Attic Eave Minimum Insulation

Last Updated: 03/14/2016

Scope

Design the roof with raised heel trusses to allow full insulation over the top plates of the exterior walls.

Design the roof to allow full insulation over the top plates of the exterior walls.

- Install raised heel trusses or use another roof framing method that allows space to install insulation over the top plates of the exterior walls, or install high-density insulation, to achieve an R-value that meets or exceeds code minimums for attic insulation.
- ENERGY STAR requires ? R-21 in climates zones 1 through 5 and ? R-30 in climates zones 6-8. The insulation must extend to the inside face of the exterior wall and be installed using Grade 1 insulation techniques (**ENERGY STAR 2015**).

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 vented attics, insulation is laid on the ceiling deck of the top floor of the home. Maintaining the insulation level throughout the entire plane of the ceiling and over the top of the perimeter walls is key to preventing heat flow through the ceiling and into or out of the home. When the roof pitch is low at the eaves, insulation may be compressed or lacking, causing cold spots in winter along exterior walls and possibly contributing to ice dam formation in snowy climates. This can be true of roofs built with pre-made trusses and roof rafters constructed on site.

Figure 1 - Standard roof trusses are narrow at the eaves, preventing full insulation coverage over the top plate of the exterior walls.

Figure 2 - Standard site-built roof rafters may pinch the insulation at the eaves.

Builders and architects have several options for designing pitched, vented roofs that allow the insulation to achieve its full thickness over the plate line of the exterior walls: elevating the heel (sometimes referred to as an energy truss, raised-heel truss, or Arkansas truss), use of cantilevered or oversized trusses, lowering the ceiling joists, or framing with a raised rafter plate (BECP 2011). For a truss roof, raised heel energy trusses or oversized (cantilevered) trusses that form elevated overhangs, in combination with rafter baffles and soffit dams, will provide clearance for both full-height insulation and ventilation.

In stick-built roofs where rafters and ceiling joists are cut and installed at the construction site, laying an additional top plate across the top of the ceiling joists at the eave will raise the roof height, prevent compression of the attic insulation, and permit ventilation. When installing a raised top plate, place a band joist at the open joist cavities of the roof framing. The band joist also serves as a soffit dam, helping to prevent wind washing of the attic insulation (where air entering the soffit vents flows through the attic insulation, which can reduce attic insulation R-values on extremely cold days or add moisture to the insulation) (**Southface and ORNL 2000**, **Straube and Grin 2010**).

With a cathedral ceiling, a vaulted parallel chord truss roof can be constructed. Cathedral ceilings must provide space between the roof deck and ceiling for adequate insulation and ventilation. The 2009 IECC requires at least R-30 in areas where the roof-ceiling design doesn't allow for more. Insulation levels of R-30 or higher can be achieved through the use of truss joists, scissor truss framing, or sufficiently large rafters. For example, cathedral ceilings built with 2x12 rafters have space for standard 10-inch, R-30 batts and ventilation.

The designer should specify energy trusses or other constructions that will allow full height construction and baffles on building plans. These designs will be implemented by the framer. The insulation contractor should install the insulation correctly to full depth and install rulers. This task should be included in the contract for the appropriate trade, depending on the workflow at a specific job site.

See the "compliance" tab for 2009 IECC-specified wall insulation levels. Some building scientists note that fully vented, pitched attic assemblies can be the lowest cost, highest R-value, and most durable roofs in all climates zones (except perhaps IECC Zone 1 and Zone 2 with high coastal humidity), as long as no major sources of potential air leakage (e.g., HVAC ducts or recessed light fixtures) are present in the ceiling plane. Given the low cost, high insulation levels (R-60 to R-100) are affordable and economically justified in Zones 5 through 8 and the only change required to meet these high levels, other than an airtight ceiling, is to construct raised heel trusses or rafter designs to accommodate the increased amount of insulation (**Straube and Grin 2010**).

