PENNBOC Conference September 19, 2024
Christopher Hine (PHRC)

Residential Enclosure Control Layers: Building Assemblies that Play Well Together

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- 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.
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Program Description

As the codes continue to evolve by increasing the energy efficiency of the total dwelling unit, attention to detail has never been more important. In today's session we will look at residential enclosure control layers and how they can the contribute to the performance and health of the foundation, floor, wall, and attic assemblies. This will include the management of air, moisture (bulk and water vapor) and thermal control layers. All control layers must play well together to ensure the overall health of the residential enclosure.

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Today's Goal

- New thermal envelope provisions are driving wall assemblies to be more energy efficient.
- Because of this, wall assemblies are less forgiving when moisture is introduced as vapor or in bulk form.
- We will look at how to reduce the risk of bulk water intrusion by discussing deflection and drainage.
- We will look at strategies and materials to allow drying through diffusion.

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Controlling Moisture in Wall Assemblies

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Common Control Layers in a Residential Exterior Wall Assembly

- Bulk water
- Air
- Water vapor
- Thermal

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Common Control Layers in a Residential Exterior Wall Assembly

- Bulk water
- Air
- Water vapor
- Thermal

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Items that can Inadvertently Introduce Moisture Stress to the Exterior Wall Assembly

- 3 ACH50
- Whole house mechanical ventilation
- Prescriptive provision for Class I or II Vapor Retarder
- Reservoir cladding
- Architectural designs

"For every action there is an equal and opposite reaction"

- Newton's Third Law

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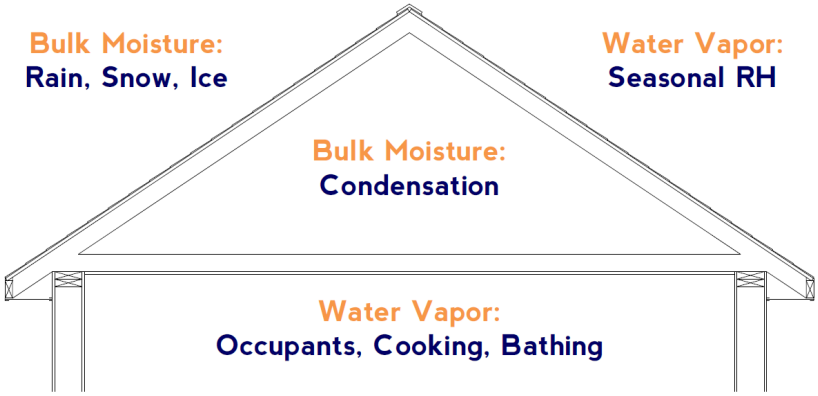
Where Does Moisture Come From?



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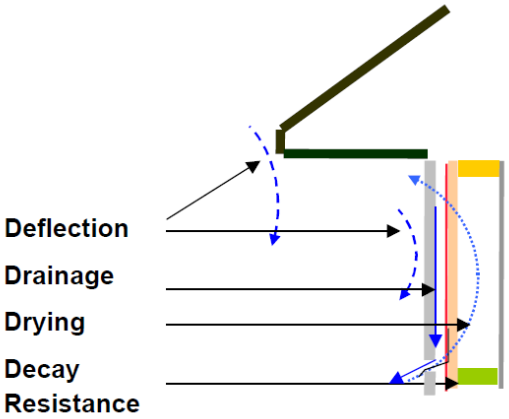
What are the 4 D's?

- First developed by D. Hazleden & P. Morris out of Canada



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Moisture Control Layer / Strategy: Deflection

- Deflection involves the prevention of as much precipitation as possible from hitting exterior walls (including foundations)
- Properly design enclosure elements can deflect up to 90% of precipitation
  - Source: Designing for Durable Wood Construction: The 4Ds

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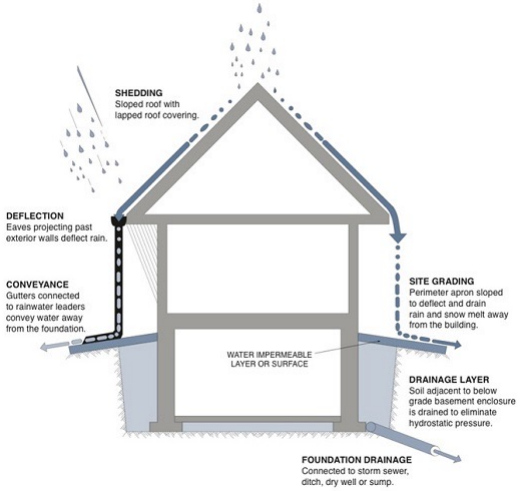
Deflection

- What is Deflection?



Source: Whole Building Design Guide – Moisture Management Strategies

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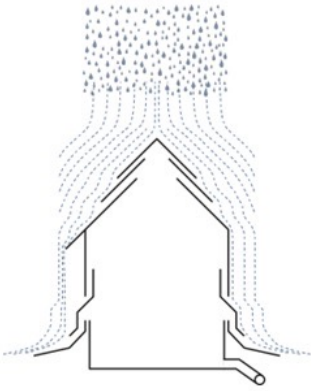
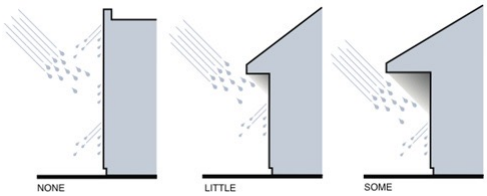
Roof Overhangs for Deflection

- Roof overhangs at eaves are a critical strategy for deflecting rain away from exterior walls and foundations below





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Source: Whole Building Design Guide – Moisture Management Strategies

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Protection of Openings

- Some penetrations in the enclosure are difficult to flash
  - Exterior doors
    - Entry doors
    - Patio doors
    - Garage doors
- Long-term exposure to the elements tends to rot the base of common trim materials at these openings

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Conclusions - Deflection

- Keys to Deflection
  - Roof shape
  - Roof overhangs
  - *Drip edges / caps*
  - *Kickout flashing*
  - *Gutters & downspouts*
  - *Site grading*

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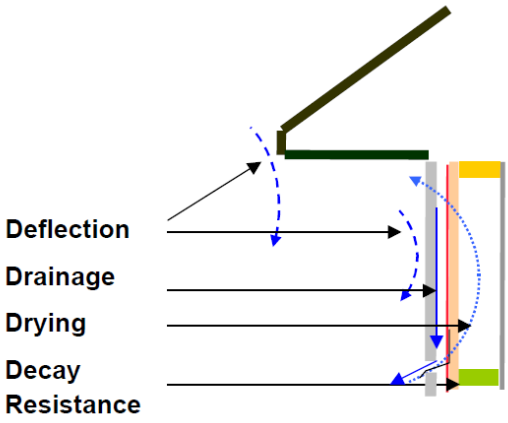
What are the 4 D's?



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Moisture Control Layer / Strategy: Drainage

- Drainage involves the shedding of any precipitation that may penetrate the exterior cladding
  - Water must be able to drain down and out (away) from enclosure
- Properly designed enclosure systems (flashing, WRB, etc.) can address most of the remaining 10% of precipitation present at the enclosure

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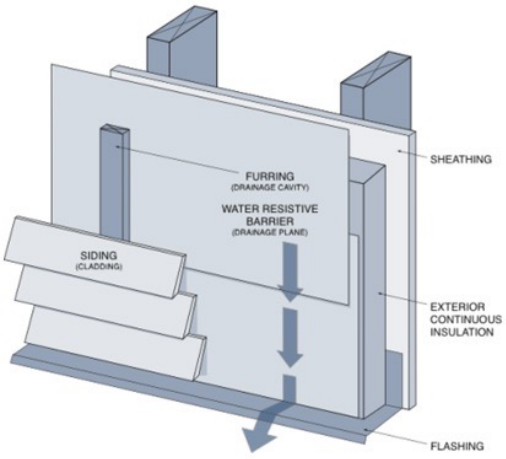
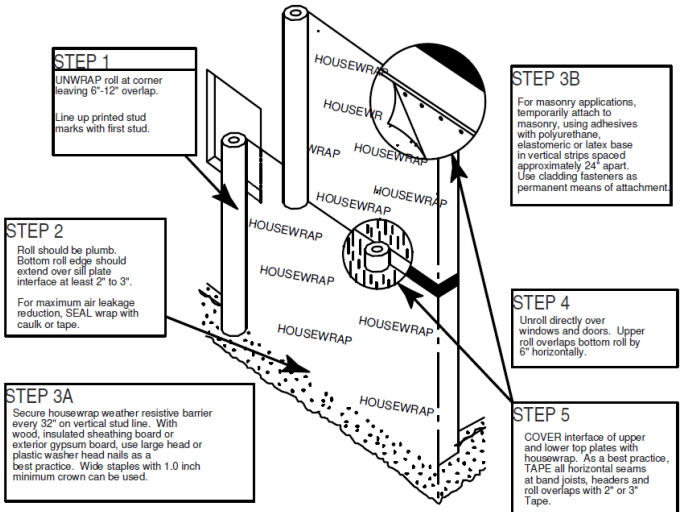
What is a Drainage Plane?

- Control layer in an exterior wall assembly that serves as the primary surface for bulk moisture to drain down to an exit point in the enclosure
  - Water-managed systems
- Water-resistive barrier (WRB)

How Does a WRB Function?



HOUSE WRAP - WALL APPLICATION



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WRB's with Enhanced Drainage

- Flat water-resistive barriers can have reduced ability to drain water when cladding is installed tight against the WRB
- Some WRB's have ridges or wrinkles to keep cladding off of the surface of the exterior wall to promote drainage of bulk moisture

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Types of Rainscreen Systems

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Hybrid Sheathing & WRB Systems

- Integrated structural, water resistant, and air barrier functions in a single panel
- Treated sheathing as a water resistant barrier
- Considerations are taping and flashing reverse shingle

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What is the Purpose of Flashing?

- Integrate penetrations through the drainage plane (WRB) into the WRB using compatible and durable materials in a specific sequence

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Critical Flashing Locations

- Windows
- Doors
- Utility Penetrations
- Changing in Cladding Material or Type
- Roof / Wall Intersection

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Utility Penetration Flashing

- All penetrations through the exterior wall assembly must be flashed properly
- Challenges
  - Sequence
  - Responsibility
  - Coordination of trades

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Control of Water Vapor in Diffusion

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Items that can Inadvertently Introduce Moisture Stress to the Exterior Wall Assembly

- 3 ACH50
- Whole house mechanical ventilation
- Prescriptive provision for Class I or II Vapor Retarder
- Reservoir cladding
- Architectural designs

"For every action there is an equal and opposite reaction"

- Newton's Third Law

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Typical Assembly Behavior

- Enclosure assemblies typically get wet through:
  - Convection
  - Bulk moisture penetration
- Enclosure assemblies typically dry though:
  - Diffusion
  - Evaporation

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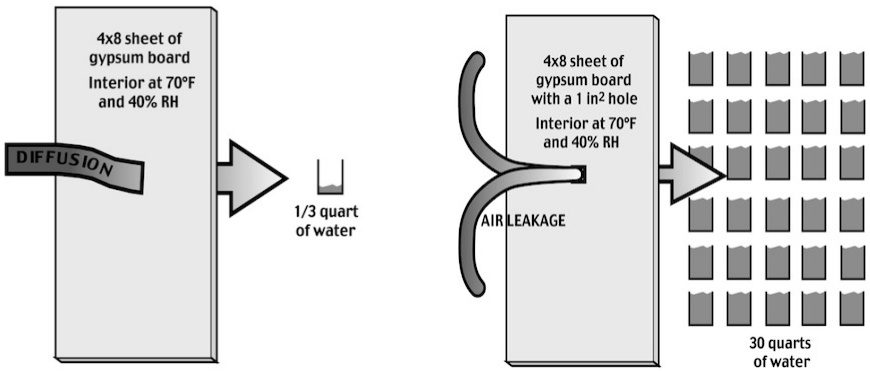
Diffusion vs. Convection



Source: Building Science Corporation.

