Continuous Insulation:

Research, Applications, and Resources for Walls, Roofs, and Foundations

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Applied Building Technology Group (ABTG) is committed to using sound science and generally accepted engineering practice to develop research supporting the reliable design and installation of foam sheathing. ABTG's educational program work with respect to foam sheathing is supported by the Foam Sheathing Committee (FSC) of the American Chemistry Council.

ABTG is a professional engineering firm, an approved source as defined in Chapter 2 and independent as defined in Chapter 17 of the IBC.

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Foam sheathing research reports, code compliance documents, educational programs and best practices can be found at www.continuousinsulation.org.

Foam Plastic Applications for Better Building

OUTLINE

- Introduction
- Background
- CI Applications and Functions
- Coordination with Other Building Code Requirements
- Conclusion & Questions

INTRODUCTION

- Continuous insulation (ci) has many building applications:
  - Walls
  - Roofs
  - Foundations
  - Floors

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INTRODUCTION

- Definition (IECC, ASHRAE 90.1):
  - *Continuous insulation (c.i.):* insulation that is uncompressed and continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope.

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INTRODUCTION

- Relevant Codes and Standards include:
  - ASTM C578 (polystyrene EPS or XPS foam board) ~ R4 to R5/in
  - ASTM C1289 (polyisocyanurate foam board) ~ R6/in
  - IECC/IRC Chapter 11 – Model energy conservation code
  - ASHRAE 90.1 – Model energy conservation standard (commercial)
  - IBC – Model commercial building code
  - IRC – Model residential building code

INTRODUCTION

- Additional Resources: www.continuousinsulation.org
  - Design guides
  - On-line calculator tools (U-factor/R-value + moisture control)
  - Construction details
  - Installation guidance
  - Code compliance resources & evaluation reports
  - Research reports

BACKGROUND

- CI is not a new concept:
  - Wood board sheathing was recognized for ~R-1 insulating value in the early 1900s
  - Wood fiberboard (~R2.6/in) was invented in the late 1800s (based on paper-making technology) and used for insulating sheathing by early 1900s

BACKGROUND

- CI technology in recent decades:
  - 1940s-1950s, "appearance of plastic foam created a huge revolution"
  - 1970's oil crisis helped draw attention to foam plastic insulating sheathing used as continuous insulation
  - Modern energy codes include continuous insulation on the basis of energy savings and economic cost-benefits
    - Environment (e.g., GWP reduction), durability, and comfort also are an important drivers for improved building envelopes

BACKGROUND

- Three envelop insulation approaches:
  - Cavity Insulation Only (traditional)
  - Cavity + Continuous Insulation (hybrid)
  - Continuous Insulation Only (high performance)
- We will focus primarily on the latter two approaches for building walls, roofs, foundations, and floors
- We will also focus primarily on use of Foam Plastic Insulating Sheathing (FPIS)

BACKGROUND

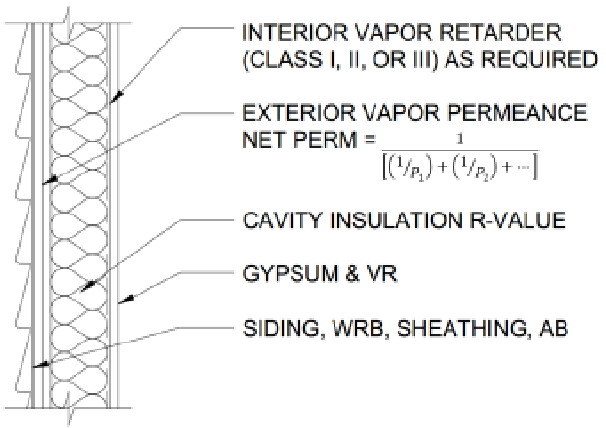
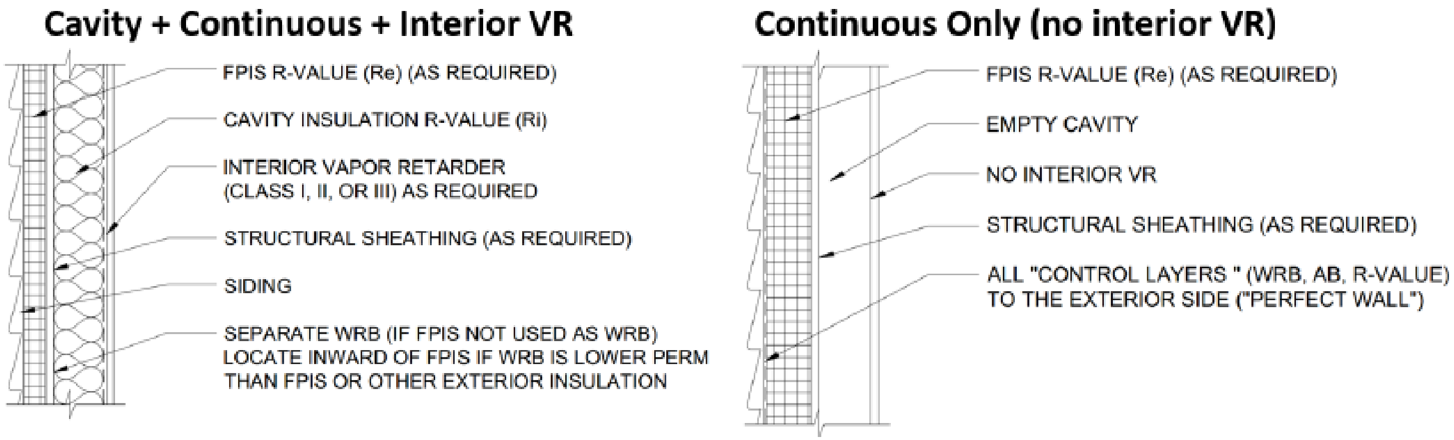


Figure A1. Typical "Method A" Wall Assembly with Cavity Insulation Only



(a) Cavity Insulation + Continuous Insulation + Interior VR

(b) Exterior Insulation Only (no interior VR)

Figure A2. Typical "Method B" Wall Assemblies

CI APPLICATIONS & FUNCTIONS

- Thermal Control
- Water Vapor Control
- Water-Resistive Barrier (WRB)
- Air Barrier (AB)
- Foundation Moisture & Frost Protection
- Roof Above Deck Insulation

1. Thermal Control

- Wearing your sweater is better than eating it !!
  - same applies to buildings
- The primary thermal benefit of CI is that it is placed continuously on the exterior of the building
  - Mitigates thermal bridges within and at interfaces of building envelope assemblies (see Table 1 next slide)
  - Provides effective means of compliance with energy codes and standards

1. Thermal Control

How the "sweater" works

R-13 cavity insulation

CONCLUSION:

Uh Oh, baby ate sweater…

Source: FreeImages.com/Hector Landaeta

½" rigid foam CI added

CONCLUSION:

Warm baby, happy baby…

Source: Dryvit/DOW
http://continuingeducation.construction.com/article.php?L=38&C=1147&P=3

Source: http://www.flickr.com/photos/vatobob
(Wikimedia commons – well-clothed baby)

1. Thermal Control

TABLE 1 (abbreviated*)

Wall Construction & Insulation Strategy:	2x6@16"oc Wood Frame Wall		Cold-Formed Steel Stud Wall	
	"R25" (cavity only)	"R20+5" (cavity + ci)	"R19" (cavity only)	"R13+6" (cavity + ci)
Total Nominal R-value of Insulation:	R25	R25	R19	R19
U-factor	0.0573	0.0464	0.0905	0.0639
Effective R-value	**17.5**	**21.6**	**11.1**	**15.7**

*See Table 1 in paper for detailed calculations

1. Thermal Control

- Observations from Table 1:
  - Wood Frame: R20+5ci wall has 20% better U-factor / Effective R than R25 cavity insulation only wall
  - Steel Frame: R13+6ci wall has 40% better U-factor / Effective R than R19 cavity insulation only wall
  - These comparisons each have the same total nominal R-value of insulation components, but very different performance.

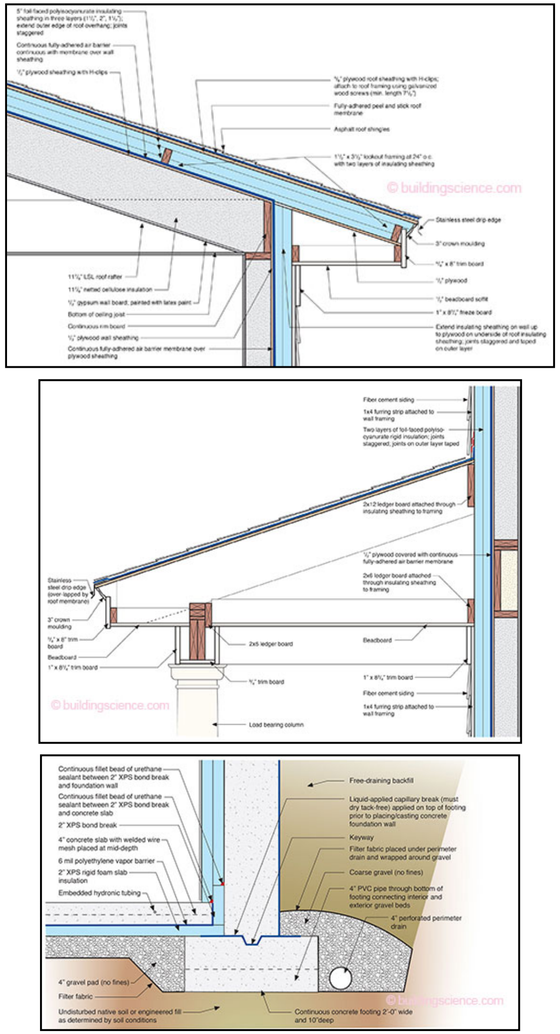
1. Thermal Control

- "R20+5" and "R13+6" symbolizes an insulation strategy (hybrid) with cavity and continuous insulation components
  - It is not a math equation: "R20+5" ≠ "R25" and "R13+6" ≠ "R19"
  - Similarly, a "4x4" truck is not a "16" truck.

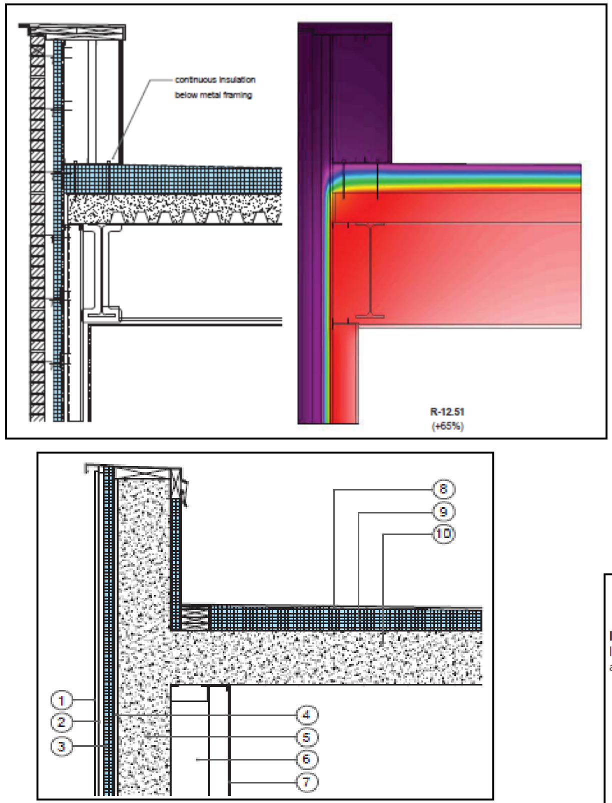
1. Thermal Control

- Insulation location matters because continuous insulation mitigates framing thermal bridges; cavity insulation does not.
- Adding cavity and continuous insulation R-values is like adding apples and oranges and is prohibited by the energy code as a means of compliance.
  - You can add cavity insulation R-values where multiple materials are in the cavity (apples + apples).
  - You can add continuous insulation R-values where multiple layers are used (oranges + oranges).