How to Construct a Roof with Full Insulation at the Eaves

1. Order and install oversized or raised heel trusses (Figure 3), or install site-built rafters with raised top plates (Figure 4). Specify 2- to 2½-foot overhangs, which are higher, providing more room for insulation at the top plate and additional window shading.
2. Install baffles and soffit dams at each rafter bay to provide a clear path for ventilation air above the insulation and to prevent insulation from falling into the soffit vents.

   Figure 3 - Raised heel energy trusses extend further past the wall and are deeper at the wall, allowing room for full insulation coverage over the top plate of the exterior walls.

   Figure 4 - A site-built rafter roof with a raised top plate allows for more insulation underneath.
3. For cathedral roofs, specify and install parallel chord trusses (Figure 5).

Figure 5 - In cathedral ceilings, parallel chord trusses allow thicker insulation levels over the exterior wall top plates.

4. Install attic rulers to show that blown insulation is installed to the proper depth. (The rules should be installed with numbering facing the attic entrance; one ruler for every 300 ft^2).
5. Fill the attic with blown, spray foam, or batt insulation to at least the required minimum insulation level. Blown or spray foam insulation should cover the tops of the ceiling joists. Batts should completely fill the joist cavities; an additional layer of batts can be layed over top of and running perpendicular to the joists. Shake batts to ensure proper loft. If joist spacing is uneven, fill any gaps with scrap pieces of insulation. Cut slits in batt nsulation to fit around wiring, plumbing, or ductwork without compressions.

Ensuring Success

The quality of the insulation installation should be visually inspected by the site supervisor. It may be possible to detect heat loss at the tops of exterior walls with an infrared camera if a sufficient temperature difference exists between the outside and the conditioned space of the house. Attic rulers should be installed upright from the ceiling deck and facing the attic entrance, one ruler for every 300 ft^2 including at the eaves, to make it easier for the inspector to confirm that proper insulation depth has been achieved.

Climate

Install insulation in amounts that meet or exceed code-required levels for your climate zone. See for example Table R402.1.1 in the International Energy Conservation Code (**2009 IECC**, **2012 IECC** or Table R402.1.2 in the **2015 IECC**).

ENERGY STAR Certified Homes

ENERGY STAR Certified Homes (Ver. 3/3.1 Ver 08) Rater Field Checklist, 3. Reduced Thermal Bridging. For insulated ceilings with attic space above (i.e., non-cathedralized), Grade I insulation extends to the inside face of the exterior wall below and is ? R-21 in CZ 1-5; ? R-30 in CZ 6-8.

DOE Zero Energy Ready Home

DOE Zero Energy Ready Home (Rev 05) Exhibit 1: Envelope: Ceiling, wall, floor, and slab insulation shall meet or exceed 2012 or 2015 IECC levels.

International Energy Conservation Code (IECC) Climate Regions

Training

Right and Wrong Images

Display Image: ES_TESRC_4.1_PG88_148b_102811_0.jpg

Reference: Thermal Enclosure System Rater Checklist Guidebook

Author(s): EPA
Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

Display Image: ES_TESRC_4.1_PG88_148b_102811_0.jpg

Reference: Thermal Enclosure System Rater Checklist Guidebook

Author(s): EPA
Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

Display Image: ES_TESRC_4.1_PG88_149c_102811_1.jpg

Reference: Thermal Enclosure System Rater Checklist Guidebook

Author(s): EPA
Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

Display Image: ES_TESRC_4.1_PG88_149c_102811_1.jpg

Reference: Thermal Enclosure System Rater Checklist Guidebook

Author(s): EPA
Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

Display Image: ES_TESRC_4.1_PG88_149c_102811_1.jpg

Reference: Thermal Enclosure System Rater Checklist Guidebook

Author(s): EPA
Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

Display Image: ES_TESRC_4.1_PG88_149c_102811_1.jpg

Reference: Thermal Enclosure System Rater Checklist Guidebook

Author(s): EPA
Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

Display Image: [ES_TESRC_4.1_PG88_150d_102811_0.jpg]

Reference: [Thermal Enclosure System Rater Checklist Guidebook]

Author(s): EPA
Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

Display Image: [ES_TESRC_4.1_PG88_150d_102811_0.jpg]

Reference: [Thermal Enclosure System Rater Checklist Guidebook]