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Moisture Control Layer / Strategy: Drying

- Drying is the result of properly designing enclosure assemblies to allow for intruding moisture to dry to the interior, exterior, or both by diffusion and evaporation

Water Vapor Flow

- Water vapor = water in gaseous state
- Key concepts related to water vapor:
  - Relative humidity
  - Dew point
  - Condensation

What is a Throttle?

- The material in a building enclosure assembly with the lowest vapor permeability
  - This material will limit the overall amount of water vapor that can travel through the enclosure via diffusion
  - Example: vapor retarders are throttles by design

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What is a Vapor Retarder?

- The element that is designed and installed in an assembly to retard the movement of water by vapor diffusion. (Building Science Corporation, *Understanding Vapor Barriers*)

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Vapor Retarders

- Keep it out and let it out if it gets in. (Building Science Corporation, *Understanding Vapor Barriers*)
- Air Control and Vapor Control can be the same material within the assembly, but often are not.

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Vapor Barriers & Retarders

- Material that limits the flow of vapor through diffusion
- Vapor retarders are NOT vapor barriers

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Vapor Retarder Classifications - IRC

- Class I Vapor Retarder:
  < 0.1 perm
- Class II Vapor Retarder:
  0.1 perm – 1.0 perm
- Class III Vapor Retarder:
  1.0 perm – 10.0 perm

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Vapor Permeability

- Vapor impermeable: < 0.1 perm
  - Foil facing, Rubber membrane
- Vapor semi-impermeable: 0.1 perm – 1.0 perm
  - Extruded polystyrene (XPS), Kraft paper
- Vapor semi-permeable: 1.0 perm – 10.0 perm
  - OSB, Drywall
- Vapor permeable: > 10 perms
  - Brick veneer

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Vapor Retarder Classification Examples

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What do you use as your required vapor retarder?

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What Class is it?

- Kraft faced fiberglass batt insulation

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What Class is it?

- Kraft faced fiberglass batt insulation
- 1 perm = Class II

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What Class is it?

- "Tyvek" house wrap

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What Class is it?

- "Tyvek" house wrap
- 54 perm = Vapor permeable / Vapor open

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What Class is it?

Source: Menards.com

- 1” of Johns Manville AP Foil-Faced polyisocyanurate continuous insulation

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What Class is it?

Source: Menards.com

- 1” of Johns Manville AP Foil-Faced polyisocyanurate continuous insulation
- 1” 0.05 perm = Class I

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What Class is it?

- 1” DuPont Styrofoam XPS Foam Insulation

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What Class is it?

- 1” DuPont Styrofoam XPS Foam Insulation
- 1” 1.5 perm = Class III

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Product Specifications Matter

- Not all rigid foam is the same
- Specify the type of foam specifically to include or exclude facings

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Drying Through Vapor Transmission and the 2018 IRC

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2018 IRC R702.7 – Vapor Retarders

- Class I or II vapor retarders are required on the interior side of frame walls in Climate Zones 5, 6, 7, 8 and Marine 4.
  - Exception:
    1. Basement walls
    2. Below-grade portions of any wall
    3. Construction where moisture or its freezing will not damage the materials

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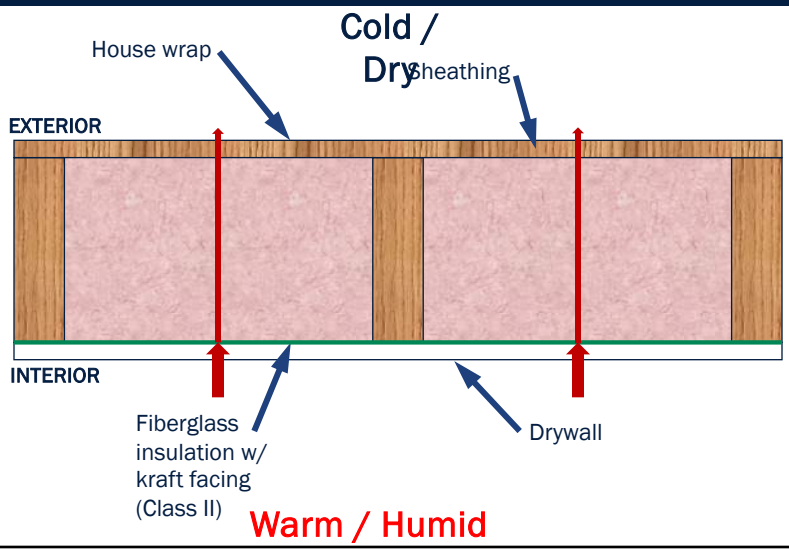
Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.

Vapor Drive in Winter



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Use of Class III Vapor Retarders

- R702.7.1 Class III vapor retarders shall be permitted where any one of the conditions in Table R702.7.1 is met.

TABLE R702.7.1 CLASS III VAPOR RETARDERS

CLIMATE ZONE	CLASS III VAPOR RETARDERS PERMITTED FOR:[a]
Marine 4	Vented cladding over wood structural panels. Vented cladding over fiberboard. Vented cladding over gypsum. Continuous insulation with *R*-value ≥ 2.5 over 2 × 4 wall. Continuous insulation with *R*-value ≥ 3.75 over 2 × 6 wall.
5	Vented cladding over wood structural panels. Vented cladding over fiberboard. Vented cladding over gypsum. Continuous insulation with *R*-value ≥ 5 over 2 × 4 wall. Continuous insulation with *R*-value ≥ 7.5 over 2 × 6 wall.
6	Vented cladding over fiberboard. Vented cladding over gypsum. Continuous insulation with *R*-value ≥ 7.5 over 2 × 4 wall. Continuous insulation with *R*-value ≥ 11.25 over 2 × 6 wall.
7 and 8	Continuous insulation with *R*-value ≥ 10 over 2 × 4 wall. Continuous insulation with *R*-value ≥ 15 over 2 × 6 wall.

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

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2018 IECC Table R402.1.2

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[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] 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	0.32	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

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

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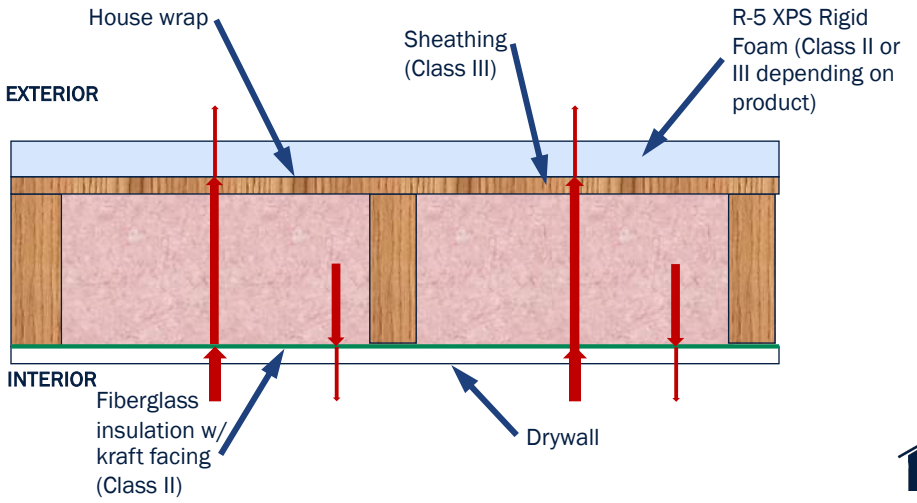
7 and 8	Continuous insulation with *R*-value ≥ 10 over 2 × 4 wall. Continuous insulation with *R*-value ≥ 15 over 2 × 6 wall.

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

2x6 Wall with 1" R-5 XPS



More Restrictive Throttle

- 1" Rigid XPS = 1.5 perm max/inch; Class III
- Kraft faced batt insulation = 1 perm; Class II
- House wrap = 11-54 perm; Vapor Open

Is this good?
Remember "Throttle"
Code Compliant?

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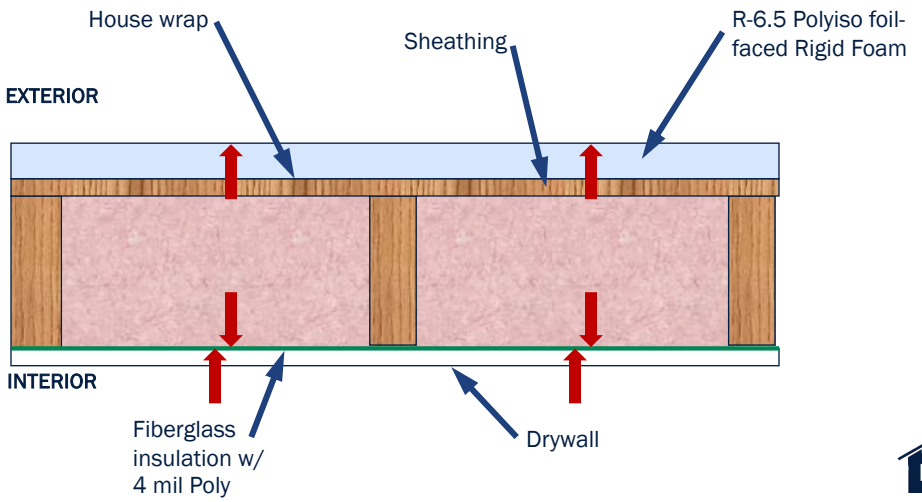
2x6 Wall with 1" R-6.5 Polyiso Exterior Foam



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More Restrictive Throttle

- 1" Rigid Polyiso Foil Faced = 0.05 perm max./inch; Class I
- Batt insulation w/ Poly = 0.04 perm; Class I
- House wrap = 11-54 perm; Vapor Open

Is this good?

Remember "Throttle"

CZ6 must be >R-11.25 to reduce vapor retarder to a Class III

Is this Code Compliant?

Can this be risky in a Temperate Climate?

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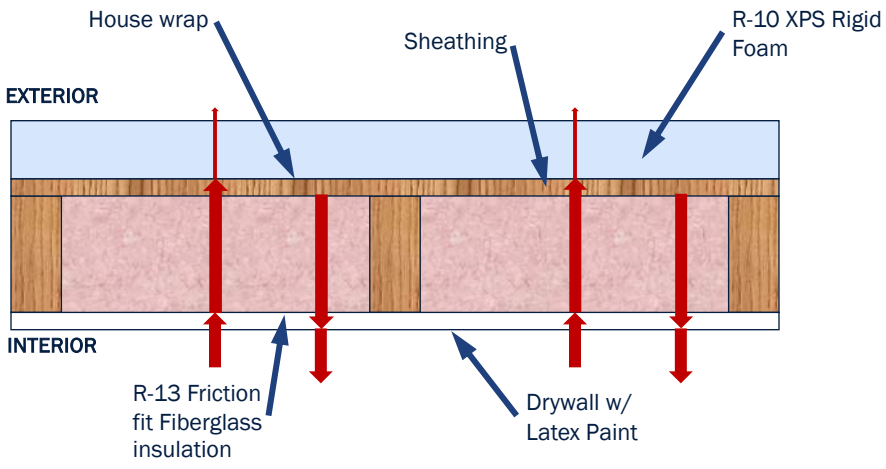
2x4 Wall with 2" R-10 XPS Exterior Foam



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Potential for Double Class II Vapor Retarder

- 2" R-10 Rigid XPS = .7 perm max./inch; Class II
- R-13 Friction Fit batt insulation = N/A
- Drywall with Latex Pain = 6 perm; Class III
- House wrap = 11-54 perm; Vapor Open

Is this good?

