insulation to fill the base of the wall cavity above the top of the foundation to air seal it to the back side of the existing wall sheathing, as shown in Figure 1.

3. Apply a spray-on thermal/ignition barrier as required by the local code.

ALTERNATELY, build a perimeter stud wall on the interior side of the spray foam. Don’t insulate the stud wall. Cover it with non-paper-faced gypsum board as the thermal/ignition barrier on the interior side. If metal studs are used for the interior wall, do not insulate it unless the metal studs are placed at least 1 inch to the interior side of the foundation wall insulation.
Ensuring Success

Provide a continuous layer of spray foam insulation extending from the base of the wall cavity above down to the basement slab.

Manage bulk and capillary water prior to the insulation/air seal retrofit.

Provide a thermal/ignition barrier as required by the current adopted building code.
Climate

The basement 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 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 basement wall assemblies. The table below provides the minimum thermal resistance (R-value) requirements for basement 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>2009 IECC</th>
<th>2012 IECC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3 except Marine</td>
<td>5/13**</td>
<td>5/13**</td>
</tr>
<tr>
<td>4 and Marine 4</td>
<td>10/13</td>
<td>10/19</td>
</tr>
<tr>
<td>5 and Marine 4</td>
<td>15/19</td>
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<tr>
<td>7 and 8</td>
<td>15/19</td>
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* The first value is cavity insulation, the 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% 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 R-Value Requirements for Slab Insulation in the 2009 and 2012 IECC
Training

Right and Wrong Images

Display Image: TE7233_SprayFoamFoundation-1R_BSC_02-20-2012.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. Some states have adopted the 2012 or 2015 IECC. Visit the U.S. DOE Building Energy Codes Program to see what code has been adopted in each state.

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 levels4, 5, 6 OR;
3.1.2 Achieves ≥ 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:5, 6
- 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

4. Air Sealing (Unless otherwise noted below, “sealed” indicates the use of caulk, foam, or equivalent material).
4.3 Above-grade sill plates adjacent to conditioned space sealed to foundation or sub-floor. Gasket also placed beneath above-grade sill plate if resting atop concrete / masonry & adjacent to conditioned space.5, 6

Water Management System Builder Requirements

1.8 Drain tile installed at basement and crawlspace walls, with the top of the drain tile pipe below the bottom of the concrete slab or crawlspace floor. Drain tile surrounded with ? 6 in. of ½ to ¾ in. washed or clean gravel and with gravel layer fully wrapped with fabric cloth. Drain tile level or sloped to discharge to outside grade (daylight) or to a sump pump. If drain tile is on interior side of footing, then channel provided through footing to exterior side.5

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 conducting retrofits are welcome to seek certification for existing 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.
Exhibit 1, Item 6) Certified under EPA Indoor airPLUS.

EPA Indoor airPLUS (Revision 04)

1.4 Basement and Crawlspace Insulation and Conditioned Air.
- Seal crawlspace and basement perimeter walls to prevent outside air infiltration.
- Insulate crawlspace and basement perimeter walls according to the prescriptive values determined by local code or R-5, whichever is greater.
- Provide conditioned air at a rate not less than 1 cfm per 50 sq. ft. of horizontal floor area. This can be achieved by a dedicated supply (2015 IRC section R408.3.2.2) or through crawlspace exhaust (2015 IRC section R408.3.2.1). However, if radon-resistant features are required (see Specification 2.1), do not use the crawlspace exhaust method.

See Indoor airPLUS Specifications for exceptions.

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 402.2.7 Basement walls
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 R402.2.8 Basement walls
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 R402.2.9 Basement walls
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 R401.3 Drainage
Section R403.1.4.1 Frost protection
Section R403.1.6 Foundation anchorage
Section R403.3 Frost protected shallow foundations
Section R403.3.4 Termite damage
Section R404.1.4.2 Concrete foundation walls
Section R405 Foundation drainage
Section R406 Foundation waterproofing and dampproofing
Section N1101.4 Building thermal envelope insulation
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 N1102.2.7 Basement walls
Table N1102.4.2 Air barrier and insulation inspection

2012 IRC
Section R401.3 Drainage
Section R403.1.4.1 Frost protection
Section R403.1.6 Foundation anchorage
Section R403.3 Frost protected shallow foundations
Section R403.3.4 Termite damage
Section R404.1.4.2 Concrete foundation walls
Section R405 Foundation drainage
Section R406 Foundation waterproofing and dampproofing
Section N1101.12.1 (R303.1.1) Building thermal envelope insulation
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 N1102.2.8 (R402.2.8) Basement walls
Table N1102.4.1.1 (R402.4.1.1) Air barrier and insulation inspection

2015 and 2018 IRC
Section R401.3 Drainage
Section R403.1.4.1 Frost protection
Section R403.1.6 Foundation anchorage
Section R403.3 Frost protected shallow foundations
Section R403.3.4 Termite damage
Section R404.1.4.2 Concrete foundation walls
Section R405 Foundation drainage
Section R406 Foundation waterproofing and dampproofing
Section N1101.12.1 (R303.1.1) Building thermal envelope insulation
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 N1102.2.8 (R402.2.8) Basement walls
Table N1102.4.1.1 (R402.4.1.1) Air barrier and insulation inspection

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.
More Info.

Access to some references 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.

Case Studies

   Author(s): CARB
   Organization(s): CARB
   Publication Date: November, 2013
   Case study describing a gut rehab of a multifamily, masonry building.

2. Existing Whole-House Solutions Case Study: Conway Street Apartments - Greenfield, Massachusetts
   Author(s): CARB
   Organization(s): CARB
   Publication Date: December, 2014
   Case study about a deep energy retrofit, turning an old school into 12 high-end apartments in Greenfield, MA.

3. Existing Whole-House Solutions Case Study: Multifamily Individual Heating and Ventilation Systems, Lawrence, Massachusetts
   Author(s): BSC
   Organization(s): BSC
   Publication Date: November, 2013
   Case study about a multifamily retrofit project using individual heat recovery ventilators in 10 separate building units.

   Author(s): BSC
   Organization(s): BSC
   Publication Date: March, 2010
   Case study describing a retrofit project in the cold and very-cold climate zones.

References and Resources*

   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.

**Author(s):** International Code Council  
**Organization(s):** ICC  
**Publication Date:** November, 2017  
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):** 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](#)