Author(s): EPA
Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

Display Image: ES_TESRC_4.1_PG88_151e_102811_0.jpg

Reference: Thermal Enclosure System Rater Checklist Guidebook

Author(s): EPA
Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

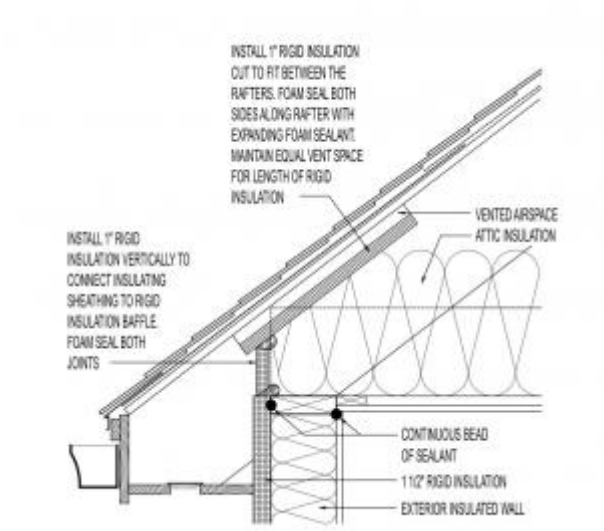
Display Image: ES_TESRC_4.1_PG88_151e_102811_0.jpg

Reference: Thermal Enclosure System Rater Checklist Guidebook

Author(s): EPA
Organization(s): EPA

Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

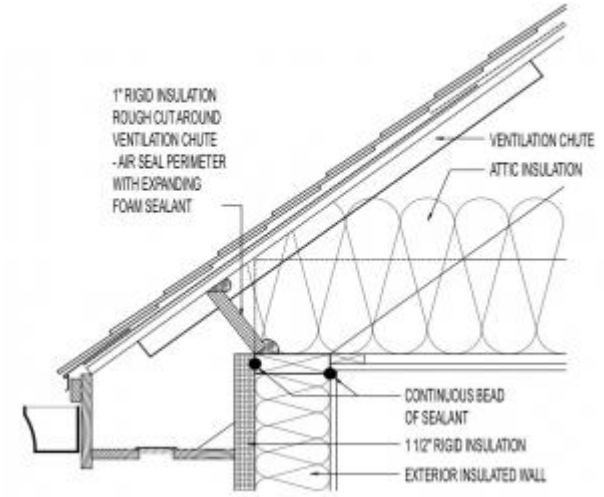
CAD



CAD FILE: 41_CAD_1-3_1-inch_exterior_foam_attic_eave_baffle_and_vent_5-01005_GBA_1-31-12.dwg
PDF: 41_CAD_1-3_1-inch_exterior_foam_attic_eave_baffle_and_vent_5-01005_GBA_1-31-12.pdf

Reference: Building Plans for Advanced Framing

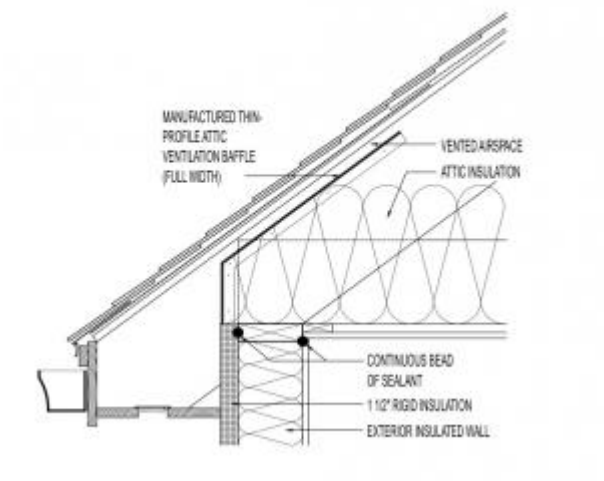
Author(s): Green Building Advisor
Organization(s): Green Building Advisor
Website providing CAD files and drawings of advanced framing details.