Remember "Throttle"

>1/3 (R-7.6) of the total insulation is on the exterior which can reduce the risk of condensation

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Summary

- Wall assemblies are now less tolerant of water in all forms
- Must manage bulk water
- Must manage water vapor through diffusion by choosing the correct materials
- Understand the moisture drive, the "throttle" and permeability to allow for drying
- Have a strategy and choose the materials that help achieve that strategy

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Questions?

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Air and Thermal Control Layers in Bonus Room Assemblies

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Why Are You Here?

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We Must Understand the Problem Before We Can Fix It.

- Before we can fix our thermal discomforts, we must first understand how heat moves.

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Building Science Principles

- Heat Flow, Moisture Flow & Air Flow
  - High pressure ⟶ low pressure
  - High concentration ⟶ low concentration

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Heat Flow

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Heat Flow

- From hot to cold (high concentration to low concentration)
- Summer - flow directed inward
- Winter - flow directed outward
- Through 3 Mechanisms
  - Conduction
  - Convection
  - Radiation

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Heat Flow Mechanisms – Conduction

- Conduction
  - Heat flow through a substance or material by direct contact
  - Conduction takes place within a single material or between materials in direct contact
- Where does conduction occur in a home?

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Image Source: https://www.shawneestructures.com/2018-garage-sheds/onsite-attic-28x35interior-1000.jpg.

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Heat Flow Mechanisms – Convection

- Convection
- Transfer of heat through air (for building enclosures)
- Where does convection occur in a home?

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Wind Washing of Air Permeable Insulation

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Heat Flow Mechanisms – Radiation

- Radiation
  - Transfer of heat through electromagnetic waves traveling in a gas or vacuum
- Where does radiation occur in a home?

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What is a Bonus Room?

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Bonus Room Explained

- Typically a room above a garage
- Can be completely over a garage or partially over a garage
- Room often gets built inside a truss. This truss is often referred to as a “Bonus Room” truss
- Due to the nature of this area, it is often difficult to thermally isolate and air seal

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Habitable Attic – R325.6

- A habitable attic shall not be considered a story where complying with all of the following requirements:
  1. The occupiable floor area is not less than 70 square feet in accordance with Section R304.
  2. The occupiable floor area has a ceiling height in accordance with Section R305.
  3. The occupiable space is enclosed by the roof assembly above, knee walls (if applicable) on the sides and the floor-ceiling assembly below.
  4. The floor of the occupiable space shall not extend beyond the exterior walls of the floor below.

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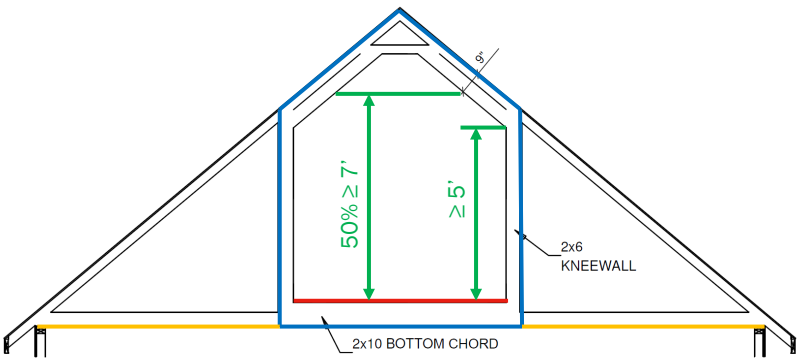
Bonus Room Truss

1. > 70 sq. ft.
2. Ceiling Height
3. The occupiable space is enclosed by the roof, knee walls, and floor-ceiling assembly
4. The floor of the occupiable space shall not extend beyond the exterior walls of the floor below



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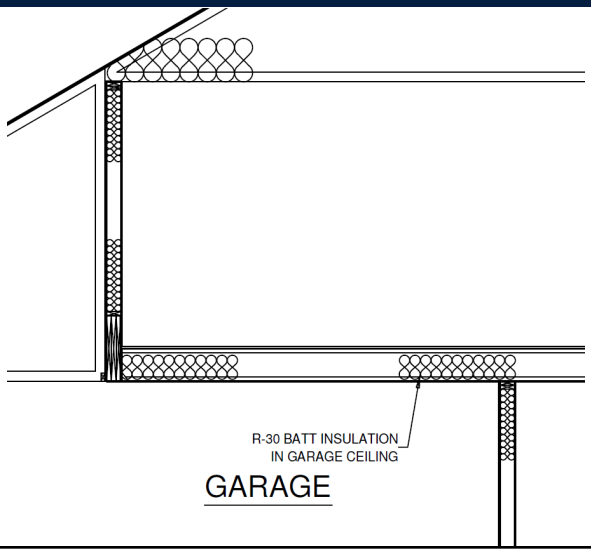
Room Over Unconditioned Space



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Concerns

- Cold floors
- Cold / hot interior space
- Air infiltration / odor control

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Cold Floors

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Floor R-Value Insulation

- Insulation requirements in PA
  - Climate Zone 4: R-19
  - Climate Zone 5: R-30[g]
  - Climate Zone 6: R-30[g]

g. Alternatively, insulation sufficient to fill the framing cavity providing not less than an R-value of R-19.

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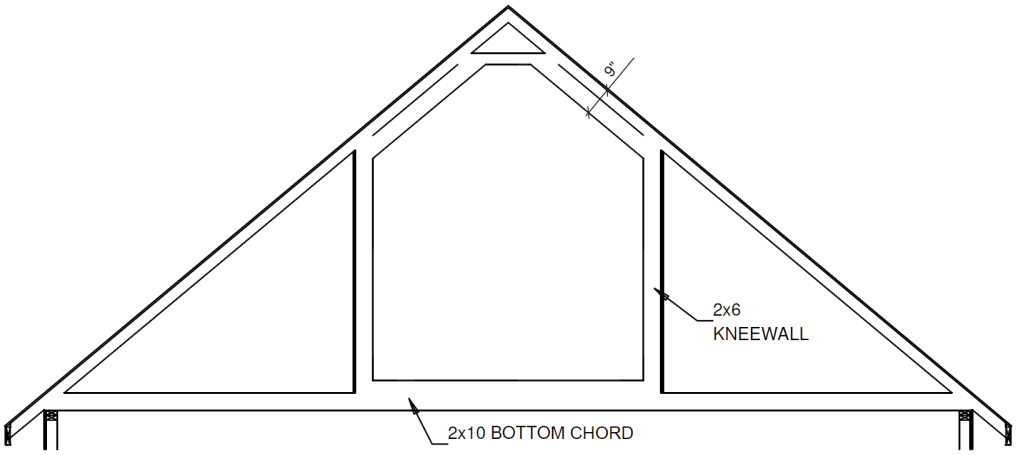
Bonus Room Truss



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Compressed Insulation Values - NAIMA

- 2x10 truss bottom cord allows a space of 9 ¼”
- R-30 insulation typically has a loft of 9 ½” – 10”

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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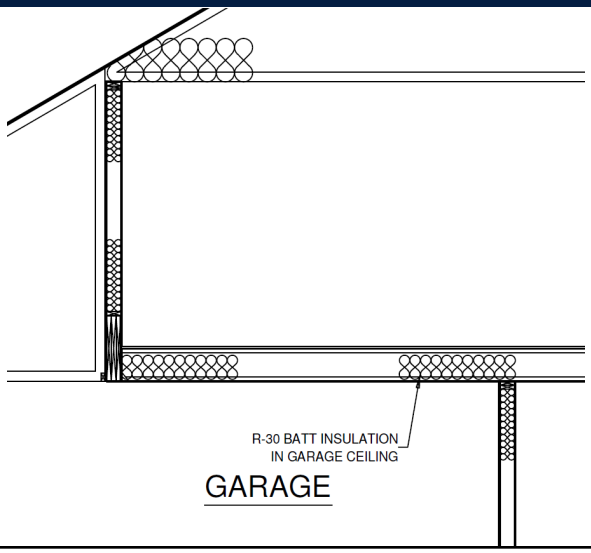
Room Over Unconditioned Space



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Floor Insulation – N1102.2.8

- Floor framing-cavity insulation **shall be installed to maintain permanent contact with the underside of the subfloor decking.**
  - Exception: As an alternative, the floor framing-cavity insulation shall be in contact with the topside of sheathing or continuous insulation installed on the bottom side of floor framing where combined with insulation that meets or exceeds the minimum wood frame wall R-value in Table N1102.1.2 and that extends from the bottom to the top of all perimeter floor framing members.

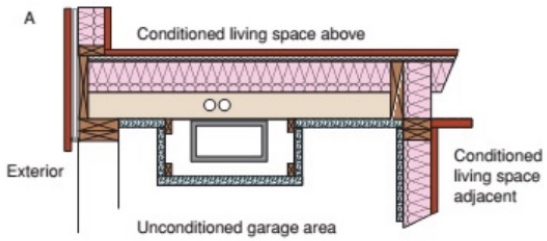
100

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

100

Floor Insulation – N1102.2.8

- Floor framing-cavity insulation shall be installed to maintain permanent contact with the underside of the subfloor decking.



101

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.
Image Source: International Code Council. (2015). 2015 Significant Changes to the IRC, ICC, Country Club Hill, Ill.

101

Floor Insulation – N1102.2.8

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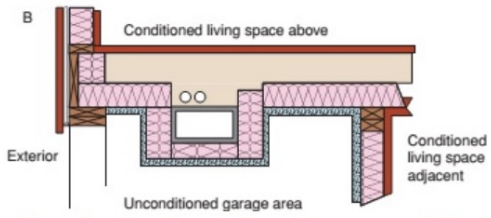
102

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

102

Alternative Floor Insulation – N1102.2.8

- As an alternative, the floor framing-cavity insulation shall be in contact with the topside of sheathing where combined with insulation that meets or exceeds the minimum wood frame wall R-value in Table N1102.1.2 and that extends from the bottom to the top of all perimeter floor framing members.



103

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.
Image Source: International Code Council. (2015). 2015 Significant Changes to the IRC, ICC, Country Club Hill, Ill.

Floor R-Value Insulation

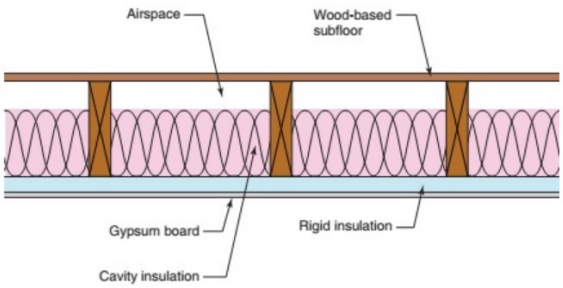
- Insulation requirements in PA
  - Climate Zone 4: R-19
  - Climate Zone 5: R-30[g]
  - Climate Zone 6: R-30[g]

g. Alternatively, insulation sufficient to fill the framing cavity providing not less than an R-value of R-19.