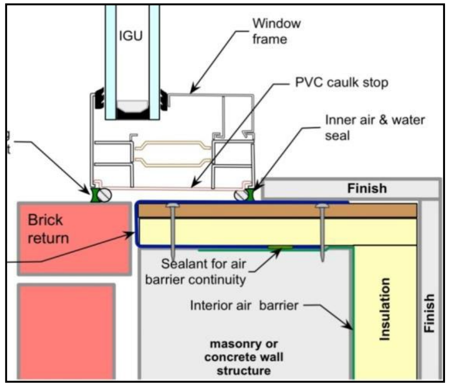
1. Thermal Control – Using CI to mitigate thermal bridges:



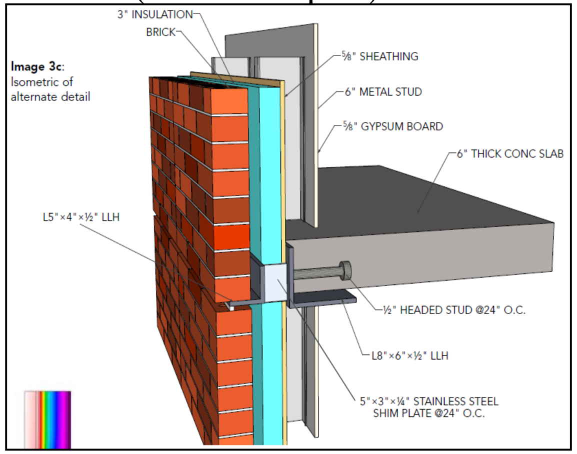
Example Details from BSI-081: Zeroing In (J. Lstiburek, Building Science Corp) as used on NIST NZERTF Project



INSULATED PARAPET DETAILS
(Payette/AIA report)



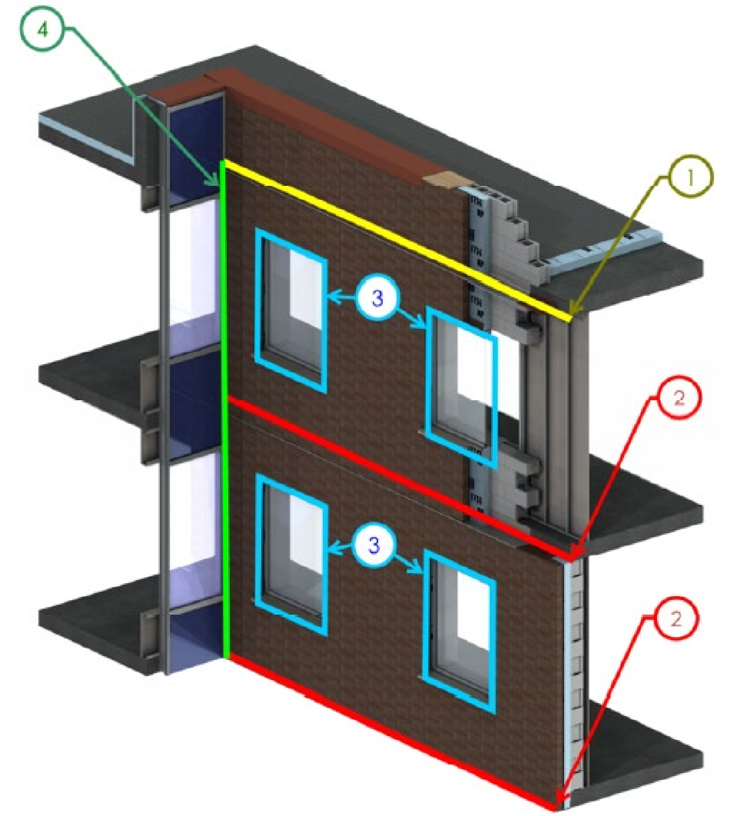
INSULATED WINDOW ROUGH OPENING DETAIL
(USACE report)



OFFSET SHELF ANGLE
(AISC/SEI article)

1. Thermal Control

– Using CI to mitigate thermal bridges:



Source: BC Hydro BETB Guide / Morrison Hershfield LTD

$$Q = [\sum (U_i \cdot A_i) + \sum (\psi_j \cdot L_j) + \sum (\chi_k \cdot n_k)] \times \Delta T$$

where:

Q = heat transfer through envelope by conduction (static)

U_i = U-factor for assembly type i

A_i = Total surface area of assembly type i

Ψ_j = Psi-factor for linear thermal bridge type j

L_j = Total length of linear thermal bridge type j

χ_k = Chi-factor for point thermal bridge type k

n_k = number of point thermal bridges of type k

$$U_{adj} = \frac{\sum(\Psi \cdot L) + \sum(\chi \cdot n)}{A_{Total}} + U_o$$

where:

U_{adj} = adjusted U-factor for use in "tricking" simulation model to account for thermal bridges that may be associated with but not "in" the assembly.

U_o = clear-field U-factor for the assembly being adjusted

2. Water Vapor Control

- Where properly used, CI helps to lower risk of:
  - Condensation
  - Moisture accumulation and cycling in building materials
  - Material damage (rot, corrosion, etc.)
  - Expansion and contraction of materials
  - Mold

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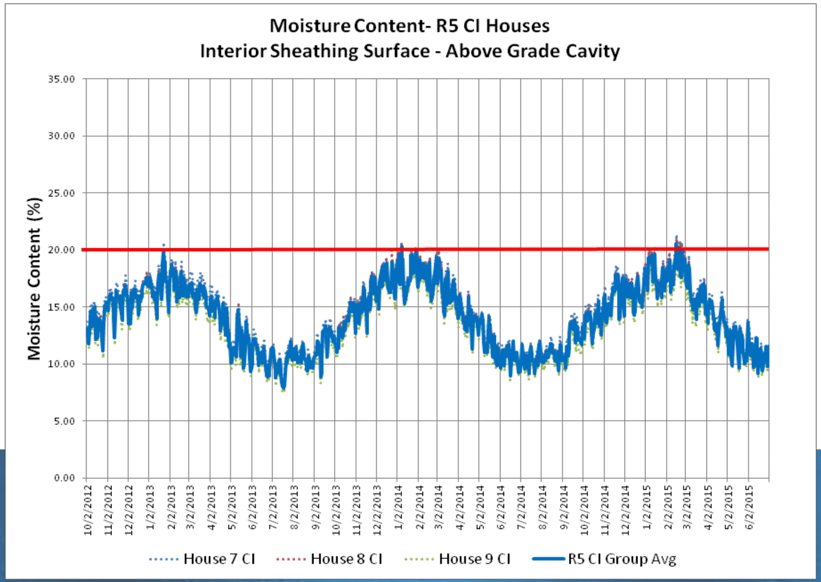
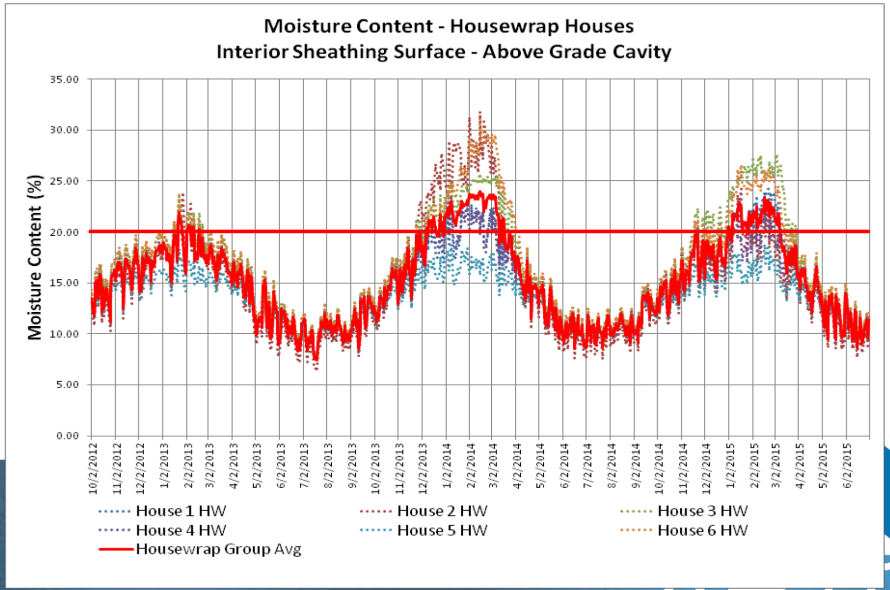
2. Water Vapor Control

- Water vapor control involves two simple concepts:
  - Minimize the risk of the assembly getting wet due to water vapor diffusion (condensation or adsorption)
  - Optimize the ability of the assembly to dry in relation to its risk of getting wet



Two "Code-Compliant" Walls:

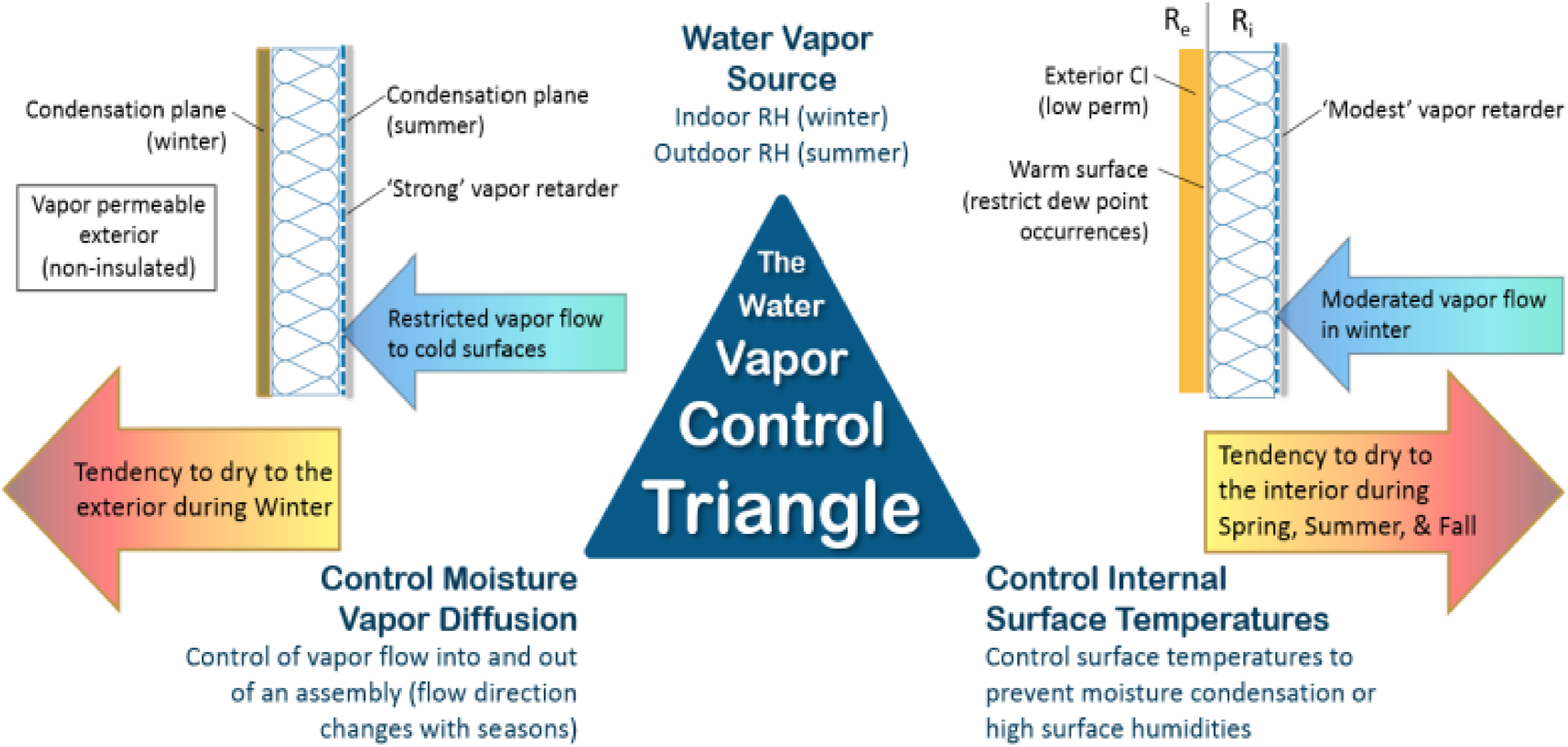
- Left – moisture cycling below 20% MC
- Right – moisture cycling above 20% MC



2. Water Vapor Control

- Two design approaches:
  - Vapor Permeance Controlled Design (Traditional)
    - Relies on interior vapor retarders; ignores vapor permeance of exterior layers and amount of insulation which makes materials cold
    - Prone to condensation or high humidity inside the assembly leading to moisture accumulation & seasonal cycling
  - Temperature Controlled Design (Contemporary)
    - Relies on a combination of continuous insulation and vapor retarders to control temperature of protected materials within the assembly
    - Reduces risk of condensation and high internal humidity levels
    - Stable & dry conditions for the structure year-round.

2. Water Vapor Control



2. Water Vapor Control

- How do you design for water vapor control with CI?
  - You use a temperature controlled design approach
- Simple:
  - Determine Climate Zone (Figure 2)
  - Select appropriate interior vapor retarder and insulation ratio (Table 2)

2. Water Vapor Control

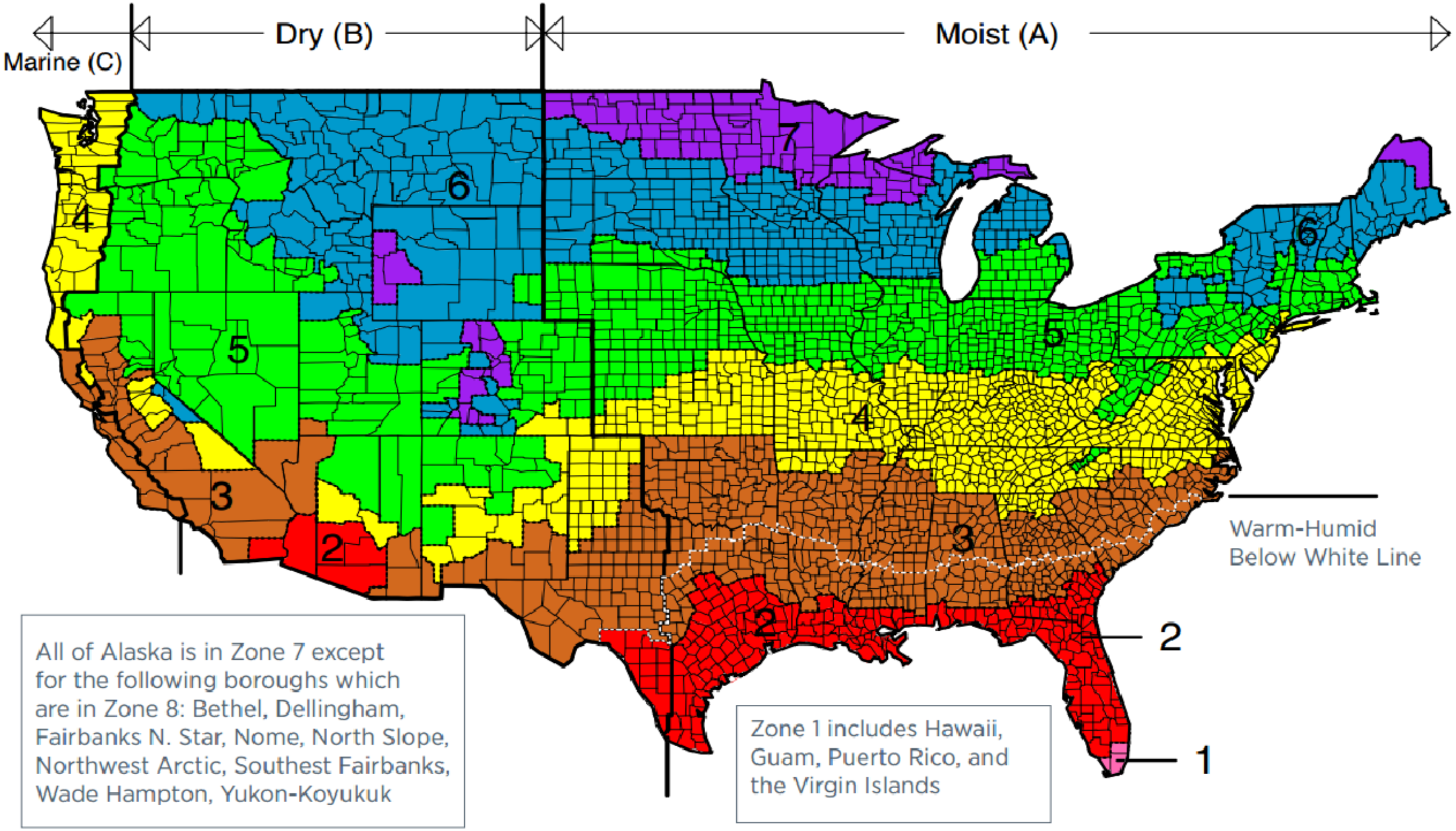


Figure 2. U.S. Climate Zone Map

2. Water Vapor Control

TABLE 2
MINIMUM INSULATION RATIO OR CONTINUOUS INSULATION R-VALUE FOR LIGHT-FRAME WALLS WHERE EXTERIOR CONTINUOUS INSULATION (ci) IS USED [a,b,c,d]

Climate Zone (Fig. 2)	Maximum Heating Degree Days (65F basis)	Interior Vapor Retarder (VR) Class			
		Class I[e]	Class II[e]	Class III	No VR[f]
1	N/A	NP	NP[g]	R-2ci minimum	R-2ci minimum
2	N/A	NP	NP[g]	R-2ci minimum	R-2ci minimum
3	3,600	NP	R-2ci minimum	R-2ci minimum	0.4
4	5,400	NP	R-2ci minimum	0.2	0.9
5	7,200	0.2	0.2	0.35	1.3
6	9,000	0.2	0.2	0.5	1.7
7	12,600	0.35	0.35	0.8	2.3
8[h]	16,200	0.5	0.5	1.1	2.8

For SI: 1 heating degree day (65°F basis) = 0.56 heating degree days (18°C basis)
NP = indicated vapor retarder class is not permitted in the indicated Climate Zone.
Table Notes & Commentary:

See Table 2 in report for important table notes & commentary!

2. Water Vapor Control

- Example Design:
  - “R20+5ci” 2x6 wall
  - Insulation Ratio (IR) = Re/Ri = 5/20 = 0.25
    - —With Class III VR, Table 2 shows it works in CZ 1-4+
    - —With Class I or II VR, Table 2 shows it works in CZ 1-6+
  - For colder climates, just use required insulation ratio for specified vapor retarder.

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2. Water Vapor Control

- Example (cont'd)
  - Table 2, Note 'e': Where Class I or II VR is used with low-perm FPIS, the VR must have a "wet cup" (ASTM E96 Procedure B) vapor permeance of 1 perm or greater.
    - **Why? To promote drying to the interior of incidental or unintended water intrusion! – safety factor.**
    - **This means a "smart" (responsive) vapor retarder, like Kraft paper or other proprietary alternatives.**
  - Data from numerous field studies shows walls with appropriate use of FPIS are consistently dry and stable (ASTM STP 1599).