CAD FILE: 41_CAD_1-3_1-inch_rigid_foam_attic_baffle_around_manufactured_vent_5-01006_GBA_1-31-12.dwg
PDF: 41_CAD_1-3_1-inch_rigid_foam_attic_baffle_around_manufactured_vent_5-01006_GBA_1-31-12.pdf

Reference: Building Plans for Advanced Framing

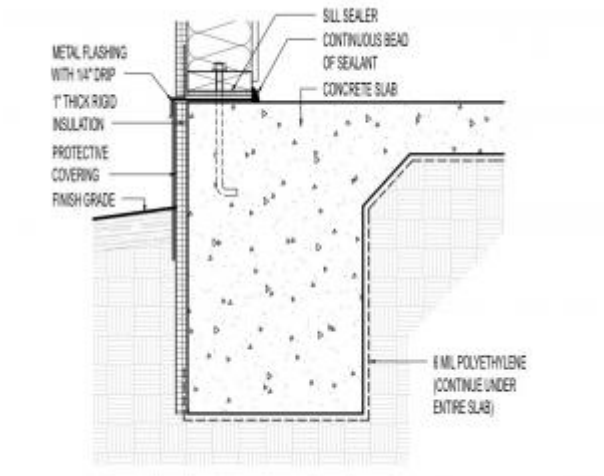
Author(s): Green Building Advisor
Organization(s): Green Building Advisor
Website providing CAD files and drawings of advanced framing details.



CAD FILE: 41_CAD_1-3_Thin_profile_attic_eave_baffle_vent_5-01004_GBA_1-31-12.dwg
PDF: 41_CAD_1-3_Thin_profile_attic_eave_baffle_vent_5-01004_GBA_1-31-12.pdf

Reference: Building Plans for Advanced Framing

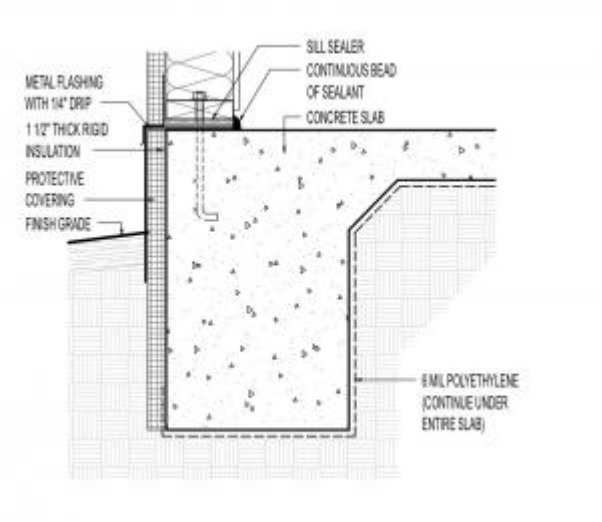
Author(s): Green Building Advisor
Organization(s): Green Building Advisor
Website providing CAD files and drawings of advanced framing details.



CAD FILE: 41_CAD_slab_1-inch_rigid_foam_1-00002_GBA_1-31-12.dwg
PDF: 42_CAD_slab_1-inch_rigid_foam_1-00002_GBA_1-31-12.pdf

Reference: Building Plans for Advanced Framing

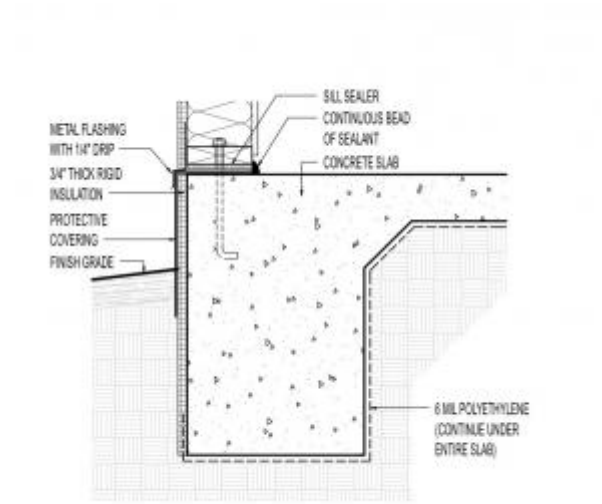
Author(s): Green Building Advisor
Organization(s): Green Building Advisor
Website providing CAD files and drawings of advanced framing details.



