Cathedral Ceiling Assemblies

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Pennsylvania Housing Research Center

- The Pennsylvania Housing Research Center (PHRC) provides and facilitates education, training, innovation, research, and dissemination to the residential construction industry for the purpose of improving the quality and affordability of housing.
- Educational programs and publications by the PHRC address a wide range of topics relevant to the home building industry and are designed to reach a diverse audience: builders, code officials, remodelers, architects, developers, engineers, planners, landscape architects, local government officials, educators, etc. to provide professional development and continuing education

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Program Description

Cathedral ceiling assemblies or ceilings without attics are not new concepts in residential designs. However, with the increased need for energy efficiency and tighter tolerance for moisture and air infiltration, the dedicated design for these assemblies cannot be overlooked. In this session, learn about prescriptive designs for ceilings without attic spaces and break down some of the critical details that may help achieve an energy-efficient assembly.

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Learning Objectives

- Understand what ceilings without attic spaces are per the definition in the 2018 IRC.
- Review 2018 IRC prescriptive designs for ceilings without attic spaces.
- Examine how the lack of attention to details can lead to increased risk in assemblies. Increased risk could include a reduced insulation rating or susceptibility to early decay of building materials.
- Review key details that can increase the longevity of ceilings without attic space assemblies, which can provide an energy-efficient assembly for the end user.

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Why Are You Here?

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Agenda

- What are the attic R-values in Pennsylvania?
- Take a look at how these R-values can change depending on the assembly
- Explain Cathedral Ceiling Assemblies and Ceilings without Attics?
- Walk through the prescriptive requirements
- Prescriptive designs
  - Vented
  - Unvented

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UCC Energy Code Summary

Chapter 11

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Residential Provisions

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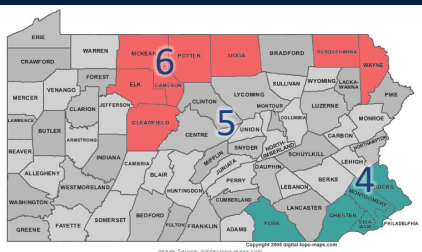
Climate Zones in PA



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2018 IRC Table N1102.1.2

Table N1102.1.2 (R402.1.2)
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT [a]

Climate Zone	Fenestration *U*-Factor	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[i]	MASS WALL *R*-VALUE	FLOOR *R*-VALUE	BAWSEMENT WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13 + 5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.32	0.55	0.40	49	20 or 13 + 5[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.30	0.55	NR	49	20 or 13 + 5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.30	0.55	NR	49	20 + 5[h] or 13 + 10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.30	0.55	NR	49	20 + 5[h] or 13 + 10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

Source: International Code Council (ICC), (2017). 2018 International Residential Code, Country Club Hill, IL

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Prescriptive Ceiling R-Value Insulation

- N1102.1.2
  - CZ 4, 5 & 6: R-49
- N1102.2.1 Ceilings with attic spaces
  - CZ 4, 5 & 6: Potential reduction to R-38
- N1102.2.2 Ceilings without attic spaces
  - CZ 4, 5 & 6: Potential reduction to R-30

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N1102.2 Specific Insulation Requirements

- In addition to the requirements of Section N1102.1, insulation shall meet the specific requirements of Sections N1102.2.1 through N1102.2.13.
  - N1102.2.1
  - N1102.2.2
  - N1102.2.3

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Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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N1102.2.1 Ceilings With Attic Spaces

- Where Section R1102.1.2 requires R-38 insulation in the ceiling, installing R-30 insulation over 100 percent of the ceiling area requiring insulation shall satisfy the requirement for R-38 insulation wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Where Section N1102.1.2 requires R-49 insulation in the ceiling, installing R-38 insulation over 100 percent of the ceiling area requiring insulation shall satisfy the requirement for R-49 insulation wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves.

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Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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What is an Attic?

- **2018 IRC Definition:**
  - The unfinished space between the ceiling assembly and the roof assembly.
- **2018 IRC Commentary also adds:**
  - An attic is the unfinished space between the ceiling joists of the top story and the roof rafters.

