Advanced Framing: Insulated Interior/Exterior Wall Intersections

Last Updated: 03/14/2016

Scope

Construct framed walls using advanced framing details like framing aligned at interior/exterior wall intersections to reduce thermal bridging and allow more space for insulation.

- Allow room for insulation at interior-exterior wall intersections by installing ladder blocking, a full-length 2x6 or 1x6 nailer behind the first partition stud, or connecting the interior partition stud to the exterior top plate using a flat metal connector plate and using drywall clips to attach drywall.
- Fill exterior wall cavity space behind intersection with wall cavity insulation to full R value.

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 stud-framed walls, where interior walls meet exterior walls, builders will typically use a conventional T-post detail. They will install two studs on the exterior wall, either touching each other or a few inches apart, at the location where the interior wall touches the exterior wall. The 2x4 stud at the end of the interior wall section is attached to these studs. If a few inches of space is left between these two exterior wall studs, insulation can be inserted in this space from outside before the exterior wall sheathing is installed; however, in practice the space rarely gets filled with insulation. This conventional framing method leaves uninsulated sections of exterior wall 3 to 6 inches in width everywhere an interior wall intersects an exterior wall.

Advanced framing techniques are described below that can be used to enable the installation of insulation along the exterior wall at the interior-exterior wall intersection.

These are some of several advanced wall framing techniques that can be employed by builders to increase energy savings by increasing insulation and reducing thermal bridging. Advanced framing also reduces costs by reducing lumber usage, materials waste, and labor time. See Minimum Wall Studs for more about advanced framing and for details on stud spacing and single top plates. Other advanced framing techniques are described in Insulated Corners, which explains how to construct corners with 2 studs instead of 3 studs to permit more insulation at the corners, Insulated Headers, which explains how and when to build open and insulated headers over windows and doors, and Minimal Framing at Doors/Windows for efficient framing around doors and windows.

Advanced framing techniques should be specified in the framer’s contract. Detailed framing elevations should be prepared after confirming permissibility in the local jurisdiction.

**Figure 1** - The conventional T-post framing detail prevents insulation from being installed on the exterior wall at the interior-exterior wall intersection.

**How to Install Advanced Framing at the Interior-Exterior Wall Intersections**

There are three options: ladder blocking, use of a support post, or use of a connector plate and drywall clips.

1. **Ladder Blocking**

   1. Install short sections of 2x4s horizontally between the studs on the exterior wall on each side of the interior-exterior wall intersection. Install them flush with the interior surface of the exterior wall studs at a spacing of 24 inches apart.
   2. Attach the 2x4 interior wall to these blocking pieces.
   3. Install insulation behind the blocking.

**ADVANCED FRAMING**

![Diagram showing advanced framing technique](image-url)
2. Support Post

1. Install a 1x6 or 2x6 support post on the exterior wall at the interior wall location, flush with the interior face of the wall. Attach it to the top plate and bottom plate.

2. Attach the interior 2x4 wall to it.

3. Insulate behind the post.
3. Connector Plate and Drywall Clips.

1. Attach the interior 2x4 wall to the exterior wall top plate with a flat metal connector plate. Toenail the interior stud directly to the bottom plate.

**Figure 5** - Interior wall post support detail, side view.
2. Attach dry wall clips to the end stud of the interior wall to support drywall.

3. Insulate behind the post.

**Figure 6** - Connector plate and dry wall clips.

**Figure 7** - Interior wall attached with top plate metal connector, drywall clips support drywall, plan view.
Figure 8 - Interior wall attached with top plate metal connector, drywall clips support drywall, side view.
Ensuring Success

Advanced framing details should be specified in the construction plans and reviewed with framers. The construction supervisor should ensure that framing crews are knowledgeable of or trained in advanced framing techniques. The framing should be visually inspected by the site supervisor before the drywall is installed.
Climate

No climate specific information applies.
Training

Right and Wrong Images

Display Image: ES_TESRC_4.4.5d_PG118_221d_102811_0.jpg
Ladder Intersection with exterior wall for added insulation
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.
3. Reduced Thermal Bridging.
3.4.3d Interior / exterior wall intersections insulated to same R-value as rest of exterior wall.\(^{24}\)

Footnote 24) Insulation shall run behind interior / exterior wall intersections using ladder blocking, full length 2x6 or 1x6 furring behind the first partition stud, drywall clips, or other equivalent alternative.