CAD FILE: 42_CAD_1-4_slab_1-1-2-inch_rigid_foam_5-01003_GBA_1-31-12.dwg
PDF: 42_CAD_1-4_slab_1-1-2-inch_rigid_foam_1-00004_GBA_1-31-12.pdf

Reference: Building Plans for Advanced Framing

Author(s): Green Building Advisor
Organization(s): Green Building Advisor
Website providing CAD files and drawings of advanced framing details.



CAD FILE: 42_CAD_1-4_slab_w_3-4-inch_rigid_foam_1-00001_1-31-12.dwg
PDF: 42_CAD_1-4_slab_w_3-4-inch_rigid_foam_1-00001_1-31-12.pdf

Reference: Building Plans for Advanced Framing

Author(s): Green Building Advisor
Organization(s): Green Building Advisor
Website providing CAD files and drawings of advanced framing details.

Compliance

The Compliance tab contains both program and code information. Exact code language is copyrighted and 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

ENERGY STAR Certified Homes (Version 3/3.1, Revision 08), Rater Field Checklist

Thermal Enclosure System:

3. Reduced Thermal Bridging

3.1 For insulated ceilings with attic space above (i.e., non-cathedralized), Grade I insulation extends to the inside face of the exterior wall below and is ? R-21 in CZ 1-5; ? R-30 in CZ 6-8[12]

Footnotes:

(12) The minimum designated R-values must be achieved regardless of the trade-offs determined using an equivalent U-factor or UA alternative calculation, with the following exception:
For homes permitted through 12/31/2012: CZ 1-5: For spaces that provide less than 5.5 in. of clearance, R-15 Grade I insulation is permitted. CZ 6-8: For spaces that provide less than 7.0 in. of clearance, R-21 Grade I insulation is permitted.
For homes permitted on or after 01/01/2013: Homes shall achieve Item 3.1 without exception.
Note that if the minimum designated values are used, then higher insulation values may be needed elsewhere to meet Item 1.2. Also, note that these requirements can be met by using any available strategy, such as a raised-heel truss, alternate framing that provides adequate space, and / or high-density insulation.

ENERGY STAR Revision 08 requirements are required for homes permitted starting 07/01/2016.

DOE Zero Energy Ready Home

DOE Zero Energy Ready Home (Rev 05) Exhibit 1: Envelope: Ceiling, wall, floor, and slab insulation shall meet or exceed 2012 or 2015 IECC levels, per RESNET standards. Compliance can be determined by meeting Zero Energy Ready Home requirements based on prescriptive insulation requirements, or U-factor alternatives. Steel-frame ceilings, walls, and floors shall meet the insulation requirements of the 2012 IECC – Table 402.2.6. 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.

2009 IECC

Table 402.1.1 lists ceiling R values by climate zone: CZ 1-3: R-30, CZ 4-5: R-38, CZ 6-8: R-49.
Section 402.2.1, Ceilings with attic spaces. R-30 will satisfy the requirement for R-38 insulation on the ceiling if the R-30 is uncompressed and extends over the top plates at the eaves. In the same way, R-38 suffices in climate zones requiring R-49 attic insulation.

2009 IRC

Table 1102.1.1 lists ceiling R values by climate zone: CZ 1-3: R-30, CZ 4-5: R-38, CZ 6-8: R-49.
Section 1102.2.1, Ceilings with attic spaces. R-30 will satisfy the requirement for R-38 insulation on the ceiling if the R-30 is uncompressed and extends over the top plates at the eaves. In the same way, R-38 suffices in climate zones requiring R-49 attic insulation.