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Vented Ceiling Assemblies

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Vented vs. Unvented

- **Vented**
  - R806.1 – Ventilation Required
  - R806.2 – Minimum Vent Area (See Brian's Webinar - Attic Ventilation Understanding the Why)
  - R806.3 – Vent & Insulation Clearance
- Unvented
  - R806.5 – Unvented Attic & Unvented Enclosed Rafter Assemblies

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R806.1 Ventilation Required

- Enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters shall have cross ventilation for each separate space by ventilating openings protected against the entrance of rain or snow.

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Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Il.

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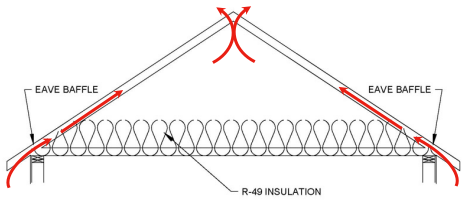
Ceilings With Attic Space



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R806.3 Vent and Insulation Clearance

- Where eave or cornice vents are installed, blocking, bridging and insulation shall not block the free flow of air. Not less than a 1-inch space shall be provided between the insulation and the roof sheathing and at the location of the vent.

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Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Il.

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N1102.2.3 – Eave Baffle

- For air-permeable insulations in vented attics, a baffle shall be installed adjacent to soffit and eave vents. Baffles shall maintain an opening equal or greater than the size of the vent. The baffle shall extend over the top of the attic insulation. The baffle shall be permitted to be any solid material.

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Eave Baffle Specifications

Dimensions

Cut-Out Width (in.)	22.5 in
Product Depth (in.)	1.5
Product Width (in.)	22.5

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Source: https://www.homedepot.com/p/Amerimax-Home-Products-Accuvent-22-5-in-x-1-5-in-Black-Soffit-Insulation-Baffle-ACCUVENT/202962730

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Eave Baffle Specifications

Dimensions

Product Depth (in.)	48 in	Product Height (in.)	2.5 in
Product Width (in.)	22.5 in		

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Source: https://www.homedepot.com/p/Owens-Corning-Raft-R-Mate-22-1-2-in-x-4-ft-Attic-Insulation-Ra…

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https://www.homedepot.com/services/c/attic-insulation-installation/2cfb8ae2be

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N1102.2.1 Ceilings With Attic Spaces

- Where Section R1102.1.2 requires R-38 insulation in the ceiling, installing R-30 insulation over 100 percent of the ceiling area requiring insulation shall satisfy the requirement for R-38 insulation wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Where Section N1102.1.2 requires R-49 insulation in the ceiling, installing R-38 insulation over 100 percent of the ceiling area requiring insulation shall satisfy the requirement for R-49 insulation wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves.

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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Compressed Insulation Values - NAIMA

Estimated R-values for Insulation Compressed into Framing Cavities

Nominal Lumber Size	Cavity Depth											
I Joist	14"	49										
I Joist	11 7/8"	44	38									
2x12	11 1/4"	42	37	30								
I Joist	9 1/2"		33	29								
2x10	9 1/4"		32	29	30	25						
2x8	7 1/4"			25	25	24						
2x6 (metal)	6"					21			19			
2x6	5 1/2"						21	20	18			
2x4 (metal)	4"						16	16	14			
2x4 (metal)	3 5/8"						15	15				
2x4	3 1/2"						15	14		15	13	11
2x3	2 1/2"									11	10	8.9
2x2 (metal)	1 5/8"											6.5
2x2	1 1/2"											6.1
Label R-Value		R-49	R-38	R-30		R-25	R-21	R-20	R-19	R-15	R-13	R-11
Label Thickness		14"	12"	10"	9 1/2"	8"	5 1/2"		6 1/4"	3 1/2"		

Source: https://insulationinstitute.org/wp-content/uploads/2016/08/Compressed_R_values.pdf