104

Alternative Floor Insulation – N1102.2.8

- As an alternative, the floor framing-cavity insulation shall be in contact with the topside of continuous insulation installed on the bottom side of floor framing where combined with insulation that meets or exceeds the minimum wood frame wall R-value in Table N1102.1.2 and that extends from the bottom to the top of all perimeter floor framing members.

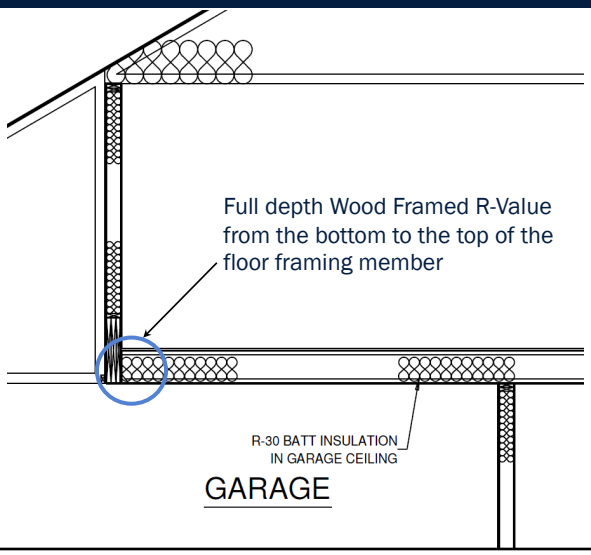


105

Source: International Code Council (ICC). (2017). 2018 International Residential Code, Country Club Hill, Ill.
Image Source: International Code Council. (2015). 2015 Significant Changes to the IRC, ICC, Country Club Hill, Ill.

105

Room Over Unconditioned Space



106

106

Cold / Hot Interior Space

107

107

Ceiling R-Value Insulation

- Insulation requirements in PA
  - Climate Zone 4: R-49
  - Climate Zone 5: R-49
  - Climate Zone 6: R-49

108

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Ceilings Without Attic Spaces

- Where Section N1102.1.2 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 (46 m2) or 20 percent of the total insulated ceiling area, whichever is less.

109

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

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109

*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

110

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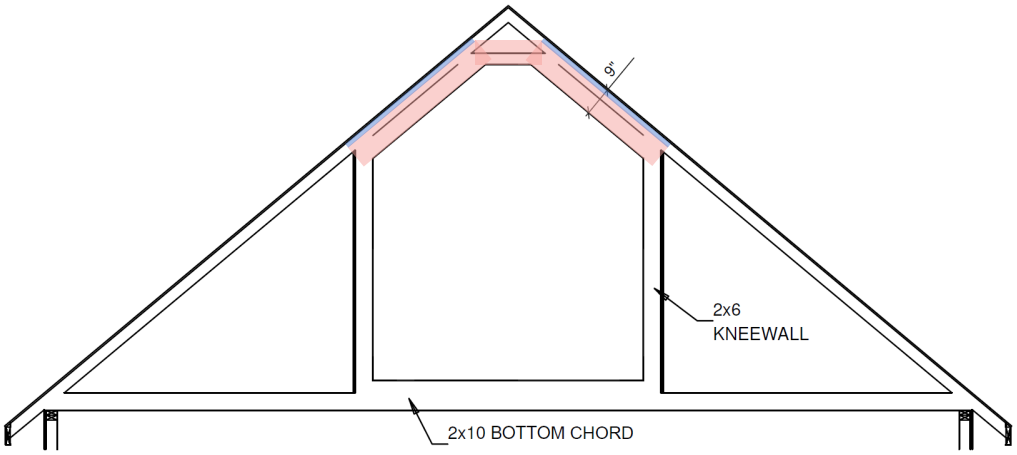
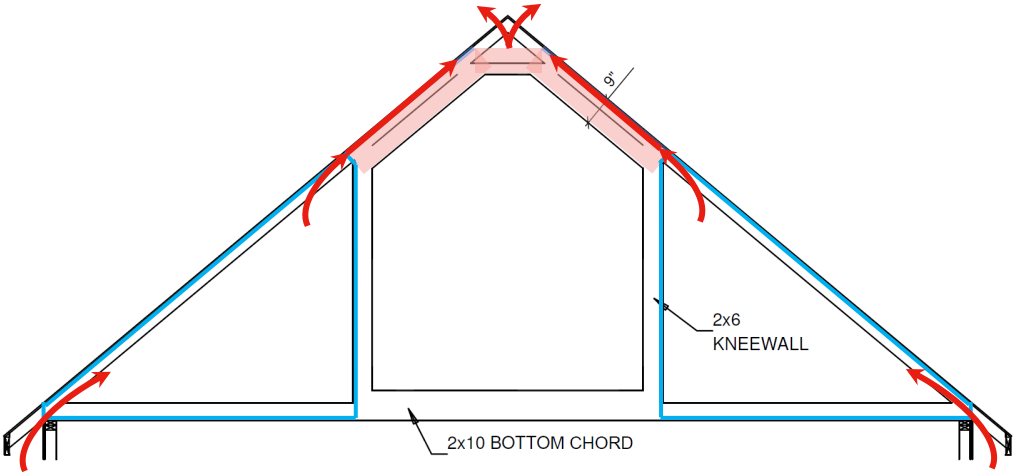
Bonus Room Truss



111

111

Attic Ventilation



112

112

Eave Baffle Specifications

Dimensions

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

113

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

113

Eave Baffle Specifications

Dimensions

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

114

Source: https://www.homedepot.com/p/Owens-Corning-Raft-R-Mate-22-1-2-in-x-4-ft-Attic-Insulation-Rafter-Baffle-Proper-Vents-10-Pieces-70RM/204848302#overlay

114

Compressed Insulation Values - NAIMA

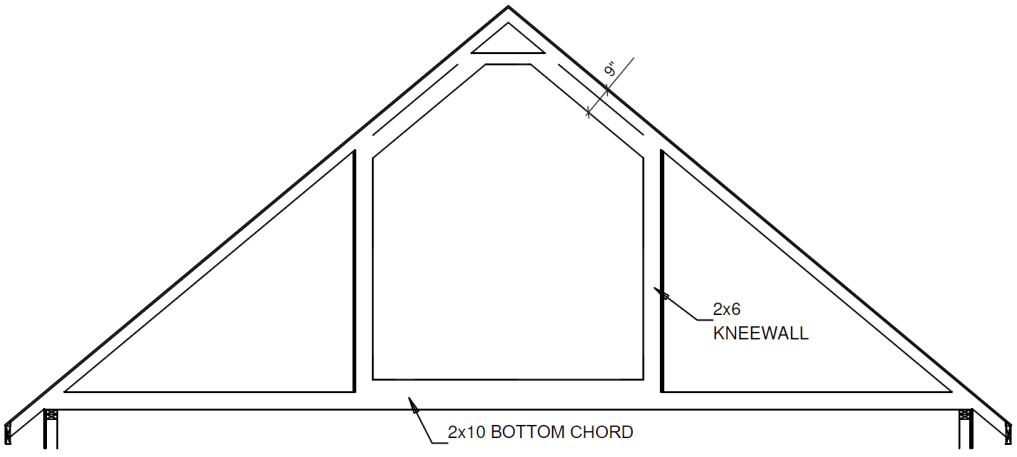
- 2x4 + 2x6 top chord = 9”
- Eave baffle= 1 ½” – 2 ½”
- R-30 compressed to 7 ½” = roughly R-25
- Potential for ½ the required R-value to be installed

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

Bonus Room Truss



Key Details

- 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
- HVAC
  - Delivery
  - Location

117

Bonus Room Air Infiltration & Odor Control

118

Table N1102.4.1.1 Air Barrier and Insulation Installation – General Requirements

- A continuous air barrier shall be installed in the building envelope.
- The exterior thermal envelope contains a continuous air barrier.
- Breaks or joints in the air barrier shall be sealed.
- Air-permeable insulation shall not be used as a sealing material.

119

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

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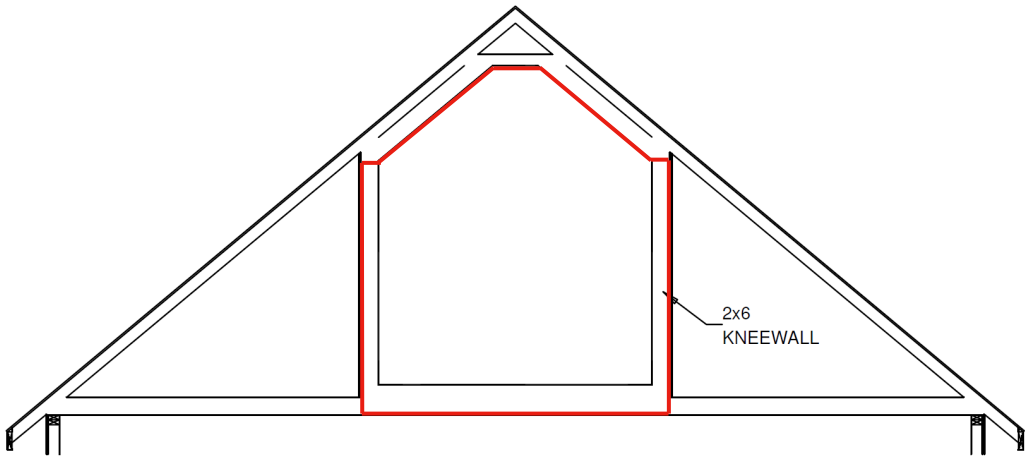
119

Pen Test



120

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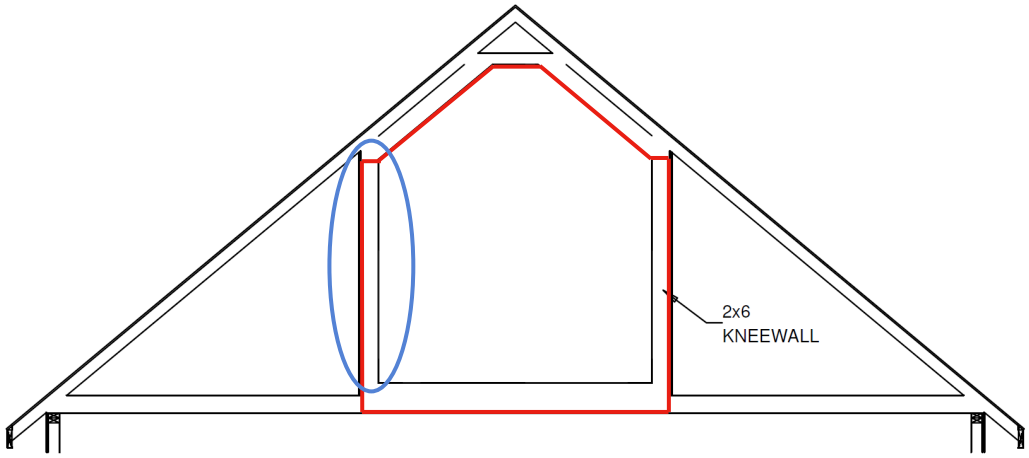
Key Location Details – Insulated Sheathing as the Air Barrier



121

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Installation of Insulated Foam Sheathing

122

Image Source: https://www.jlconline.com/how-to/insulation/fixing-the-bonus-room_o

122

Installation of Insulated Foam Sheathing

123

Image Source: https://www.jlconline.com/how-to/insulation/fixing-the-bonus-room_o

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Installation of Insulated Foam Sheathing

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Image Source: https://www.jlconline.com/how-to/insulation/fixing-the-bonus-room_o