Please see the [ENERGY STAR Certified Homes Implementation Timeline](#) for the program version and revision currently applicable in 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 2, Item 2) Ceiling, wall, floor, and slab insulation shall meet or exceed 2015 IECC levels and achieve Grade 1 installation, per RESNET standards.

**2009, 2012, 2015, and 2018 IECC**

Advanced framing is not specifically addressed in the IECC.

**Insulated Interior Exterior Wall Intersections – Code Compliance Brief**

**Overview:**

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

The junction of interior and exterior walls can be tricky to insulate with all the necessary framing, but this junction must be insulated in a way that avoids thermal bridges in the exterior wall. All interior/exterior wall intersections should be insulated to the same R-value as the rest of the exterior wall. Install insulation should run continuously behind interior/exterior wall intersections. Use one of the methods listed below or an equivalent assembly:

- Ladder blocking
- Full-length 2 x 6 or 1 x 6 nailer behind the first partition stud.
- UA Alternative

**Plan Review:**

Per the [2015 IECC/IRC, Section R103.3/R106.3, Examination of Documents](#). The code official/building official must examine or cause to be examined construction documents for code compliance. This section lists the applicable code requirements followed by details helpful for plan review regarding the provisions to meet the requirement for insulating interior/exterior wall intersections.

**Construction Documentation.** Review the construction documents to identify that the insulation of interior/exterior wall intersections is shown.

- 2015 IECC/IRC, Section R103.2/N1101.5 Information on construction documents. Construction documents should include:
- Details of the wall compliance approach taken
- Insulation materials and their R-values or U-factor
- Window and skylight U-factor (if using the UA tradeoff approach)
- Details of the insulation at the intersection of interior and exterior walls indicating use of advanced framing techniques.

The 2009, 2012, and 2015 IECC/IRC do not specifically address advanced framing. However, all three versions of the IECC allow wall compliance to be demonstrated by three prescriptive approaches: 1) R-value computation, 2) U-factor alternative, or 3) total UA alternative. The implication is that the interior/exterior wall intersection must be addressed in one way or another.

There is a way to demonstrate compliance for walls that does not use advanced framing. This is the UA alternative. To use the UA alternative, the area of wall that is not insulated to the full R-value must be calculated and treated as a separate wall with its own area and an increased U-factor. The impact of the increased U-factor for this intersection (and any other thermal bridge in the structure such as a standard corner) must be made up by reducing the U-factor or one or more other building envelope components. For example, the builder might choose to use windows with a lower U-factor or a ceiling with a lower U-factor than required to tradeoff against the areas of the wall that are not fully insulated.

Note that only the UA alternative specifically mentions "thermal bridging." This is because both the R-value and U-factor assume that the minimum R-value or maximum U-factor is achieved for the entire wall assembly. To achieve that minimum R-value or maximum U-factor for the wall in the vicinity of the interior/exterior wall intersection, advanced framing techniques must be used. Standard T-post framing does not achieve the minimum R-value or maximum U-factor. Two techniques that can help achieve the minimum R-value or maximum U-factor are ladder blocking and the use of a full-length 2 x 6 or 1 x 6 nailer behind the first partition stud. In both cases, the structural support needed at the intersection is maintained, while the cavity available for insulation installation is greatly enlarged over the stud.

**2015 IECC/IRC, Section R402.1.2/N1102.1.2 Insulation and Fenestration Criteria.** The building thermal envelope should meet the requirements of Table R402.1.2/N1102.1.2, based on the climate zone specified in Chapter 3.