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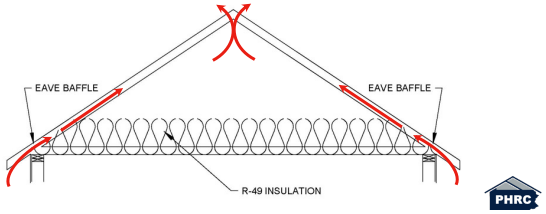
Ceilings With Attic Space



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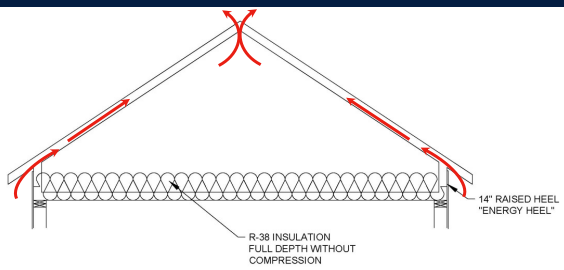
Ceilings With Attic Space



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N1102.2.2 Ceilings Without Attic Spaces

- Where Section N1102.2.1 requires insulation R-values greater than R-30 in the ceiling and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation R-value for such roof/ceiling assemblies shall be R-30. Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed. This reduction of insulation from the requirements of Section N1102.1.2 shall be limited to 500 square feet or 20 percent of the total insulated ceiling area, whichever is less.

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Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, IL

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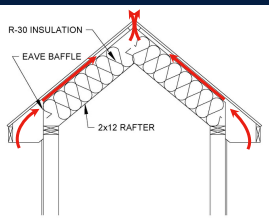
Cathedral Ceiling Assembly - Rafter

- 2x12 = 11.25”
- Eave baffle = 2.5”
- Insulation clearance = 8.75”



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Compressed Insulation Values - NAIMA

Estimated R-values for Insulation Compressed into Framing Cavities

Nominal Lumber Size	Cavity Depth											
I Joist	14”	49										
I Joist	11 7/8”	44	38									
2x12	11 1/4”	42	37	30								
I Joist	9 1/2”		33	29								
2x10	9 1/4”		32	29	30	25						
2x8	7 1/4”			25	25	24						
2x6 (metal)	6”					21			19			
2x6	5 1/2”						21	20	18			
2x4 (metal)	4”						16	16	14			
2x4 (metal)	3 5/8”						15	15				
2x4	3 1/2”						15	14		15	13	11
2x3	2 1/2”									11	10	8.9
2x2 (metal)	1 5/8”											6.5
2x2	1 1/2”											6.1
Label R-Value		R-49	R-38	R-30		R-25	R-21	R-20	R-19	R-15	R-13	R-11
Label Thickness		14”	12”	10”	9 1/2”	8”	5 1/2”		6 1/4”	3 1/2”		

Source: https://insulationinstitute.org/wp-content/uploads/2016/08/Compressed_R_values.pdf

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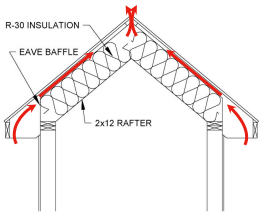
Cathedral Ceiling Assembly - Rafter

- 2x12 = 11.25”
- Eave baffle = 1.5”
- Insulation clearance = 9.75”
- 9.5” R-30 Insulation
- Eave baffle specification matters!



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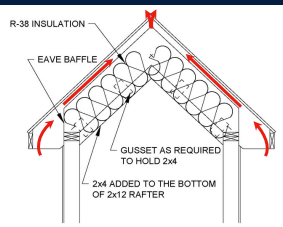
Cathedral Ceiling Assembly – Rafter & 2x4 Below Rafter

- 2x12 = 11.25”
- 2x4 = 3.5”
- Eave baffle = 2.5”
- Insulation clearance = 12.25”
- R-38 insulation = 12”



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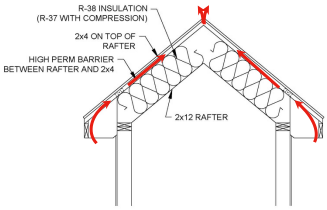
Cathedral Ceiling Assembly – Rafter & 2x4 Above Rafter

- 2x12 = 11.25”
- Insulation clearance = 11.25”
- R-38 insulation = 12”
- R-38 compressed to 11.25” = R-37