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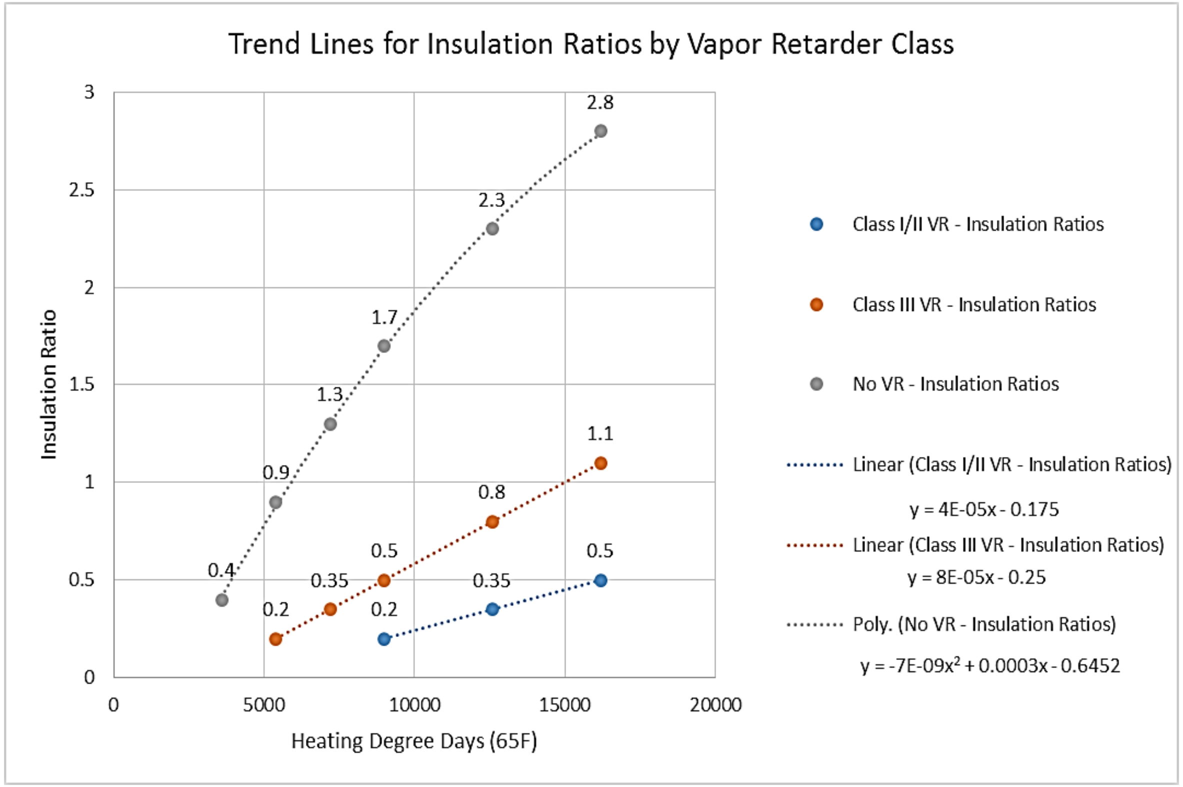
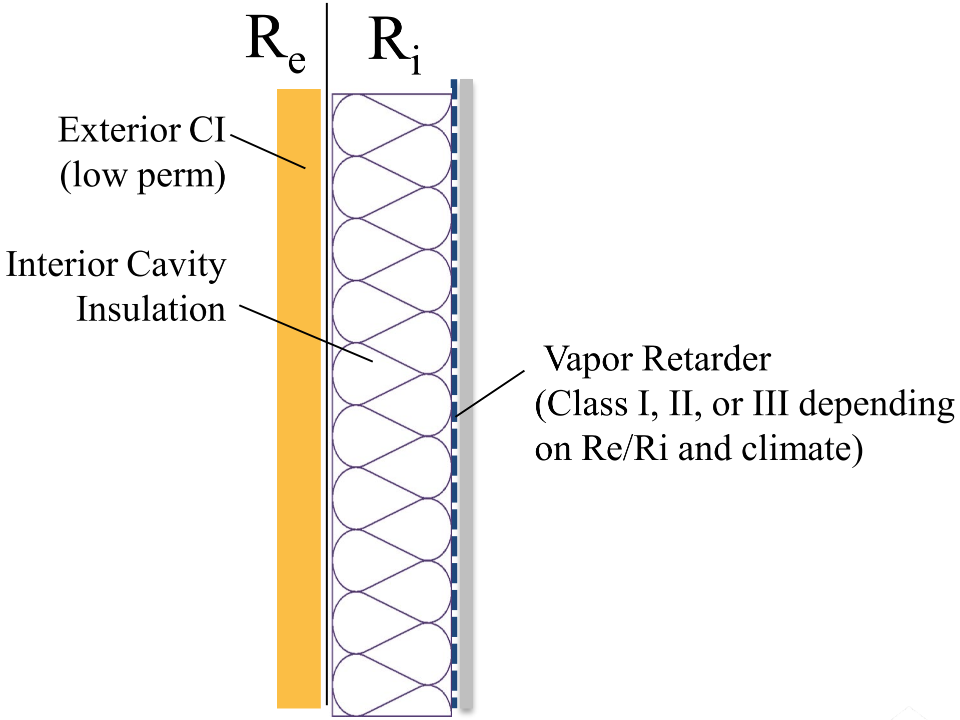
2. Water Vapor Control

- Another way to show insulation ratios:



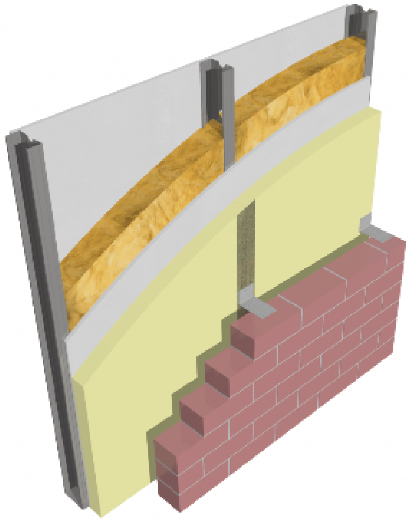


2. Water Vapor Control

- Wall Calculator for Energy Code (U-factor) and Building Code Vapor Control Compliance Check: www.continuousinsulation.org

Cold-formed Steel Wall Calculator for R-values and U-factors Including Checks for Moisture Control

This wall calculator is a tool to help coordinate energy code thermal insulation compliance and building code water vapor control compliance for a proposed steel frame wall assembly on a commercial or residential building.



It performs the following two design checks for a user inputted wall assembly:

Computes the assembly U-factor and compares it to code minimum thermal performance requirements (maximum U-factors) found in 2015 IECC Tables C402.1.4 and R402.1.4 (IRC Table N1102.1.4) which are climate dependent.

Click here to toggle additional text

Conducts a water vapor control check as an aid to help determine if the proposed wall assembly also complies with minimum building code requirements associated with various interior vapor retarder options which are dependent on climate and other factors such as insulation amount and location.

Click here to toggle additional text

The user is encouraged to confirm the suitability of this tool for the intended application, verify all outputs and recommendations, and seek professional advice as determined necessary.

Additional Moisture Control Considerations:

Inward Moisture Movement into Walls through High-Perm Exterior Coverings

RECOMMENDATIONS: In moist, warm/mixed climates (e.g., Marine and 1A – 4A), use one of the following options:

Click here to toggle additional text

Balancing Wetting & Drying Potential

RECOMMENDATIONS: Limiting wetting potential is the primary means of protecting walls against water damage in wet, wind-driven rain climates.

Click here to toggle additional text

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2. Water Vapor Control

Wall Assembly Inputs

1. Building / Energy Code & Year

Energy code & year

IBC 2015 + IECC-C 2015 (Excluding group R)

2. Climate Zone and Heating Degree Days

Climate zone

5

Enter Heating Degree Days (HDD) if you want the minimum Insulation Ratio (Re/Ri) to be based on heating degree days, rather than strictly on the climate zone minimums. Values outside the range shown will be ignored. The heating degree days option is only available for some climate zones. HDD values are on a 65°F basis.

Optional Heating degree days (Valid range: 5401 - 7200)

3. Cladding

Cladding type and R-value

Stucco (0.08)

4. Exterior Continuous Insulation

Manufacturer's rated R-value at installed thickness

7.5

5. Exterior Sheathing

Output

Energy Code Thermal Check

U-Factor Method

Factor	Proposed Wall	Code Requirement	Compliance Check
U-factor of opaque wall assembly	0.060	0.064	✓ Passed

R-Value Method

Factor	Proposed Wall	Code Requirement	Compliance Check
*R-value of opaque wall assembly	R13+7.5ci	R13+7.5ci	✓ Passed

Building Code Water Vapor Control Check

	Insulation Ratio (Re/Ri) Method		
Interior Vapor Retarder Class[1]	Proposed Ratio	Minimum Ratio Required (Zone 5)	Pass/Fail
Class I[2]	0.58	0.30	✓ Passed
Class II[3]	0.58	0.30	✓ Passed
Class III[4]	0.58	0.45	✓ Passed
No Interior Vapor Retarder	0.58	1.40	✗

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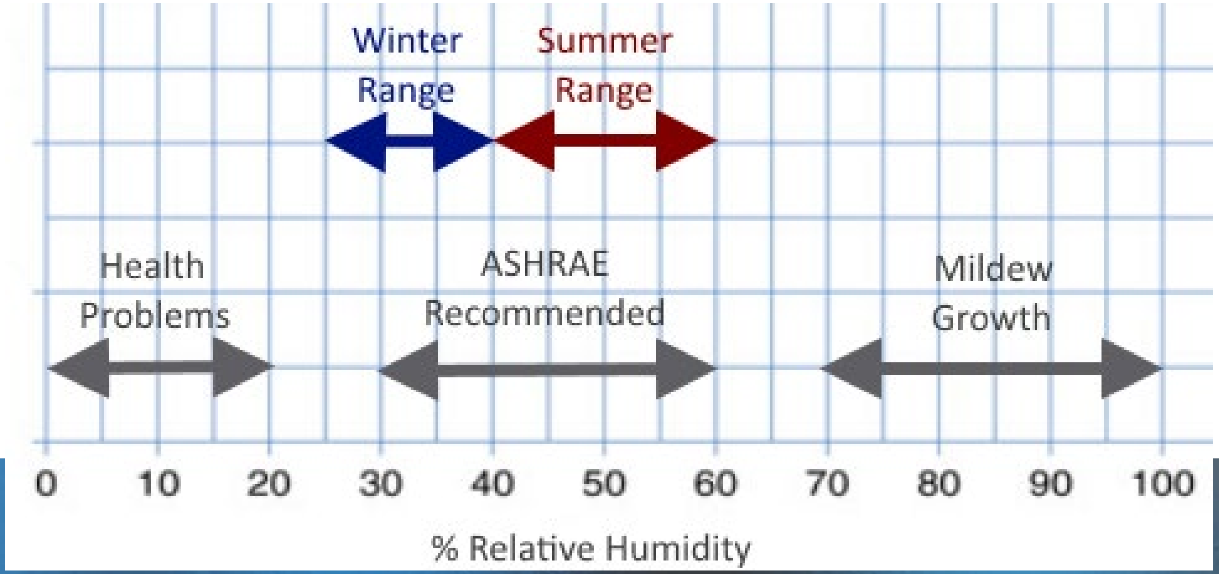
2. Water Vapor Control

- Caveats (for all design approaches and assemblies):
  - Assumes “normal” indoor RH conditions
    - —Where high indoor RH (e.g., pools, saunas, etc.) additional consideration required (e.g., increased IR, lower permeance VR, better building ventilation and dehumidification, or combination)



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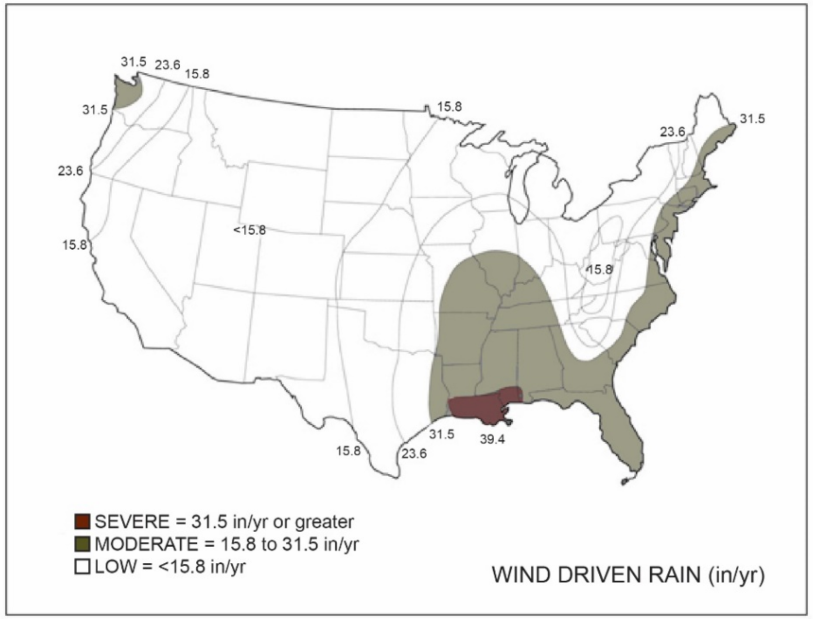
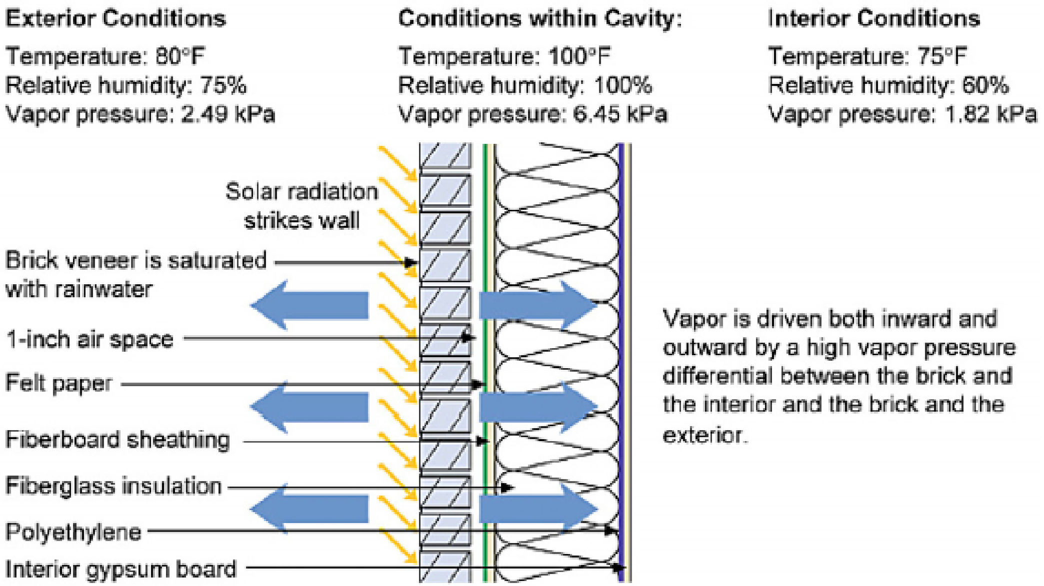
2. Water Vapor Control