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Installation of Insulated Foam Sheathing

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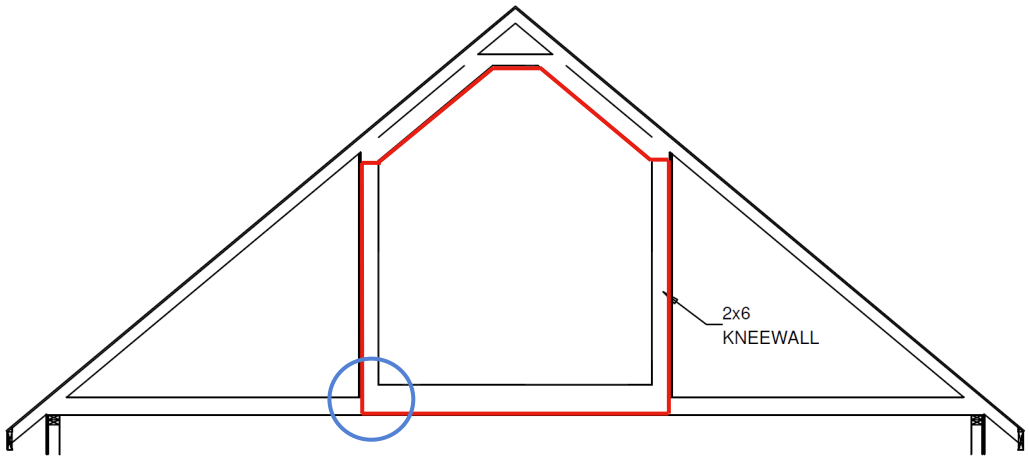
Image Source: https://www.jlconline.com/how-to/insulation/fixing-the-bonus-room_o

125

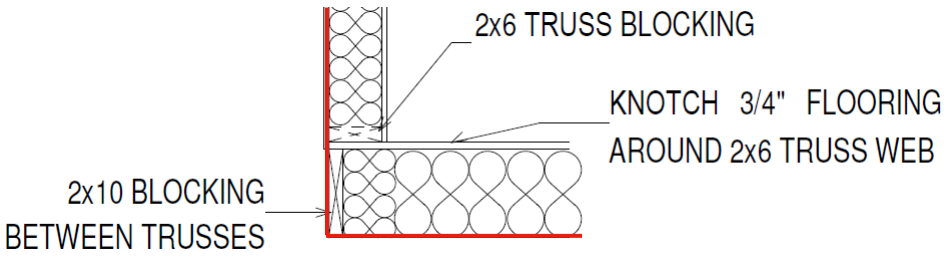
Key Location Details



126

126

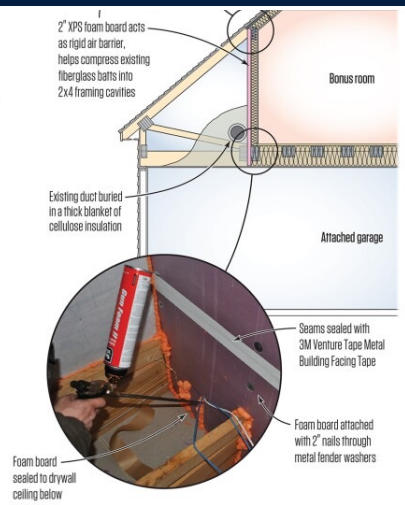
Blocking Detail – Insulated Sheathing as the Air Barrier



127

127

Foam Blocking Between Trusses

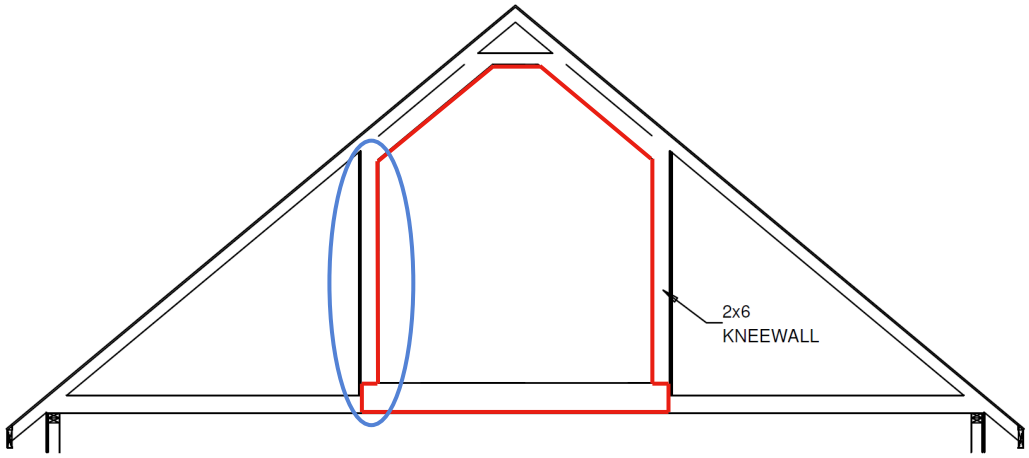


128

Image Source: https://www.jlconline.com/how-to/insulation/fixing-the-bonus-room_o

128

Key Location Details – Drywall as the Air Barrier



129

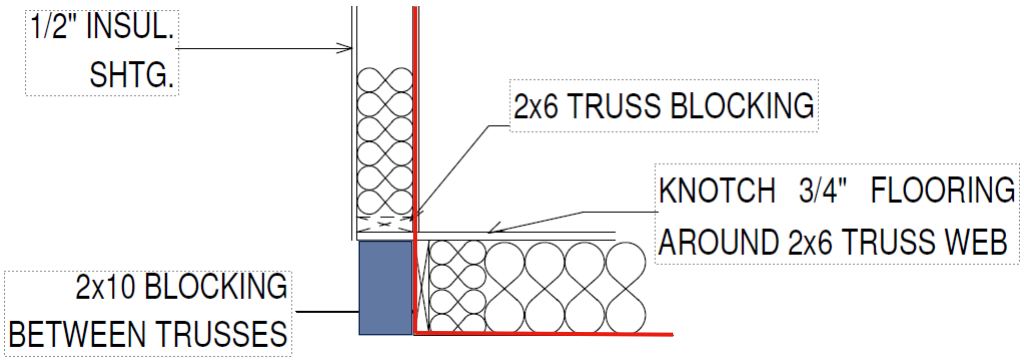
129

130

Image Source: https://www.shawneestructures.com/2018-garage-sheds/onsite-attic-28x35interior-1000.jpg.

130

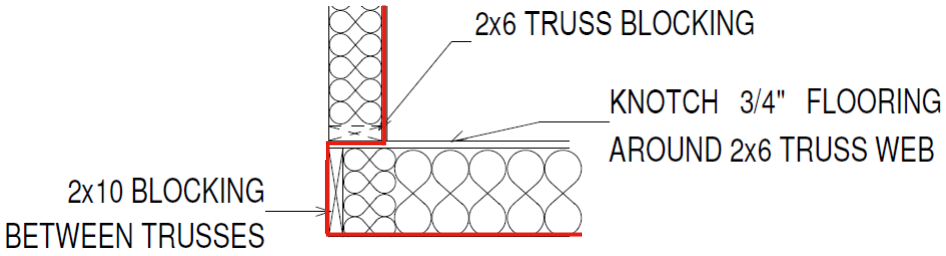
Incorrect Blocking Detail – Drywall as the Air Barrier



131

131

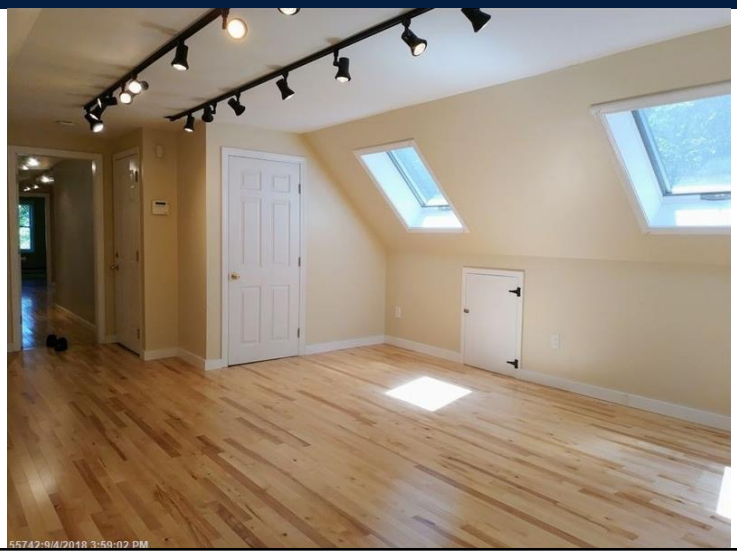
Blocking Detail – Drywall as the Air Barrier



132

132

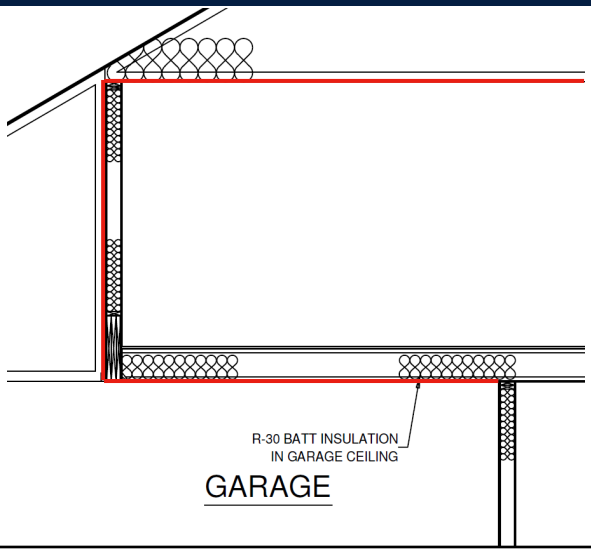
Drywall as an Air Barrier - Ceiling



133

133

Air Barrier for Room Over Unconditioned Space



134

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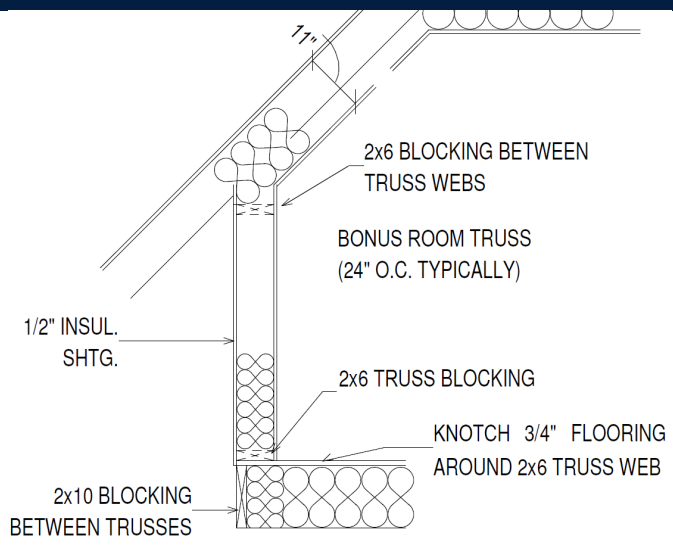
Knee Wall Blocking



135

135

Safety: Garage-Dwelling Separation

136

136

Dwelling – Garage Opening and Penetration Protection – R302.5

- R302.5.3 Other penetrations - Penetrations through the separation required in Section R302.6 shall be protected as required by Section R302.11, Item 4.
- R302.11 Fireblocking
  4. At openings around vents, pipes, ducts, cables and wires at ceiling and floor level, with an approved material to resist the free passage of flame and products of combustion. The material filling this annular space shall not be required to meet the ASTM E136 requirements.