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Josh Salinger - Fine Homebuilding - https://www.youtube.com/watch?v=tA3h2Qb0F7s

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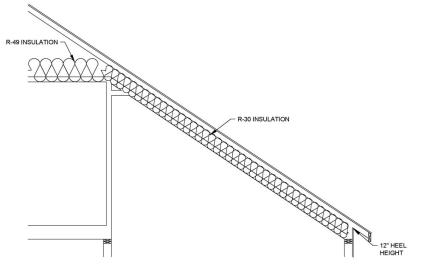
Trussed Alternatives



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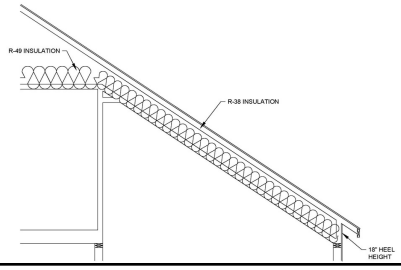
Trussed Alternatives



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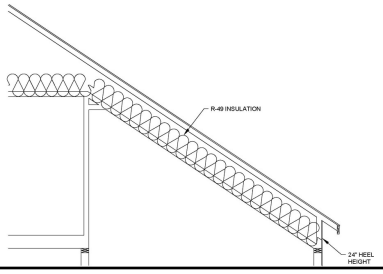
Trussed Alternatives



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Unvented Ceiling Assemblies

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Vented vs. Unvented

- Vented
  - R806.1 – Ventilation Required
  - R806.2 – Minimum Vent Area (See Brian's Webinar - Attic Ventilation Understanding the Why)
  - R806.3 – Vent & Insulation Clearance
- Unvented
  - R806.5 – Unvented Attic & Unvented Enclosed Rafter Assemblies

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R806.5 Unvented Attic and Unvented Enclosed Rafter Assemblies

- Unvented attics and unvented enclosed roof framing assemblies created by ceilings that are applied directly to the underside of the roof framing members and structural roof sheathing applied directly to the top of the roof framing members/rafters, shall be permitted where all the following conditions are met:

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, IL

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R806.5 Unvented Attic and Unvented Enclosed Rafter Assemblies – Cont.

1. The unvented attic space is completely within the building thermal envelope.
2. Interior Class I vapor retarders are not installed on the ceiling side (attic floor) of the unvented attic assembly or on the ceiling side of the unvented enclosed roof framing assembly.
3. Where wood shingles or shakes are used, a minimum 1/4-inch vented airspace separates the shingles or shakes and the roofing underlayment above the structural sheathing.
4. In Climate Zones 5, 6, 7 and 8, any air-impermeable insulation shall be a Class II vapor retarder, or shall have a Class II vapor retarder coating or covering in direct contact with the underside of the insulation.

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Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Il.

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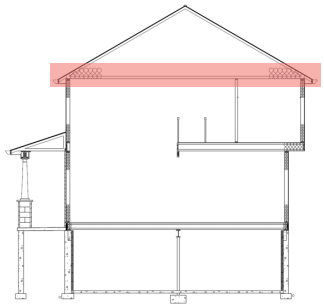

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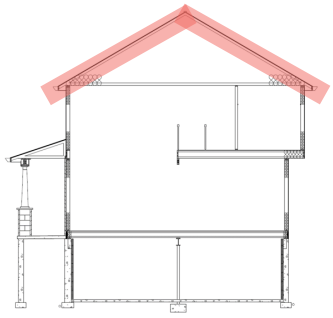

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Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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R806.5 Unvented Attic and Unvented Enclosed Rafter Assemblies – Cont.