- Caveats (for all design approaches and assemblies):
  - Adequate (code-compliant or better) air leakage control to avoid “flanking” of VR
    - —Walls with adequate CI tend to reduce moisture control threat of air leakage
  - Adequate (code-compliant or better) rain water control
    - —Appropriate use and installation of WRB and flashings
    - —Poor control of rain water will cause any wall assembly to fail.



2. Water Vapor Control

- Inward Vapor Drive & Reservoir Claddings
  - Modern experience and codes now are beginning to recognize that reservoir claddings (like stucco or adhered veneers) absorb rainwater (wow!).
  - After rain, then the sun drives that water inward in the form of water vapor (stucco dries inward and outward).



Inward Moisture Movement Due to Solar Radiation

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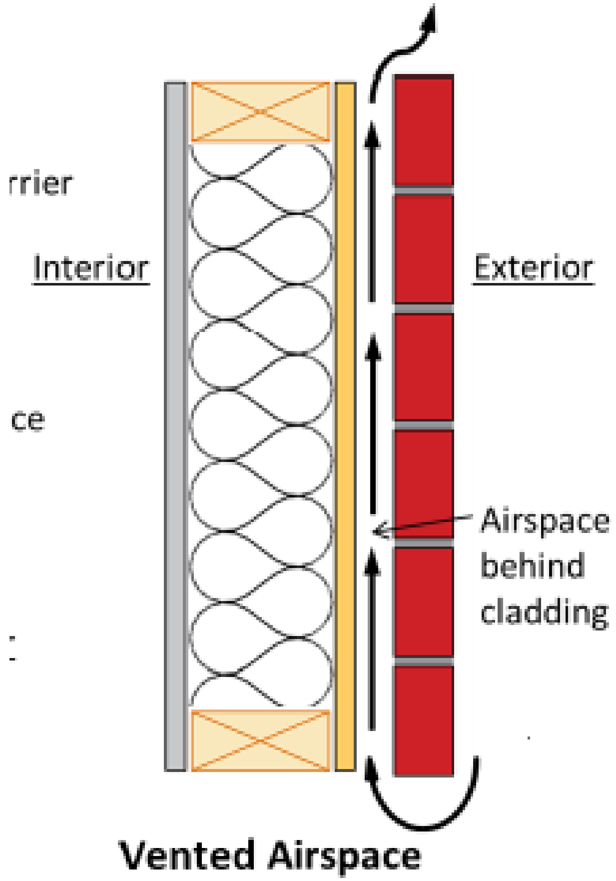
2. Water Vapor Control

- Inward vapor drives can exceed the worst outward vapor drives during winter
- This is why anchored veneers (like brick) have used a vented airspace for ages
- Particularly problematic in Moist (A) and Marine (C) Climate Regions and especially the "warm-humid" region (Figure 2).

http://www.greenbuildingadvisor.com/blogs/dept/musings/all-about-wall-rot

2. Water Vapor Control

- Solutions for inward water vapor drives in moist climates:
  - Back ventilation of reservoir cladding
  - Use of low-perm (<~5 perm) FPIS continuous insulation to block inward vapor drive
    - —Means of drainage still required as always important



2. Water Vapor Control

New code proposal related to ci application with stucco to mitigate inward vapor drive:

Add new text as follows:

2510.6.1 Dry climates. One of the following shall apply for dry (B) *climate zones*:

1. The *water-resistive barrier* shall be two layers of 10-minute Grade D paper or have a water resistance equal to or greater than two layers of *water-resistive barrier* complying with ASTM E2556, Type I. The individual layers shall be installed independently such that each layer provides a separate continuous plane and any flashing, installed in accordance with Section 1404.4 and intended to drain to the *water-resistive barrier*, is directed between the layers.
2. The *water-resistive barrier* shall be 60-minute Grade D paper or have a water resistance equal to or greater than one layer of *water-resistive barrier* complying with ASTM E2556, Type II. The water-resistive barrier shall be separated from the stucco by a layer of foam plastic insulating sheathing or other nonwater absorbing layer.

2510.6.2 Moist or marine climates. In moist (A) or marine (C) *climate zones*, water-resistive barrier shall comply with of one of the following:

1. In addition to complying with Item 1 or 2 of Section 2510.6.1, a minimum 3/16 inch (4.8 mm) space shall be added to the exterior side of the *water-resistive barrier*.
2. In addition to complying with Item 2 of Section 2510.6.1, a space with a minimum drainage efficiency of 90% as measured in accordance with ASTM E2273 or Annex A2 of ASTM E2925 is added to the exterior side of the *water-resistive barrier*.

2. Water Vapor Control

- Additional Resources:
  - ABTG Research Report No. 1701-01 (2017), *Model Moisture Control Guidelines for Light-Frame Walls: A Building Code Supplement for Builders, Designers, and Building Officials*
  - ASTM STP 1599 (2017), *Assessment of Hygrothermal Performance and Design Guidance for Modern Light-Frame Wall Assemblies*
  - ABTG Research Report No. 1401-03 (2015), *Assessment of Water Vapor Control Methods for Modern Insulated Light-frame Wall Assemblies*
  - *Durability by Design, 2nd Edition: A Professional's Guide to Durable Home Design* (2015), U.S. HUD
- Most are available for free download at **www.continuousinsulation.org**

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3. Water-Resistive Barrier (WRB)

- When properly qualified, FPIS continuous insulation can also be used as the WRB system (see next slide)
- Test requirements are some of the most stringent in the industry (e.g., ASTM E331 wall spray test with 6.24psf pressure difference)
- Joint sealing components also individually tested for weatherization/durability and water-resistance
- Use FPIS manufacturer's approved materials and installation instructions; don't substitute

3. Water-Resistive Barrier (WRB)

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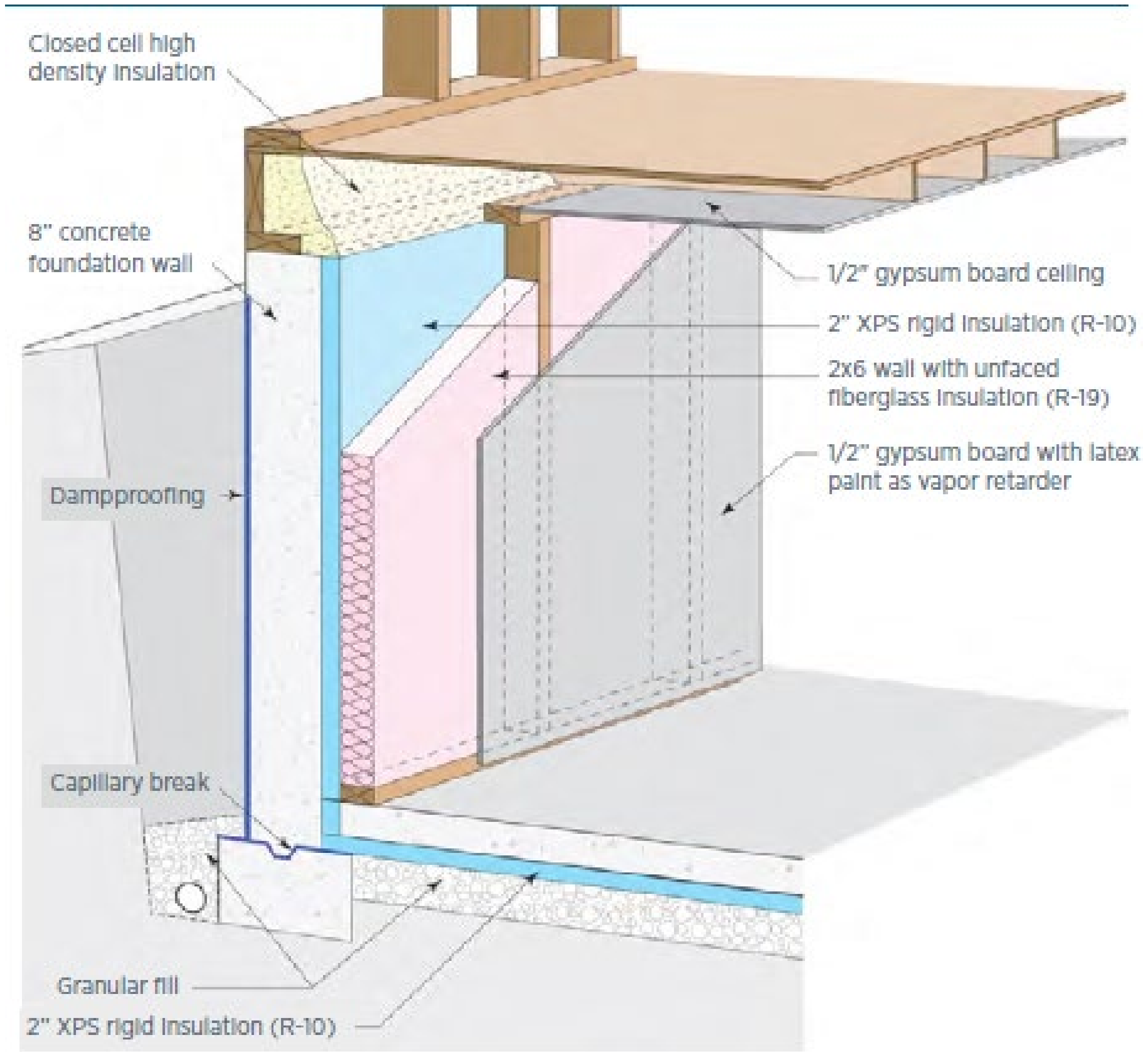
4. Air Barrier (AB)

- FPIS continuous insulation can also be used as an air barrier
- Deemed to comply in IECC and ASHRAE 90.1 (i.e., XPS and Polyiso, min ½" thick)
- Alternatively, can comply with material air permeability limits per ASTM testing.
- If using FPIS WRB system per building code, then taped/sealed joints also serve as means to create a continuous air barrier system as required by the energy code.