137

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

137

Dwelling-Garage Fire Separation – R302.6

- The garage shall be separated as required by Table R302.6. Openings in garage walls shall comply with Section R302.5. Attachment of gypsum board shall comply with Table R702.3.5. The wall separation provisions of Table R302.6 shall not apply to garage walls that are perpendicular to the adjacent dwelling unit wall.

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Dwelling – Garage Separation

TABLE R302.6 DWELLING-GARAGE SEPARATION

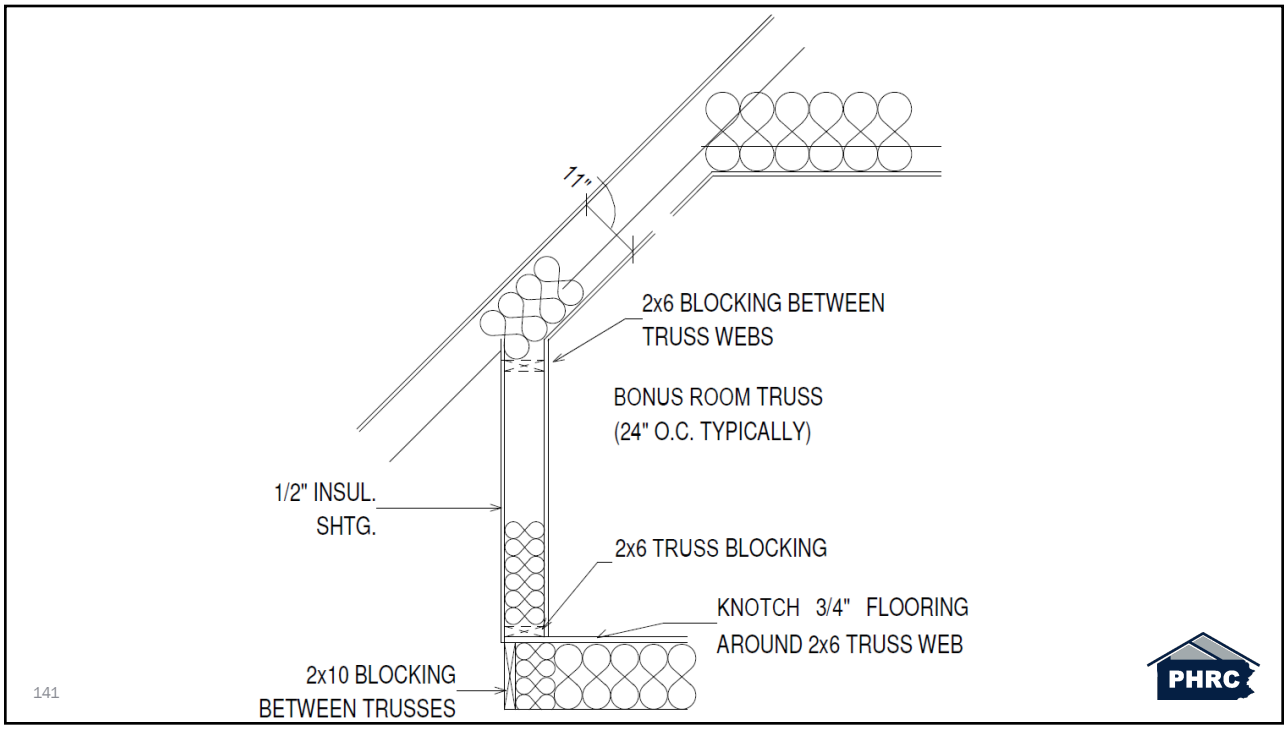
SEPARATION	MATERIAL
From the residence and attics	Not less than $^{1}/_{2}$-inch gypsum board or equivalent applied to the garage side
From habitable rooms above the garage	Not less than $^{5}/_{8}$-inch Type X gypsum board or equivalent
Structure(s) supporting floor/ceiling assemblies used for separation required by this section	Not less than $^{1}/_{2}$-inch gypsum board or equivalent
Garages located less than 3 feet from a dwelling unit on the same lot	Not less than $^{1}/_{2}$-inch gypsum board or equivalent applied to the interior side of exterior walls that are within this area

139

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

Summary

- It's hard to fix what you can't see so understanding how heat is transferred is critical
- Design structural members for the installation of at least the minimum required insulation without compression
- Understand your air barrier and be sure it is continuous
- Encapsulate your insulation to reduce wind washing



141

Questions?

www.phrc.psu.edu

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Thermal Control Layers in Vented and Unvented Attic Assemblies

143

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Agenda

- What are the wall R-values in Pennsylvania in the 2021?
- Take a look at how these R-values can change depending on the assembly
- Explain moisture and air permeability issues related to a double stud wall assembly.
- Walk through the prescriptive requirements
- Prescriptive designs
  - Vented
  - Unvented

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UCC Energy Code Summary

Chapter 11

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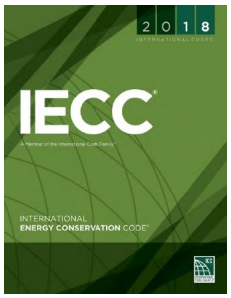

Residential Provisions

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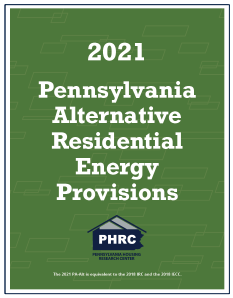

On our website: phrc.psu.edu

145

145

Climate Zones in PA

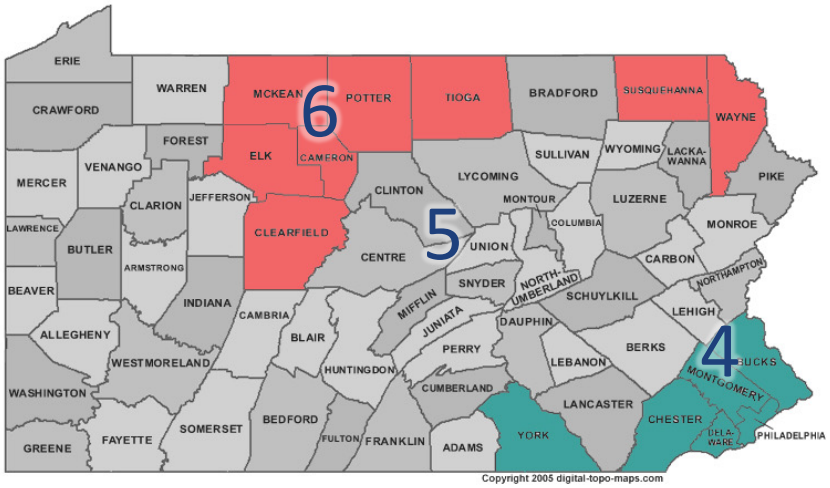

Image Source: digital-topo-maps.com

146

146

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[j]	MASS WALL *R*-VALUE	FLOOR *R*-VALUE	BAWSEMENT[c] 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

147

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

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 – Ceilings With Attic Space
  - N1102.2.2 – Ceilings Without Attic Space
  - N1102.2.3 – Eave Baffle

148

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

Prescriptive Ceiling R-Value Insulation

- N1102.1.2 Insulation & Fenestration Table
  - 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

149

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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

151

151

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

152

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R806.1 Ventilation Required

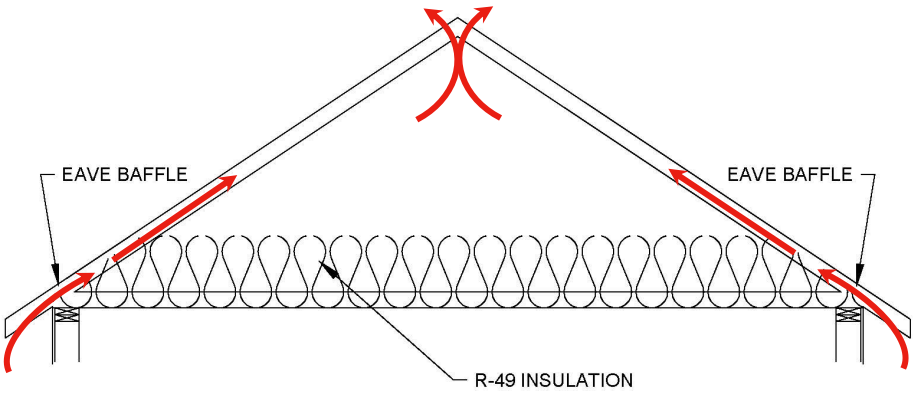
- Enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters shall have cross ventilation for each separate space by ventilating openings protected against the entrance of rain or snow.

153

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

153

Ceilings With Attic Space



154

154

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.

155

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

155

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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156

Eave Baffle Specifications

Dimensions

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

157

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

157

Eave Baffle Specifications

Dimensions

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

158

Source: https://www.homedepot.com/p/Owens-Corning-Raft-R-Mate-22-1-2-in-x-4-ft-Attic-Insulation-Rafter-Baffle-Proper-Vents-10-Pieces-70RM/204848302#overlay

158

159

https://www.homedepot.com/services/c/attic-insulation-installation/2db8aa2ba

159

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.

160

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

160

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

161

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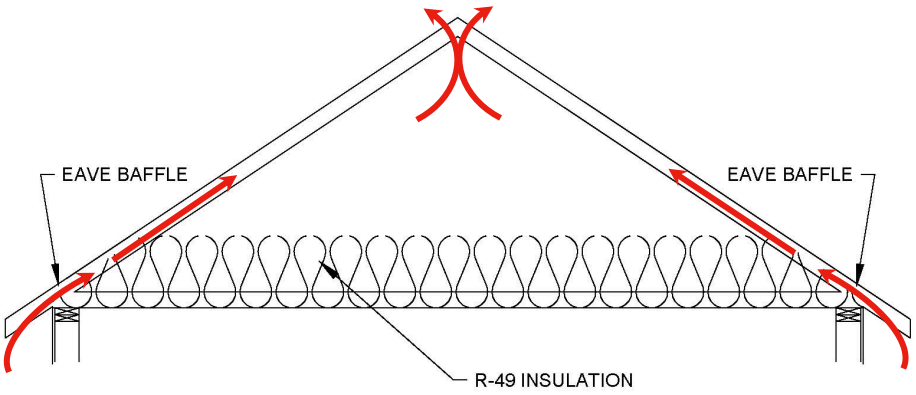
Ceilings With Attic Space



162

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N1102.2.1 Ceilings With Attic Spaces

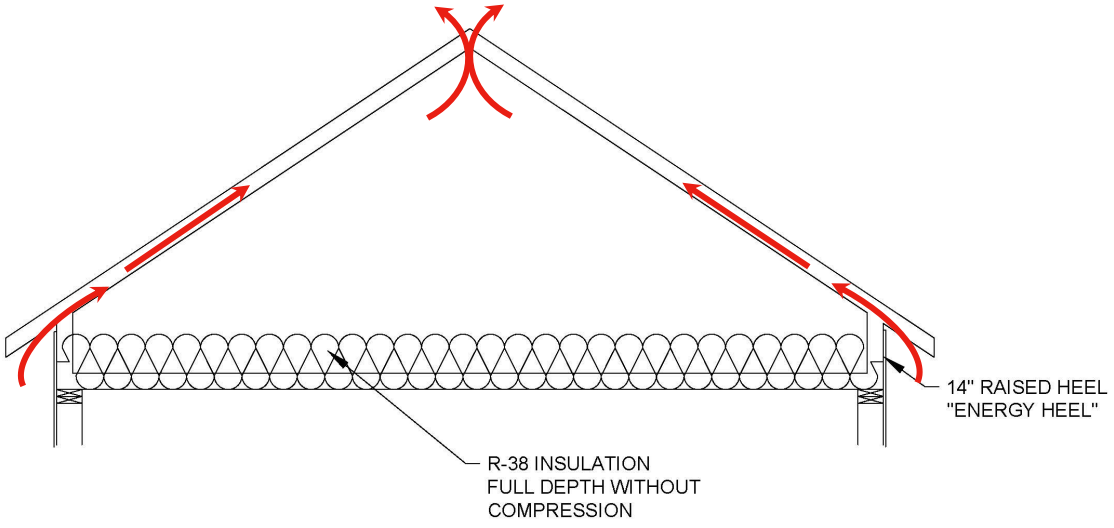
- Where Section R1102.1.2 requires R-38 insulation in the ceiling, installing R-30 insulation over 100 percent of the ceiling area requiring insulation shall satisfy the requirement for R-38 insulation wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves.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

163

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

163

Ceilings With Attic Space



164

164

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.