2012 IECC

Table 402.1.1 lists ceiling R values by climate zone: CZ 1: R-30, CZ 2-3: R-38, CZ 4-8: R-49.
Section 402.2.1, Ceilings with attic spaces. R-30 will satisfy the requirement for R-38 insulation on the ceiling if the R-30 is uncompressed and extends over the top plates at the eaves. In the same way, R-38 suffices in climate zones requiring R-49 attic insulation

2012 IRC

Table 1102.1.1 lists ceiling R values by climate zone: CZ 1: R-30, CZ 2-3: R-38, CZ 4-8: R-49.
Section 1102.2.1, Ceilings with attic spaces. R-30 will satisfy the requirement for R-38 insulation on the ceiling if the R-30 is uncompressed and extends over the top plates at the eaves. In the same way, R-38 suffices in climate zones requiring R-49 attic insulation

2015 IECC

Table 402.1.1 lists ceiling R values by climate zone: CZ 1: R-30, CZ 2-3: R-38, CZ 4-8: R-49.
Section 402.2.1, Ceilings with attic spaces. R-30 will satisfy the requirement for R-38 insulation on the ceiling if the R-30 is uncompressed and extends over the top plates at the eaves. In the same way, R-38 suffices in climate zones requiring R-49 attic insulation.

2015 IRC

Table 1102.1.2 lists ceiling R values by climate zone: CZ 1: R-30, CZ 2-3: R-38, CZ 4-8: R-49.
Section 1102.2.1, Ceilings with attic spaces. R-30 will satisfy the requirement for R-38 insulation on the ceiling if the R-30 is uncompressed and extends over the top plates at the eaves. In the same way, R-38 suffices in climate zones requiring R-49 attic insulation.

*Due to copyright restrictions, exact code text is not provided. For specific code text, refer to the applicable code.

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

None Available

References and Resources*

1. **2009 IECC Air Barrier and Insulation Inspection Component Criteria**
   Author(s): Southface Energy Institute
   Organization(s): Southface Energy Institute
   Publication Date: January, 2009
   Document intended to help graphically demonstrate the air leakage provisions of section 402.4 of the 2009 IECC.

2. **Advanced Wall Framing**
   Author(s): NAHB, Southface Energy Institute, ORNL, NREL
   Organization(s): NAHB, Southface Energy Institute, ORNL, NREL
   Publication Date: January, 2002
   Information sheet about advanced wall framing.

3. **Attics & Roofs for Northern Residential Construction**
   Author(s): Seifert
   Organization(s): University of Alaska
   Publication Date: January, 2003
   Document describing approaches to energy efficiency and moisture considerations for roofs in northern climates.

4. **Ceilings and Attics**
   Author(s): Southface Energy Institute, ORNL
   Organization(s): Southface Energy Institute, ORNL
   Publication Date: February, 2000
   Information sheet with information about insulating and ventilating attics.

5. **DOE Zero Energy Ready Home National Program Requirements**
   Author(s): DOE
   Organization(s): DOE
   Publication Date: August, 2015
   Standard requirements for DOE's Zero Energy Ready Home national program certification.

6. **ENERGY STAR Certified Homes, Version 3 (Rev. 08) National Program Requirements**
   Author(s): EPA
   Organization(s): EPA
   Publication Date: September, 2015
   Document outlining the program requirements for ENERGY STAR Certified Homes, Version 3 (Rev. 08).

7. **Georgia State Supplements and Amendments to the International Energy Conservation Code**
   Author(s): Georgia Department of Community Affairs
   Organization(s): Georgia Department of Community Affairs
   Publication Date: January, 2011
   Georgia state's minimum standard energy code, including state supplements and amendments.

8. **High-R Roofs Case Study Analysis**
   Author(s): Straube, Grin
   Organization(s): BSC
   Publication Date: March, 2009
   Report that considers a number of promising wall systems that can meet the requirement for better thermal control.

9.

Raised Truss
Author(s): DOE
Organization(s): DOE
Publication Date: September, 2011
Information sheet with the definition and uses for a raised truss.

10. **Thermal Enclosure System Rater Checklist Guidebook**
Author(s): EPA
Organization(s): EPA
Publication Date: October, 2011
Guide describing details that serve as a visual reference for each of the line items in the Thermal Enclosure System Rater Checklist.

*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 Building America Teams contributed to the content in this Guide.

Pacific Northwest National Laboratory