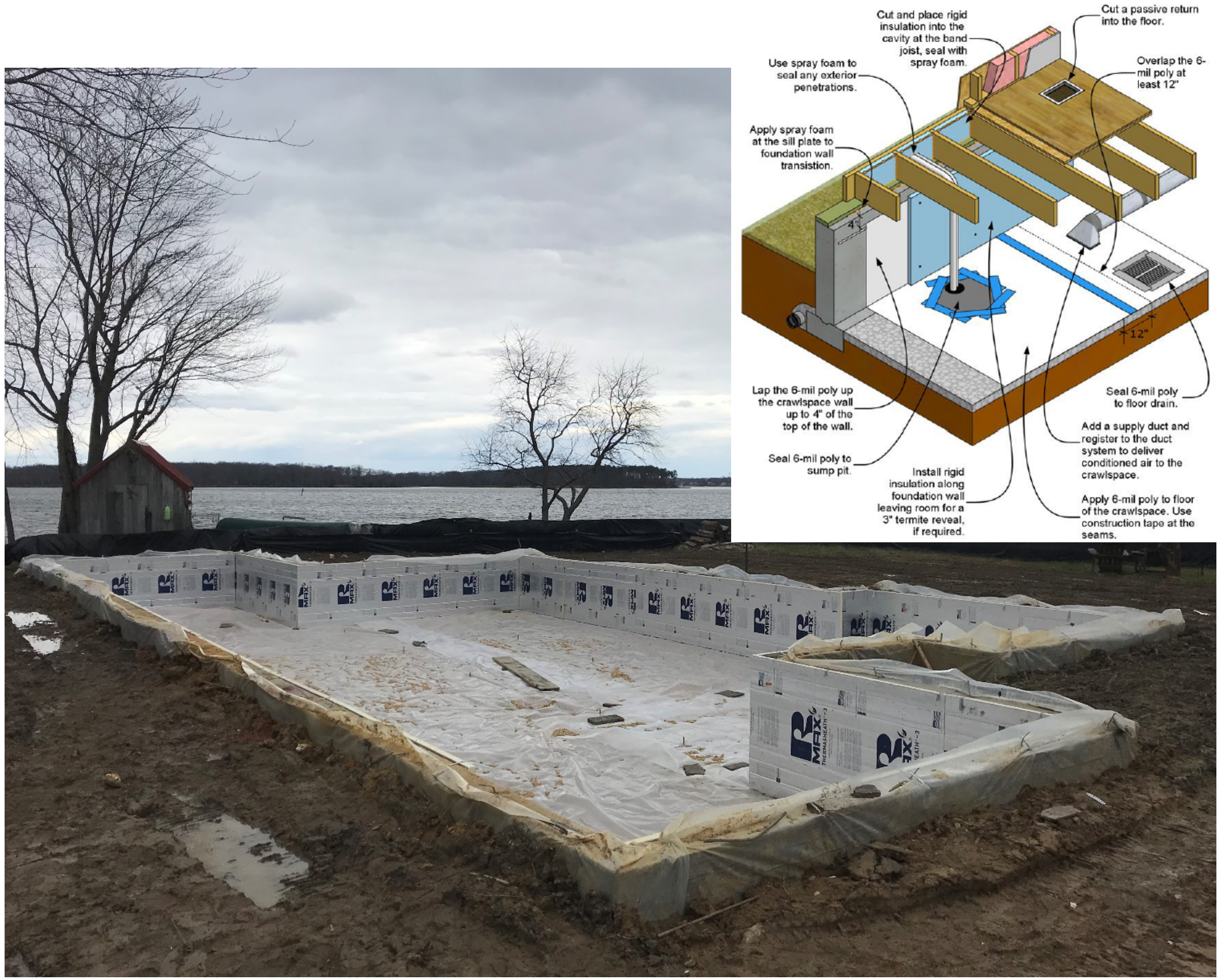
5. Foundations

- FPIS continuous insulation is considered a “hall of fame” insulation method for basement walls by DOE Building America Program
  - Improved energy efficiency and moisture resistance



5. Foundations

- Also, works great for unvented (conditioned) crawlspaces
  - Allows ductwork in conditioned space; warm floor; no moist air foundation vents; storage
  - Place insulation only at crawlspace perimeter, not between every joist



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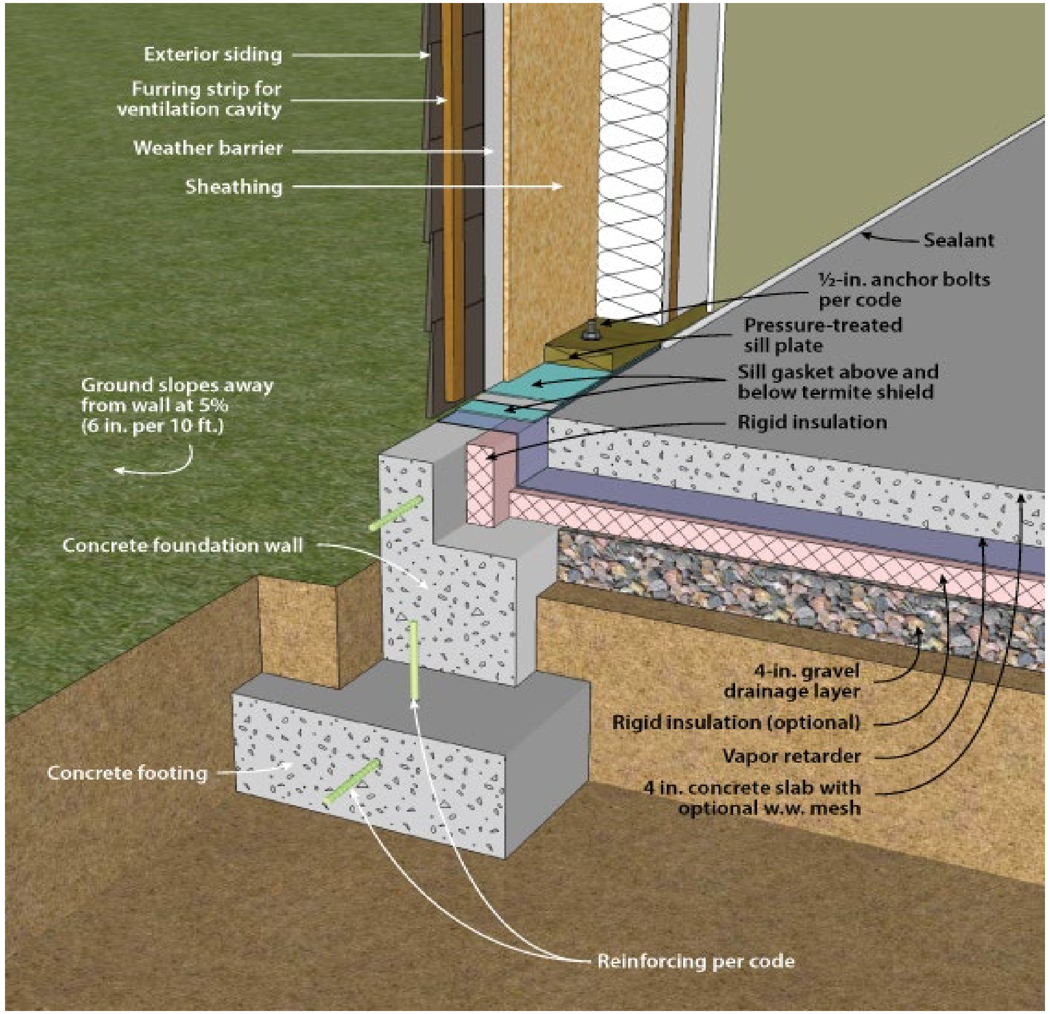
5. Foundations

- Heated and Unheated Slabs
  - Improved energy savings, comfort, condensation control



5. Foundations

- Frost-Protected Shallow Foundations
  - Energy Savings and Construction Cost Savings ($$$)
  - ASCE 32 standard, IRC, and IBC

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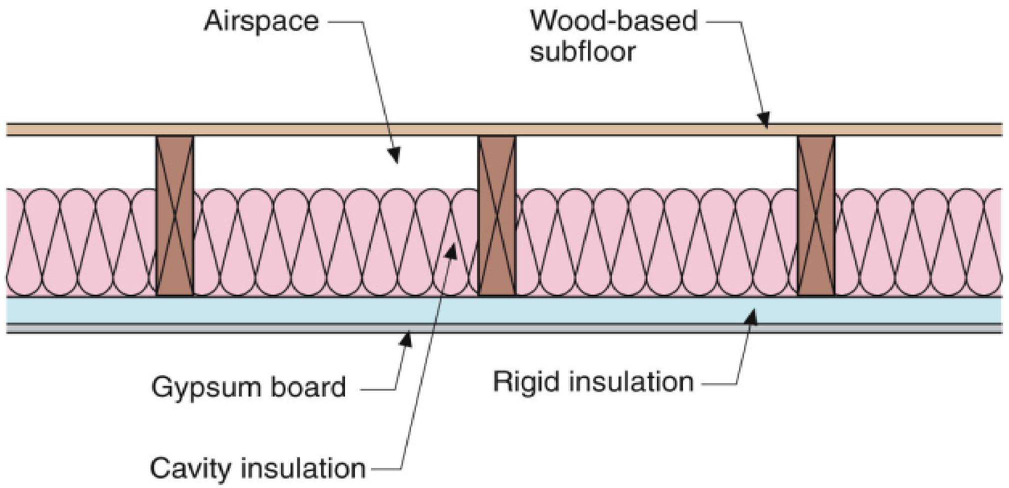
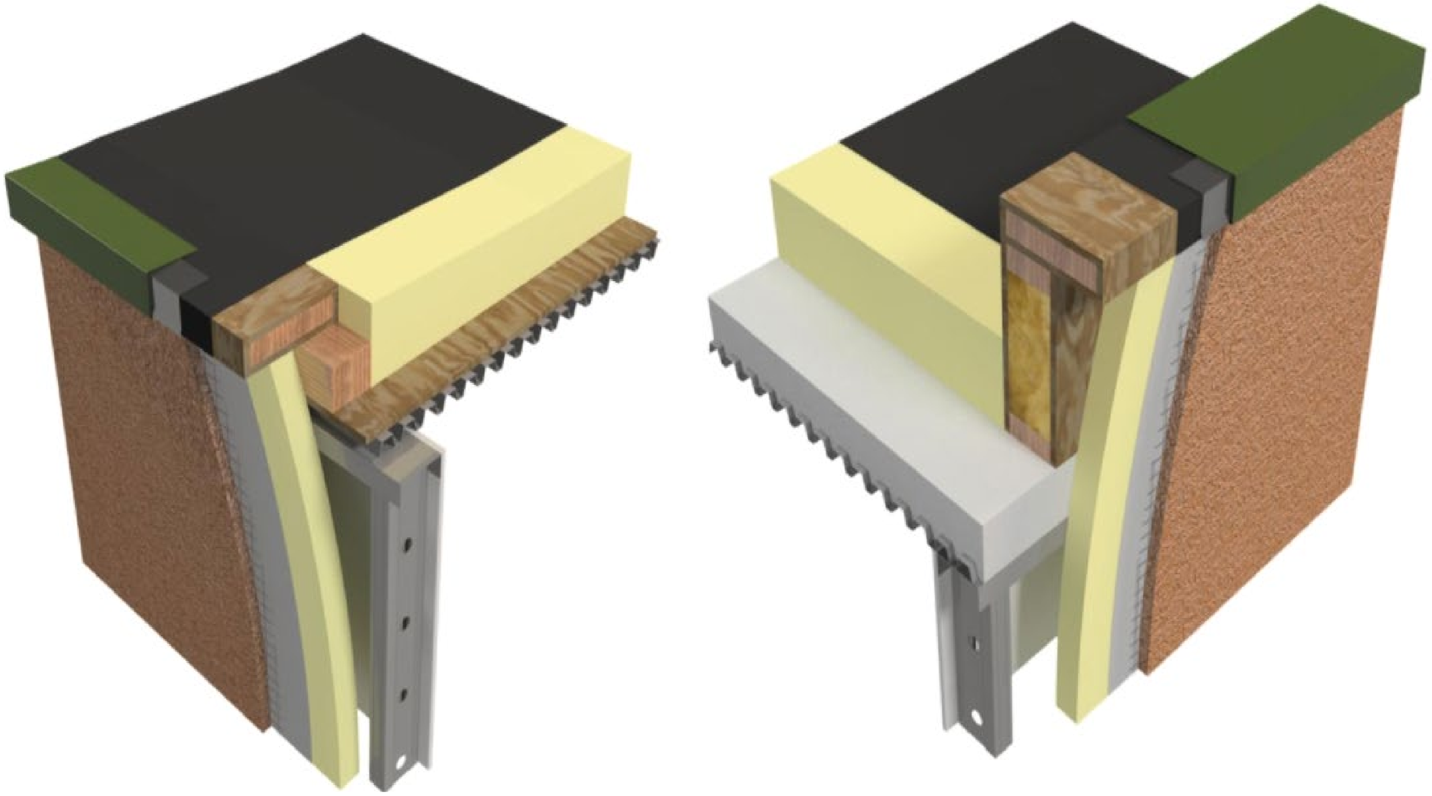
5. Foundations