165

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

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Prescriptive Ceiling R-Value Insulation

- N1102.1.2 Insulation & Fenestration Table
  - 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

166

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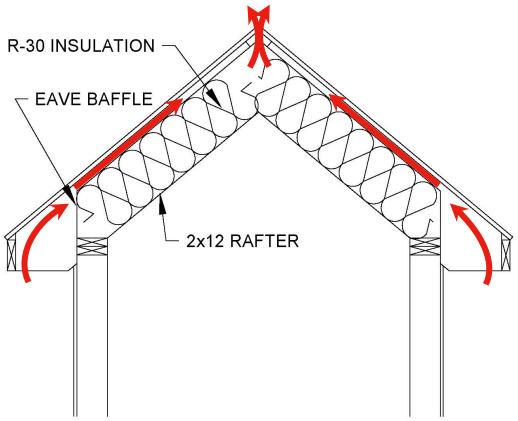
N1102.2.2 Ceilings Without Attic Spaces

- 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.

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

Cathedral Ceiling Assembly - Rafter

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



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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"		

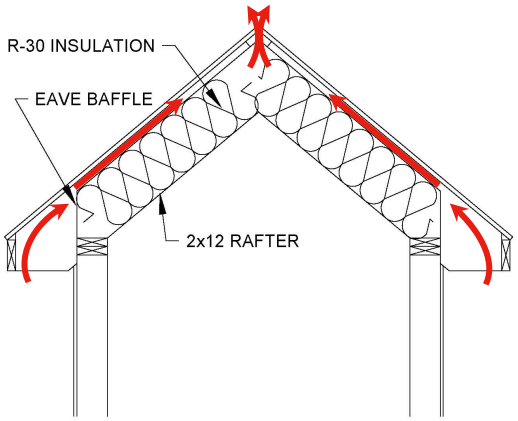
169

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

169

Cathedral Ceiling Assembly - Rafter

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



170

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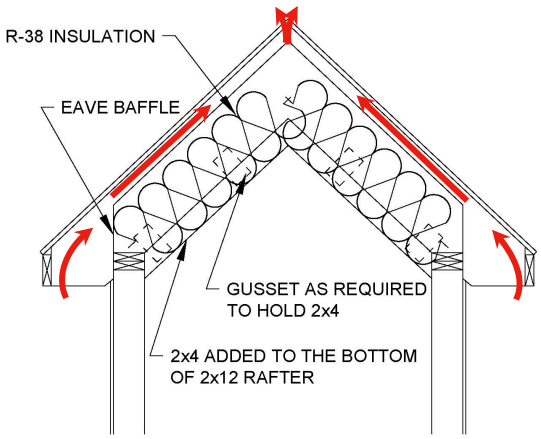
Cathedral Ceiling Assembly – Rafter & 2x4 Below Rafter

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

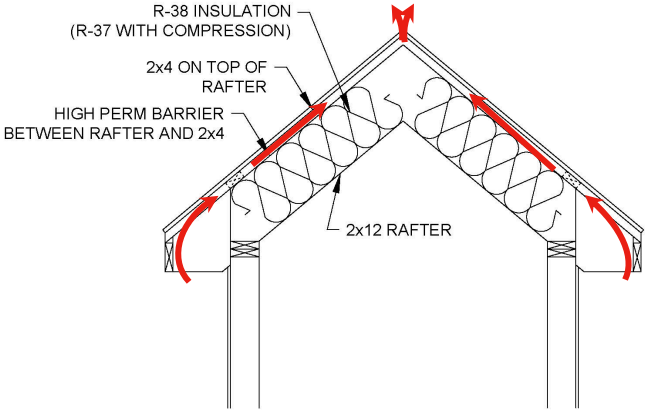


171

171

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



172

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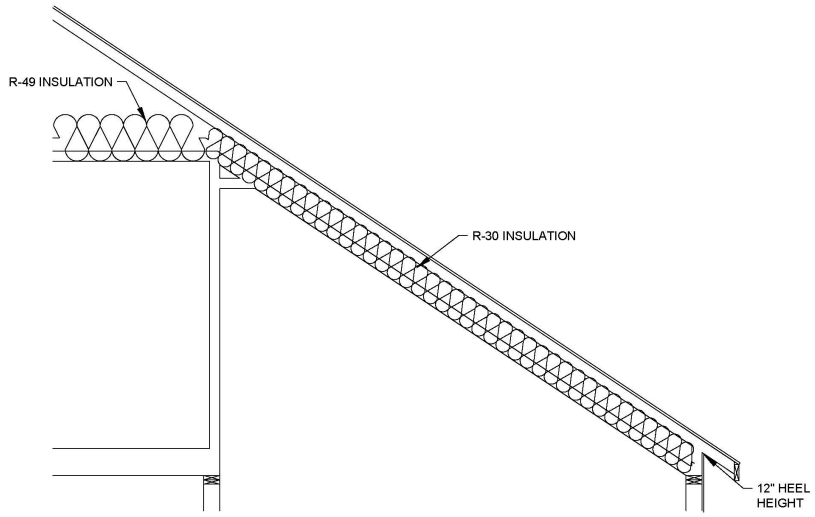
173

Josh Salinger - Fine Homebuilding - https://www.youtube.com/watch?v=fA3hZOb0F7s

173

Trussed Alternatives



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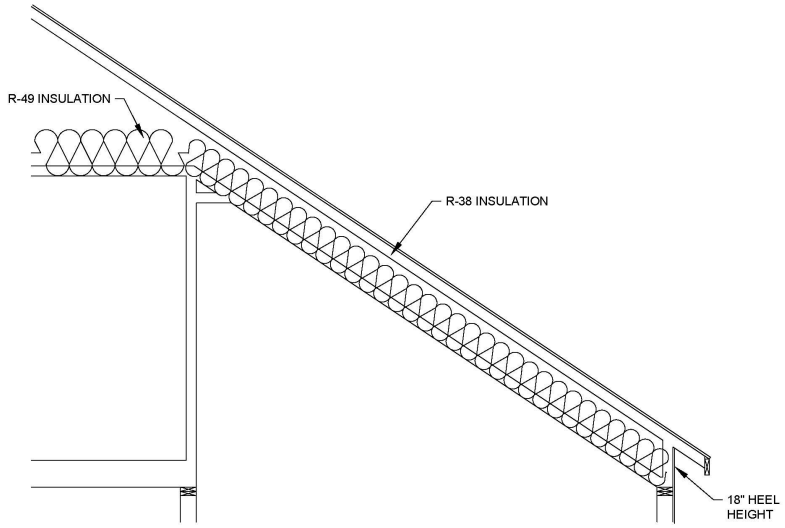
174

Trussed Alternatives



175

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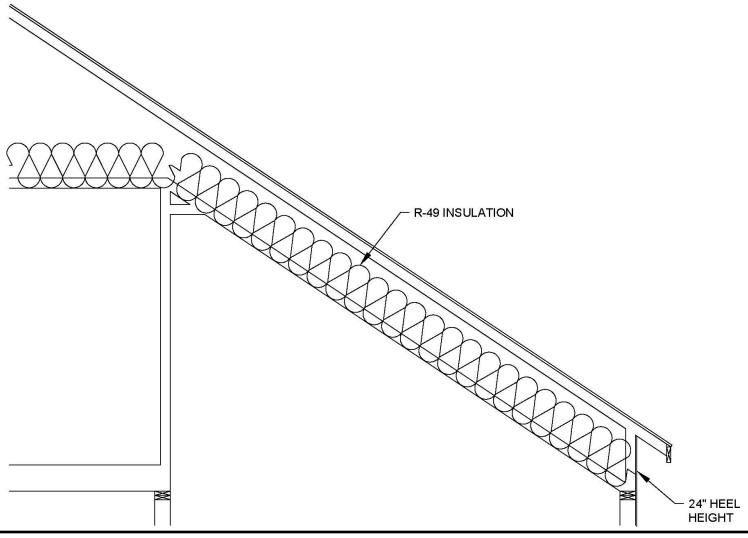
Trussed Alternatives



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Unvented Ceiling Assemblies

177

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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:

179

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

179

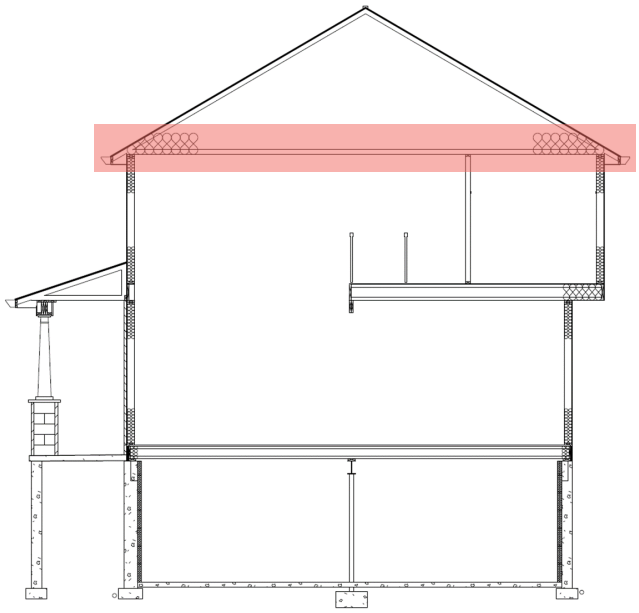
R806.5 Unvented Attic and Unvented Enclosed Rafter Assemblies – Cont.

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.

180

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

180



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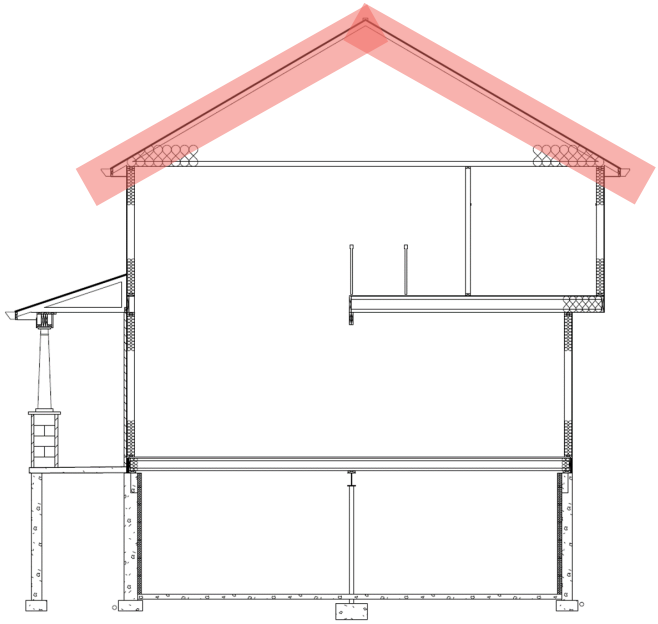

182

182

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.