**2015 IECC/IRC, Section R402.1.3/N1102.1.3 R-Value Computation.** Insulation material used in layers, such as framing cavity insulation, or continuous insulation should be summed to compute the corresponding component R-value. The manufacturer’s settled R-value should be used for blown insulation. Computed R-values should not include an R-value for other building materials or air films. 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.

Excerpt from the Insulation and Fenestration Requirements by Component

**Table R402.1.2/N1101.1.2 (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>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Frame</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>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>

\(^{a}\) 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.

**2015 IECC/IRC, Section R402.1.4/N1102.1.4 U-Factor Alternative.** An assembly with a U-factor equal to or less than that specified in Table R402.1.4/N1102.1.4 should be permitted as an alternative to the R-value in Table R402.1.2/N1102.1.2.

Excerpt from the Insulation and Fenestration Requirements by Component

**Table R402.1.4/N1101.1.4 (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>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Frame U-factor</td>
<td>0.084</td>
<td>0.084</td>
<td>0.060</td>
<td>0.060</td>
<td>0.060</td>
<td>0.045</td>
<td>0.045</td>
</tr>
</tbody>
</table>

**2015 IECC/IRC, Section R402.1.5/N1102.1.5 Total UA Alternative.** If the total building thermal envelope\(^{2}\) UA (sum of U-factor times assembly area) is less than or equal to the total UA resulting from using the U-factors in Table R402.1.4/N1102.1.4 (multiplied by the same assembly area as in the proposed building), the building should be considered in compliance with Table R402.1.2/N1102.1.2. The UA calculation should be done using a method consistent with the ASHRAE\(^{3}\) Handbook of Fundamentals and should include the thermal bridging effects of framing materials. The SHGC requirements must be met in addition to UA compliance.

The general equation for calculating heat flow through building envelope components is

\[
U_0 = \left[ U_1 \times \text{Area}_1 + U_2 \times \text{Area}_2 + \ldots \right] / \left[ \text{Area}_1 + \text{Area}_2 + \ldots \right]
\]

where the subscripts identify different series of materials that present a different path of heat transfer; e.g., \(\text{Area}_1\) is the area between the framing and \(\text{Area}_2\) is the area of the framing. The U-factor is the inverse of the sum of all the material R
values for each path of heat transfer and includes the insulating value of surface air films. Equation (A.1) is sufficiently accurate unless any of the construction material is highly conductive (e.g., steel framing).

As an example, for envelope components with wood frame construction, Equation (A.1) becomes (A.2)

$$U_o = \frac{\text{Area}_{\text{STUDS}} / \sum R_{\text{FRAME PATH}} + \text{Area}_{\text{INSULATION}} / \sum R_{\text{INSULATION PATH}}}{\text{Area}_{\text{STUDS}} + \text{Area}_{\text{INSULATION}}}$$

Per ANSI/ASHRAE/IES Standard 90.1-2010, Normative Appendix A, Rated R-value of Insulation and Assembly U-factor, C-factor, and F-factor Determinations

A3.4 Wood-framed Walls, A3.4.1 General

The base assembly is a wall where the insulation is installed between 2 inch nominal wood framing. Cavity insulation is full depth, but values are taken from Table A9.4C for R-19 insulation, which is compressed when installed in a 5.5 inches cavity. Headers are double 2 inches nominal wood framing. The U-factors include R-0.17 for exterior air film, R-0.08 for stucco, R-0.56 for 0.625 inches gypsum board on the exterior, R-0.56 for 0.625 inches gypsum board on the interior, and R-0.68 for interior air film, vertical surfaces. Additional assemblies include continuous insulation, uncompressed and uninterrupted by framing. U-factors are provided for the following configurations:

Standard framing: wood framing at 16 inches on center with cavities filled with 14.5 inches wide insulation for both 3.5 inches deep and 5.5 inches deep wall cavities. Double headers leave no cavity. Weighting factors are 75% insulated cavity, 21% studs, plates, and sills, and 4% headers.