5. Insulation shall comply with Item 5.3 and either Item 5.1 or 5.2:
   - 5.1. Item 5.1.1, 5.1.2, 5.1.3 or 5.1.4 shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing.
     - 5.1.1. Where only air-impermeable insulation is provided, it shall be applied in direct contact with the underside of the structural roof sheathing.
     - 5.1.2. Where air-permeable insulation is installed directly below the structural sheathing, rigid board or sheet insulation shall be installed directly above the structural roof sheathing in accordance with the R-values in Table R806.5 for condensation control.
     - 5.1.3. Where both air-impermeable and air-permeable insulation are provided, the air-impermeable insulation shall be applied in direct contact with the underside of the structural roof sheathing in accordance with Item 5.1.1 and shall be in accordance with the R-values in Table R806.5 for condensation control. The air-permeable insulation shall be installed directly under the air-impermeable insulation.
     - 5.1.4. Alternatively, sufficient rigid board or sheet insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) is assumed and the exterior air temperature is assumed to be the monthly average outside air temperature of the three coldest months.

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Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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R806.5 Unvented Attic and Unvented Enclosed Rafter Assemblies – Cont.

5. Insulation shall comply with Item 5.3 and either Item 5.1 or 5.2:
   - 5.2 In Climate Zones 1, 2 and 3, air-permeable insulation installed in unvented attics shall meet the following requirements:
     - 5.2.1 An approved vapor diffusion port shall be installed not more than 12 inches (305 mm) from the highest point of the roof, measured vertically from the highest point of the roof to the lower edge of the port.
     - 5.2.2 The port area shall be greater than or equal to 1:600 of the ceiling area. Where there are multiple ports in the attic, the sum of the port areas shall be greater than or equal to the area requirement.
     - 5.2.3 The vapor-permeable membrane in the vapor diffusion port shall have a vapor permeance rating of greater than or equal to 20 perms when tested in accordance with Procedure A of ASTM E96.
     - 5.2.4 The vapor diffusion port shall serve as an air barrier between the attic and the exterior of the building.
     - 5.2.5 The vapor diffusion port shall protect the attic against the entrance of rain and snow.
     - 5.2.6 Framing members and blocking shall not block the free flow of water vapor to the port. Not less than a 2-inch (51 mm) space shall be provided between any blocking and the roof sheathing. Air-permeable insulation shall be permitted within that space.
     - 5.2.7 The roof slope shall be greater than or equal to 3:12 (vertical/horizontal).
     - 5.2.8 Where only air-permeable insulation is used, it shall be installed directly below the structural roof sheathing.
     - 5.2.9 Air-impermeable insulation, if any, shall be directly above or below the structural roof sheathing and is not required to meet the R-value in Table 806.5. Where directly below the structural roof sheathing, there shall be no space between the air-impermeable insulation and air-permeable insulation.
     - 5.2.10 The air shall be supplied at a flow rate greater than or equal to 50 CFM (23.6 L/s) per 1,000 square feet (93 m2) of ceiling. The air shall be supplied from ductwork providing supply air to the occupiable space when the conditioning system is operating. Alternatively, the air shall be supplied by a supply fan when the conditioning system is operating.

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Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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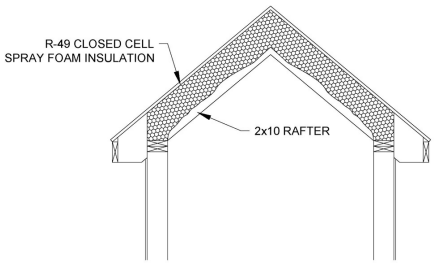
Following R806.5 Part 5.1.1



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Following R806.5 Part 5.1.1

5.Insulation shall comply with Item 5.3 and either Item 5.1 or 5.2:

- 5.1. Item 5.1.1, 5.1.2, 5.1.3 or 5.1.4 shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing.
  - 5.1.1. Where only air-impermeable insulation is provided, it shall be applied in direct contact with the underside of the structural roof sheathing.

4. In Climate Zones 5, 6, 7 and 8, any air-impermeable insulation shall be a Class II vapor retarder, or shall have a Class II vapor retarder coating or covering in direct contact with the underside of the insulation.