183

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

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183

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.

184

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

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184

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.

185

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

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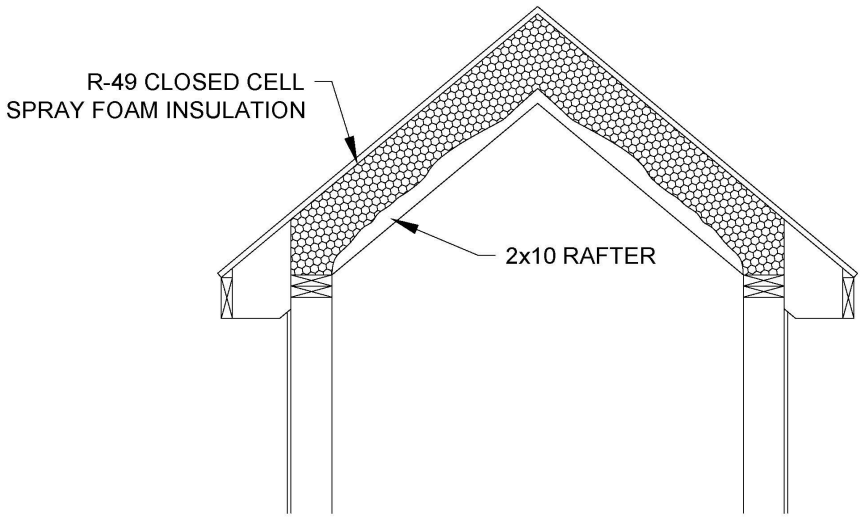
185

Following R806.5 Part 5.1.1



186

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186

Following R806.5 Part 5.1.1

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   - 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.

187

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

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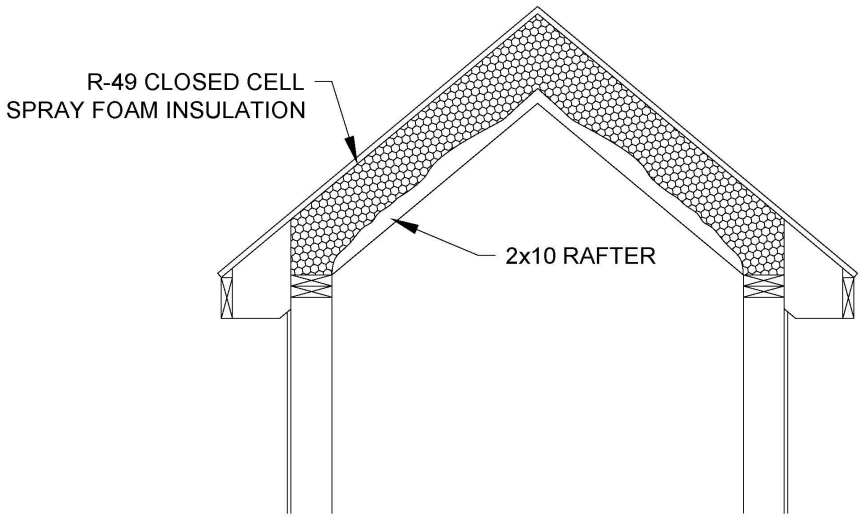
187

Following R806.5 Part 5.1.1



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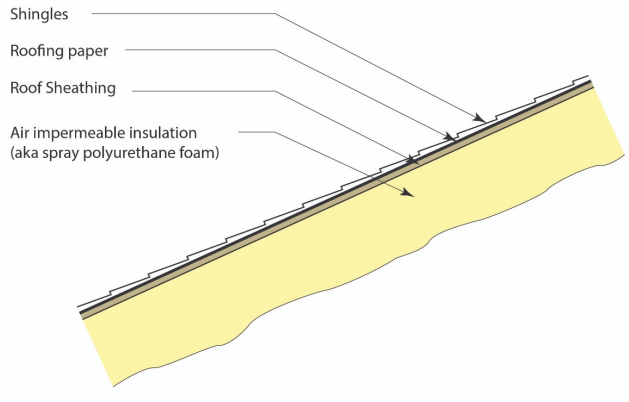
Why Closed Cell Foam?

- 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.



189

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

189

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").

190

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

190

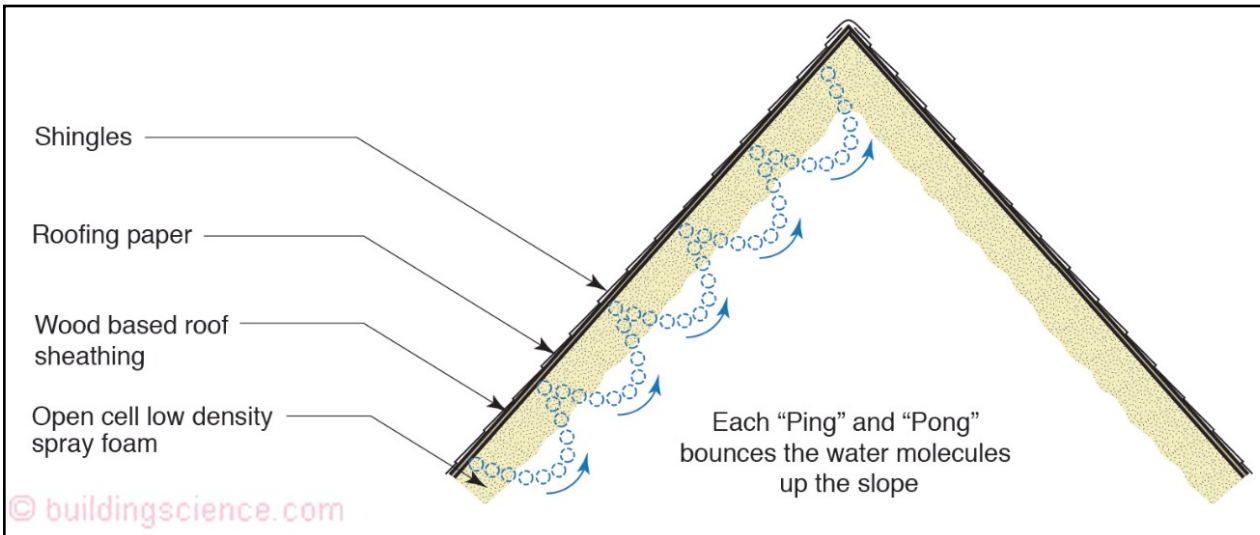


Figure 1: “Ping Pong Water” - Water vapor from the interior passes up through the ocSPF and is stored in the wood based roof sheathing – and then driven out by solar radiation. In and then out…in and then out…a “ping” followed by a “pong” leading to an increase in moisture accumulating at the ridge requiring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

191

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

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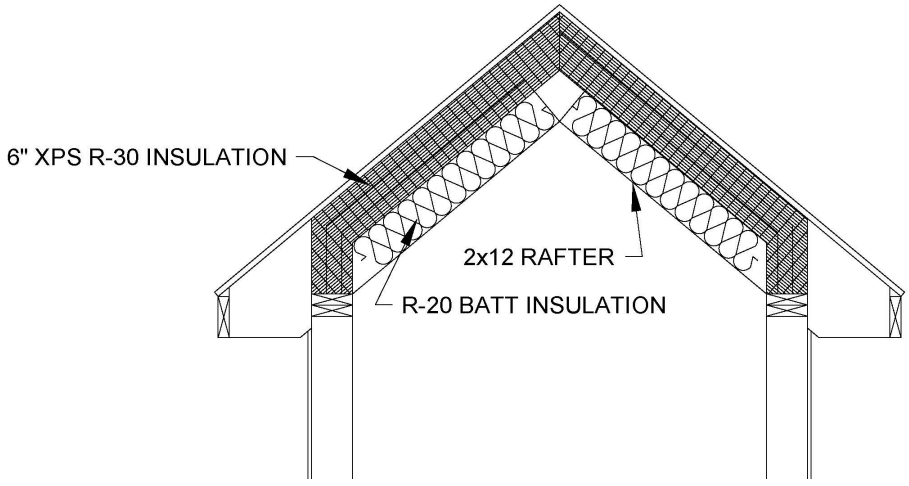
191

Following R806.5 Part 5.1.3



192

PHRC

192

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     - 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.

193

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

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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.

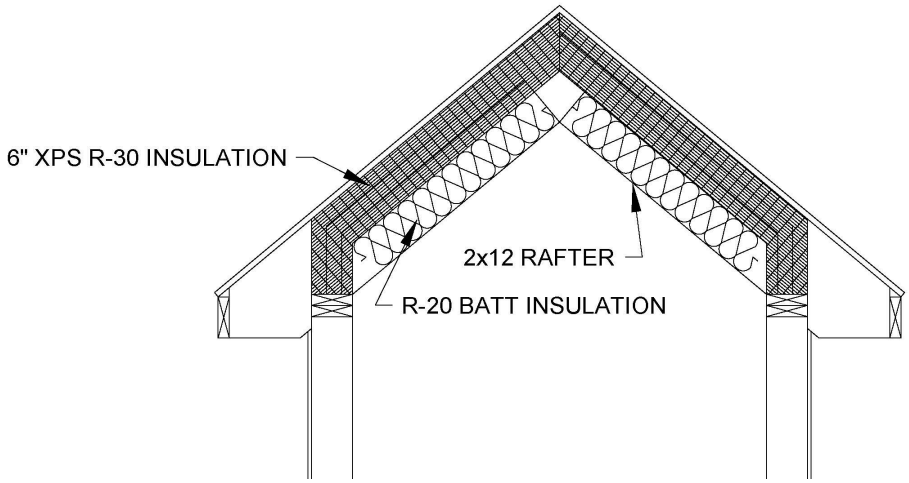
b. Alternatively, sufficient continuous insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) is assumed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

194

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

194

Following R806.5 Part 5.1.3



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Ceilings Without Attic Spaces – Limited Area

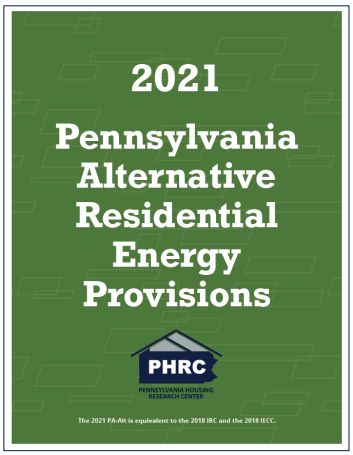
- Where Section N1102.2.1 requires insulation R-values greater than R-30 in the ceiling and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation R-value for such roof/ceiling assemblies shall be R-30. Insulation shall extend 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.

196

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

196

*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 (4)	Central (5)	North (6)
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

- Be careful of insulation compression
- This should be designed as an assembly, not constructed with individual components
- Know the specifications of your products
- Eave baffles and spray foams aren't created equal. Know your product
- Choose a lane and stick with it. If it's vented, vent it correctly. If it's unvented, air seal and follow the vapor retarder requirements correctly.

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Questions?

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