- Floor over Unconditioned Space (e.g., vented crawlspace or raised coastal foundation, etc.)
  - Improved comfort, energy savings, and moisture control
  - Same as sideways wall or upside-down roof.



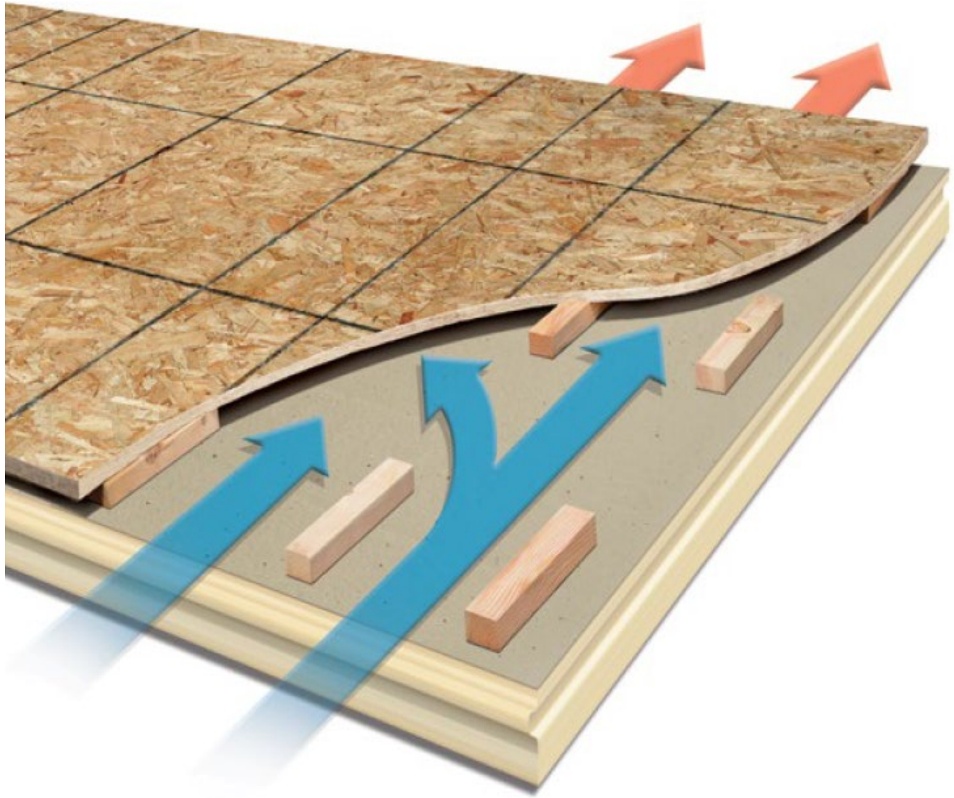
6. Roofs

- Commonly used for low-slope roofs as “above deck” continuous insulation
  - Under roof membrane (most common)
  - Over roof membrane (Protected Membrane Roof System)



6. Roofs

- Also, used for steep slope roofs
  - Cathedral roofs
  - Attic roofs (puts ducts in condition space)
  - Improved energy efficiency
  - Converts vented attic into storage or living space



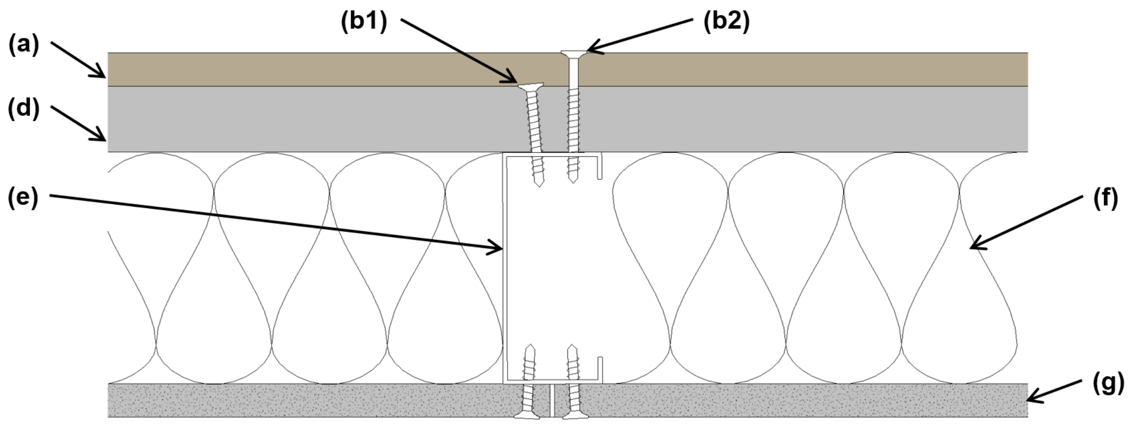
Vented nail-base roof deck panel (image courtesy GAF)

COORDINATION WITH OTHER BUILDING CODE REQUIREMENTS

- Cladding Attachment
- Window/Door Installation
- Wall Bracing
- Wind Resistance
- Fire Safety and Use of FPIS

1. Cladding Attachment

- Prescriptive provisions for attachment of cladding and furring through FPIS to wood and steel framing:
  - Commercial: IBC Chapter 26
  - Residential: IRC Section R703
- Proprietary fasteners & brackets
- Additional resources at www.continuousinsulation.org



NOTE: Design procedure can be used to also design structural connections (e.g., roof or deck ledgers) through FPIS

1. Cladding Attachment

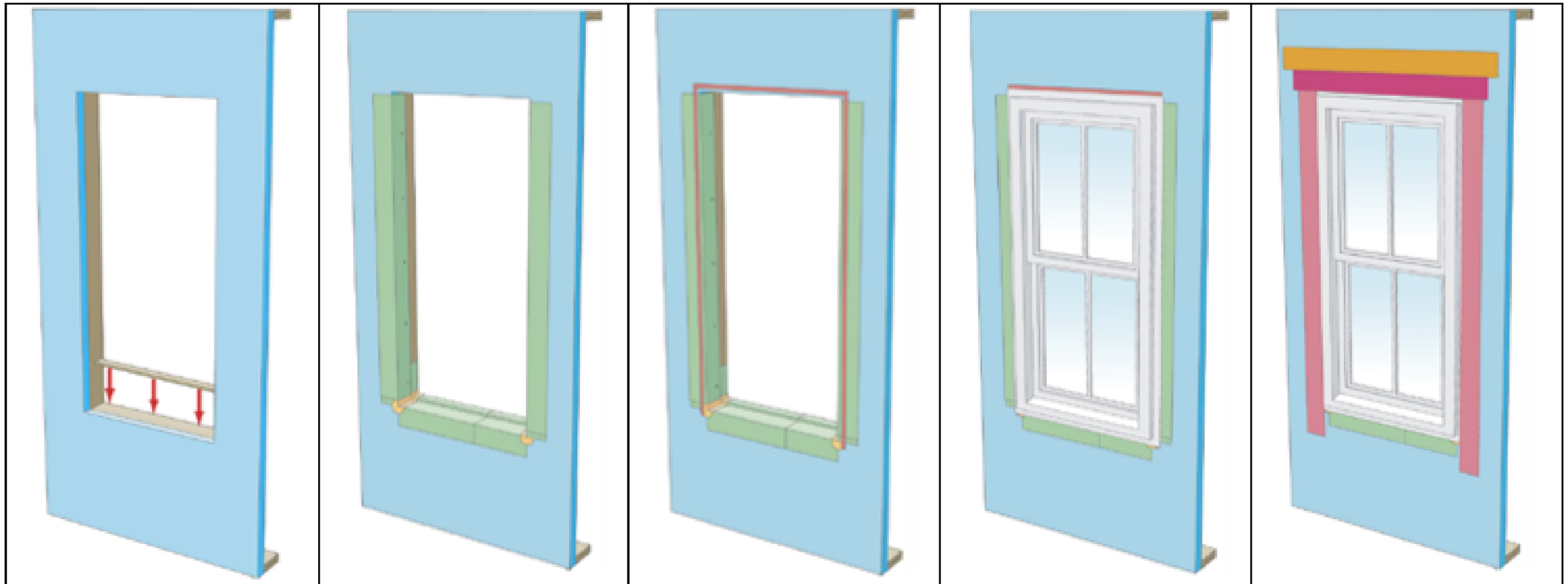
TABLE 2603.12.1
CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]