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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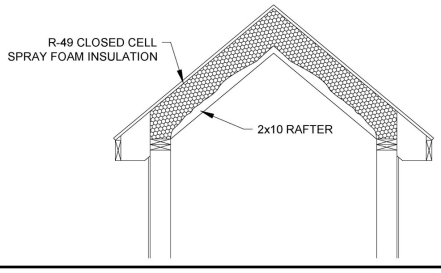
Following R806.5 Part 5.1.1



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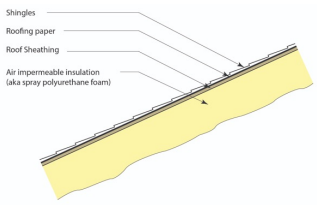
Why Closed Cell Foam?

- Unvented conditioned attics can be constructed by installing low density open cell or high density closed cell spray foam directly to the underside of the roof deck (Figure 5). Both foam types work in most climates. In IECC Climate Zones 5 and higher only high density closed cell spray foam should be used.



https://buildingscience.com/documents/guides-and-manuals/gm-2102-residential-spray-foam-guide#:~:text=Unvented%20conditioned%20attics%20can%20be,spray%20foam%20should%20be%20used.

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Photograph 8: Open Cell Spray Polyurethane Foam (ocSFP) - When you spray ocSPF into wall cavities from the interior the ocSPF can act as the air control layer and thermal control layer. It can't act as the vapor control layer – it is too vapor open. This is a problem when you spray ocSPF on the underside of roof/attic assemblies you can end up with problems ("Ping Pong Water").

https://buildingscience.com/documents/building-science-insights/bsi-126-dirty-harry-does-insulation

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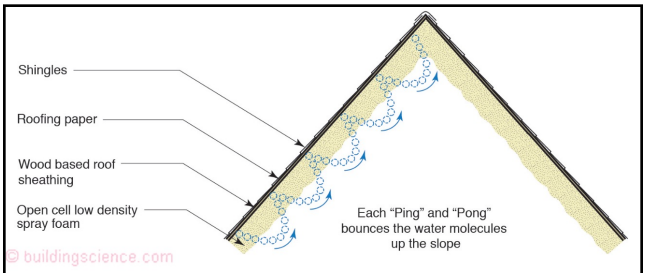

Figure 1: "Ping Pong Water" - Water vapor from the interior passes up through the ocSPF and is stored in the wood based roof sheathing – and then driven out by solar radiation. In and then out…in and then out…a "ping" followed by a "pong" leading to an increase in moisture accumulating at the ridge requiring a means of moisture removal….either air supply and return from the house or a dehumidifier.

https://buildingscience.com/documents/buildingscience-insights/bsi-126-dirty-harry-does-insulation

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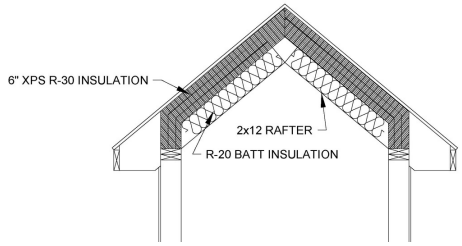
Following R806.5 Part 5.1.3



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Following R806.5 Part 5.1.3

5.Insulation shall comply with Item 5.3 and either Item 5.1 or 5.2:

- 5.1. Item 5.1.1, 5.1.2, 5.1.3 or 5.1.4 shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing.
  - 5.1.3. Where both air-impermeable and air-permeable insulation are provided, the air-impermeable insulation shall be applied in direct contact with the underside of the structural roof sheathing in accordance with Item 5.1.1 and shall be in accordance with the R-values in Table R806.5 for condensation control. The air-permeable insulation shall be installed directly under the air-impermeable insulation.
- 5.3. Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

Source: International Code Council (ICC), (2017). 2018 International Residential Code, Country Club Hill, Il.

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Table R806.5 Insulation for Condensation Control

TABLE R806.5 INSULATION FOR CONDENSATION CONTROL

CLIMATE ZONE	MINIMUM RIGID BOARD ON AIR-IMPERMEABLE INSULATION *R*-VALUE[a, b]
2B and 3B tile roof only	0 (none required)
1, 2A, 2B, 3A, 3B, 3C	R-5
4C	R-10
4A, 4B	R-15
5	R-20
6	R-25
7	R-30
8	R-35

a. Contributes to but does not supersede the requirements in Section N1102.

b. Alternatively, sufficient continuous insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) shall be assumed and the exterior air temperature is assumed to be the monthly average outside air temperature of the three coldest months.