Advanced framing: wood framing at 24 inches on center with cavities filled with 22.5 inches wide insulation for both 3.5 inches deep and 5.5 inches deep wall cavities. Double headers leave uninsulated cavities. Weighting factors are 78% insulated cavity, 18% studs, plates, and sills, and 4% headers.

Advanced framing with insulated headers: wood framing at 24 inch on center with cavities filled with 22.5 inch wide insulation for both 3.5 inch deep and 5.5 inch deep wall cavities. Double header cavities are insulated. Weighting factors are 78% insulated cavity, 18% studs, plates and sills, and 4% headers.

Air Sealing/Air Leakage Control. The building thermal envelope should be constructed to limit air leakage.

— 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 that include the wall intersections. Exterior thermal envelope insulation for framed walls should be in substantial contact and continuous alignment with the air barrier.

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1"Thermal Bridging" is defined as when a more conductive (or poorly insulating) material allows an easier pathway for heat transfer across a thermal barrier.

2"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.


4"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. 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, the wording is somewhat different in that for on-site construction, from time to time 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 of interior/exterior wall intersections where one or more specific type 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.

- Ensure that the appearance of insulation of the interior/exterior wall in the field matches what is on the approved construction documents.
• Ensure that the advanced framing techniques identified in approved construction documents matches what was installed in the field.

• If R-value or U-factor approach for wall 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 wall and climate zone per the approved construction documents.

• If the UA tradeoff approach for wall compliance was used in the documentation, ensure that the areas and U-factors associated with the interior/exterior wall intersection match the areas and insulation levels used on the approved construction documents. Also check that the areas and U-factors associated with whatever envelope component was improved to make up for the thermal bridge at the interior/exterior wall intersection.

• Joints, seams, holes, and penetrations are caulked, gasketed, weather-stripped, or otherwise sealed.

• Continuous air barrier is properly installed. Confirm the insulation for framed walls is installed in substantial contact and continuous alignment with the air barrier.

• Corners and headers are insulated and the junction of the foundation and sill plate is sealed. The junction of the top plate and top of exterior walls are sealed.

**Technical Validation(s):**

This section provides additional related information and references to materials that are applicable to the provision.


Case Studies

1. Technology Solutions Case Study: Preventing Thermal Bypass
   (2MB)
   Author(s): PNNL
   Organization(s): PNNL
   Publication Date: October, 2012
   Case study detailing techniques used to prevent thermal bypass in new homes.

References and Resources*

1. Advanced Wall Framing
   Author(s): NAHB, Southface Energy Institute, Oak Ridge National Laboratory, National Renewable Energy Laboratory
   Organization(s): NAHB, Southface Energy Institute, Oak Ridge National Laboratory, National Renewable Energy Laboratory
   Publication Date: January, 2002
   Information sheet about advanced wall framing.

2. Building America Special Research Project- Deployment of Advanced Framing at the Community Scale
   Author(s): Lstiburek, Grin
   Organization(s): Building Science Corporation
   Publication Date: November, 2010
   Report investigating implementation of advanced framing in both production and prototype built homes built in a variety of climate regions across the USA.

   Author(s): Grin
   Organization(s): Building Science Corporation
   Publication Date: February, 2011
   Presentation about advanced framing techniques.

4. Building Science Insights: Advanced Framing
   Author(s): Lstiburek
   Organization(s): Building Science Corporation
   Publication Date: February, 2010
   Report detaining advanced framing techniques, including discussion of cost and energy savings.

5. DOE Zero Energy Ready Home National Program Requirements (Rev. 07)
   Author(s): U.S. Department of Energy
   Organization(s): DOE
   Publication Date: May, 2019
   Standard requirements for DOE's Zero Energy Ready Home national program certification.

6. ENERGY STAR Certified Homes, Version 3/3.1 (Rev. 09) National Program Requirements
   Author(s): U.S. Environmental Protection Agency
   Organization(s): EPA
   Publication Date: September, 2018
   Webpage with links to documents providing the program requirements and checklists for ENERGY STAR Certified Homes (Ver. 3/3.1, Rev. 09).

*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

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