CLADDING FASTENER THROUGH FOAM SHEATHING INTO:	CLADDING FASTENER TYPE AND MINIMUM SIZE[b]	CLADDING FASTENER VERTICAL SPACING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[c] (inches)							
			16″ o.c. fastener horizontal spacing				24″ o.c. fastener horizontal spacing			
			Cladding weight				Cladding weight			
			3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Cold-formed steel framing (minimum penetration of steel thickness plus 3 threads)	#8 screw into 33 mil steel or thicker	6	3.00	2.95	2.20	1.45	3.00	2.35	1.25	DR
		8	3.00	2.55	1.60	0.60	3.00	1.80	DR	DR
		12	3.00	1.80	DR	DR	3.00	0.65	DR	DR
	#10 screw into 33 mil steel	6	4.00	3.50	2.70	1.95	4.00	2.90	1.70	0.55
		8	4.00	3.10	2.05	1.00	4.00	2.25	0.70	DR
		12	4.00	2.25	0.70	DR	3.70	1.05	DR	DR
	#10 screw into 43 mil steel or thicker	6	4.00	4.00	4.00	3.60	4.00	4.00	3.45	2.70
		8	4.00	4.00	3.70	3.00	4.00	3.85	2.80	1.80
		12	4.00	3.85	2.80	1.80	4.00	3.05	1.50	DR

2018 IBC – similar tables also for wood framing and furring connections

2. Window/Door Installation

- Standard installation detail



Step 1: Install foam sheathing on wall and back-dam on sill

Step 2: Install adhered flexible flashing on sill and then jambs

Step 3: Apply window flange bedding sealant (not at sill flange)

Step 4: Install window in prepared opening

Step 5: Install adhered flexible flashing at jambs and then head

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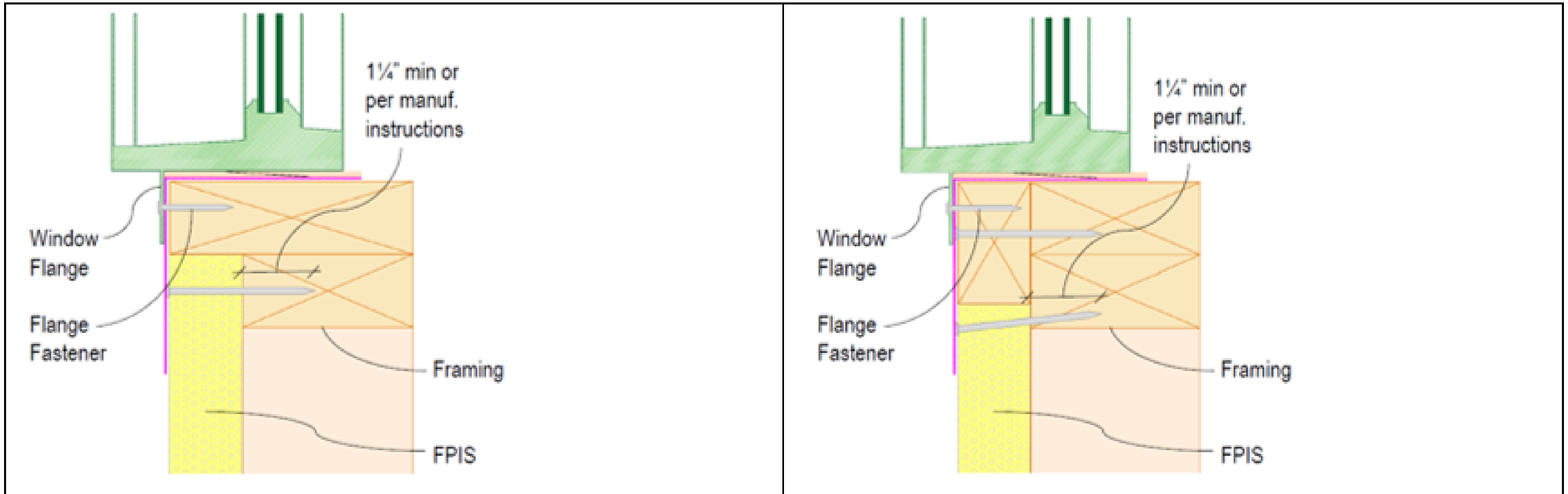
2. Window/Door Installation

- Window Buck / Picture Frame (blocking) Detail



(a) Rough opening buck

(b) Rough opening blocking

2. Window/Door Installation

- Consult with window/door manufacturer
  - May have relevant installation procedure for warranty
- Consult with design professional for unique conditions
- AAMA 540 – provides test method to evaluate fenestration installation procedures
- FPIS WRB system manufacturers test with specific flashing details & materials for windows/doors/penetrations
  - Consult FPIS manufacturer's installation instructions

3. Wall Bracing / 4. Wind Resistance

- FPIS is NOT wall bracing – must use as oversheathing or with diagonal braces (e.g., wood let-in or metal X bracing)
  - Can also use as undersheathing (e.g., Extended Plate Wall or Huber Zip-R, etc.) with adjusted framing/fastening to maintain bracing strength
  - Some FPIS materials are laminated to structural sheathing materials/facers for bracing; refer to specific manufacturer code compliance data.
- FPIS and installation/fastening is typically intended only for temporary exposure to wind during construction
  - For wind pressure rating of FPIS where installed over open cavities and fastened to resist 100% of design wind load, refer to manufacturer data per ANSI/SBCA FS100 standard.

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5. Fire Safety and Use of FPIS

- Some of the most stringent fire safety requirements for any material.
- Decades of successful experience with code compliant construction.
- Recent international fires (e.g., Grenfell) result of non-compliant construction.
- Solution: compliance and enforcement

Fire Safety & Foam Sheathing Use

The Foam Sheathing Committee of the American Chemistry Council (FSC) focuses on using reliable science in support of sound design and installation of foam sheathing. Member companies include: Atlas Roofing, Dow, GAF, Hunter Panels, Johns Manville, Kingspan Insulation, Owens Corning, and RMAX.

The foam sheathing industry has a long-standing history of advocating for the safe use of foam plastics through U.S. model codes and standards, in particular IBC Chapter 26 and NFPA 285. These provisions together with other fire-safety requirements of the IBC have served to provide a sound basis for reliable use and safe performance of foam sheathing.

Photo courtesy of Jesse Beitel, Jensen Hughes

Recent Widely Reported Exterior Fires Support Value of IBC & NFPA 285 Compliant Design & Installation

APPROVED

Current Code Requirements are Effective

30 Years of Experience has Demonstrated that NFPA 285 is Effective

Renew Emphasis on Compliance and Enforcement

A FRESH LOOK AT FIRE SAFETY

In view of the Grenfell, Torch Tower, and other international fire events, it is important for the building safety community to take a fresh look at the U.S. codes and standards environment compared to those abroad. While these events have raised interest in the use of combustible materials on exterior walls of buildings, U.S. codes and standards for safe use of foam plastics are particularly robust and have performed well due to an effective combination of building and fire code requirements.

CURRENT CODE REQUIREMENTS ARE BOTH EFFECTIVE AND USABLE

Strict regulations for foam plastics in U.S. building and fire codes have been in place since 1976. Current requirements for the use of foam plastic insulation in exterior walls for commercial buildings of Type I, II, III and IV construction of any height are covered in Section 2603.5 of the IBC. These provisions represent some of the most comprehensive, stringent, and effective fire-safety requirements for use of a combustible material on exterior walls of buildings.[1] [2] [3] [4] A key component of Section 2603.5 is the two-story wall fire test known as the NFPA 285 consensus standard. This full-scale test has proven to be a predictable indicator of acceptable fire performance since 1988. As evidenced by exterior fire events reported internationally, there is an absence of adverse life-safety protection consequences for buildings properly designed and constructed with (1) sprinklers and (2) either NFPA 285 and IBC Chapter 26 compliant exteriors (or equal) or non-combustible exteriors. [5] [6] [7]

ENGINEERING JUDGMENTS ARE A CRITICAL COMPONENT

Successful experience in the U.S., as described above, has included appropriate use of the NFPA 285 assembly test data directly and together with small-scale tests and engineering analysis, to evaluate safe substitutions of materials through what is known as "engineering judgments (EJs)" by fire engineering experts. EJs are necessary because:

- They provide a basis for material substitutions that do not add risk to the tested NFPA 285 assemblies.
- It is impractical to separately test the thousands of potential combinations of materials each as a separate assembly test variation.

COMPLIANCE AND ENFORCEMENT FOCUS

When the reported international fire events are viewed in the context of the effectiveness and reliability of U.S. codes, which govern the use of foam plastics in exterior walls, clearly a crucial focus needs to be on compliance and enforcement. This is a very important and appropriate response. Refer to key resources listed below.

Resources:
To promote compliance and enforcement, FSC has developed a resource for use of foam sheathing materials in building envelopes at www.continuousinsulation.org and a list of NFPA 285 compliant assemblies by FSC member manufacturers is available at www.drjengineering.org/system/files/drj/tan/node/56/drr120204foamintypeivconstruction.pdf

References:
[1] Beitel, J., Spiewak, B., Code and Fire Test Requirements for Foam Plastic Insulation Used in Exterior Walls, ICC Building Safety Journal, August 2010, http://bsj.iccsafe.org/august/features/code_and_fire.html
[2] DrJ Engineering, Foam Plastic Insulating Sheathing Products in Exterior Walls of Type I, II, III or IV Construction, January 2016, www.drjengineering.org/system/files/drj/tan/node/56/drr120204foamintypeivconstruction.pdf
[3] Beitel, J. Fire Requirements for Foam Plastic Insulation and WRBs in Exterior Walls, Durability + Design, 2012, www.durabilityanddesign.com/webinars/
[4] Crandell, J.H., Continuous Insulation for Code-Compliant, High-Performance Exterior Walls, RCI Interface, January 2012, www.rci-online.org/wp-content/uploads/2012-01-crandell.pdf
[5] Wieczorek, C.J., Grenfell: The Perfect Formula for Tragedy, FM Global, 2017, www.fmglobal.com/insights-and-impacts/2017/grenfell-tower-white-paper
[6] BRANZ, Fire Performance of Exterior Claddings, Fire Code Research Reform Program, April 2000. http://www.abcb.gov.au/Resources/Publications/Research/FCRC-Fire-Performance-of-Exterior-Claddings
[7] White, N. and Delichatsios, M. (2014). Fire Hazards of Exterior Wall Assemblies Containing Combustible Components, Fire Protection Research Foundation, www.nfpa.org/foundation

American Chemistry Council
Foam Sheathing Committee

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5. Fire Safety and Use of FPIS

- Example Code Requirements (IBC 2603, IRC R316):
  - Flame Spread & Smoke Development Index (max 75/450 or 25/450, depending on application)
  - Thermal barrier to separate from interior (e.g. ½" GWB)
  - Ignition barriers (attic and crawlspace applications)
  - NFPA 285 testing for Type I, II, III, and IV commercial buildings
    - **Full-scale two-story fire test with compartment fire exiting window in lower story – addresses all failure modes and most common source for exterior fires**
  - Special full scale testing per code may allow certain applications without ignition or thermal barrier, etc. (check with manufacturer)
- **Afternoon session:** "Foam Plastic Insulation: Fire Safety for Exterior Walls" (Koscher and Ross)
- **Additional Resources:** www.continuousinsulation.org/fire-performance

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CONCLUSION

- There are many applications for FPIS in walls, foundations, floors, and roofs.
- Benefits include improved thermal, moisture, durability, and comfort performance.
- Significant experience and technical information is available for appropriate and code-compliant use
  - Refer to www.continuousinsulation.org

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CONCLUSION

- THANK YOU –
  ANY QUESTIONS?