Source: International Code Council (ICC), (2017). 2018 International Residential Code, Country Club Hill, Il.

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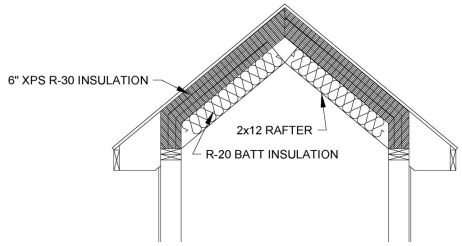
Following R806.5 Part 5.1.3



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Ceilings Without Attic Spaces – Limited Area

- Where Section N1102.2.1 requires insulation R-values greater than R-30 in the ceiling and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation R-value for such roof/ceiling assemblies shall be R-30. Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed. This reduction of insulation from the requirements of Section N1102.1.2 shall be limited to 500 square feet or 20 percent of the total insulated ceiling area, whichever is less.

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

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*2021 Pennsylvania Alternative Residential Energy Provisions

PA104 Entrance requirements. This compliance path allows for some reductions in energy efficiency that will allow simplified enforcement and construction. To utilize the PA Alternative Energy Provisions, the building owner or agent must choose at least one of the energy enhancement options in Table PA104.

Table PA104
Energy Enhancement Options

Option	Description		Minimum efficiency by climate zone		
			South (A)	Central (B)	North (E)
1	Ductless heat pumps[a]		8.5 HSPF and 15 SEER	10 HSPF and 15 SEER	10 HSPF and 15 SEER
2	All air ducts located inside the thermal envelope		Compliant	Compliant	Compliant
3	Geothermal or water source heat pump installed[a]		Compliant	Compliant	Compliant
4	Improved efficiency air source heat pump installed[a]		9.5 HSPF and 19 SEER	9.5 HSPF and 19 SEER	11 HSPF and 19 SEER
5	Improved efficiency condensing furnace installed[a]		92 AFUE	95 AFUE	95 AFUE
6	Exterior continuous insulation		R20+10	R20+10	R20+15
7	Improved efficiency windows		U-factor = 0.21	U-factor = 0.19	U-factor = 0.15
8	Package: Improved efficiency windows and higher attic R-value with raised heel truss[b]	Windows	U-factor = 0.25	U-factor = 0.21	U-factor = 0.19
		Attic	R-value = 60	R-value = 60	R-value = 60
9	Package: Improved efficiency windows and heat pump water heater	Windows	U-factor = 0.25	U-factor = 0.21	U-factor = 0.19
		Heat Pump Water Heater	Compliant	Compliant	Compliant

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*2021 Pennsylvania Alternative Residential Energy Provisions

Cathedral ceilings: R-30 insulation, for up to 75% of the total *living space* square footage area

PA302.2 Ceilings without attic spaces. Where the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, such as cathedral ceilings, the minimum required insulation for such roof/ceiling assemblies shall be R-30. Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed. This reduction of insulation from the requirements of Section PA301 shall be limited to 75% of the total *living space* square footage area.

2021 PA Alternative Residential Energy Provisions

- https://bit.ly/2021PA-Alt

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Summary

- Top chord depth needs to accommodate the full depth of R-30 insulation and eave baffle without compression.
- Specify the specific eave baffle that works for your situation

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Questions?

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Resources

- Building a Vaulted, High-Performance, and Foam-Free Roof Assembly - https://www.youtube.com/watch?v=fA3hZ0b0F7s
- GM-2102: Residential Spray Foam Guide (Building Science Corporation - https://buildingscience.com/documents/guides-and-manuals/gm-2102-residential-spray-foam-guide#:~:text=Unvented%20conditioned%20attics%20can%20be,spray%20foam%20should%20be%20used
- BSI-126: Dirty Harry Does Insulation - https://buildingscience.com/documents/building-science-insights/bsi-126-dirty-harry-does-insulation

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Cathedral Ceiling Assemblies

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