THE STEEL FRAMING INDUSTRY ASSOCIATION

SFIA 121: Integration of cladding, windows, and continuous insulation on CFS walls

AGENDA

- Welcome & housekeeping
- A word about SFIA
- Speaker introduction
- Presentation
- Q&A

SFIA
STEEL FRAMING INDUSTRY ASSOCIATION

WELCOME & HOUSEKEEPING

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- Mics are muted. Please ask any questions in the chat or Questions windows.
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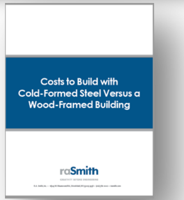
Business Planning

	Structural Tons Reported				Total
	Q1'19	Q2'19	Q3'19	Q4'19	2019
East	51,100	52,368	-	-	103,468
North Central	18,368	20,529	-	-	38,897
South Central	27,605	28,445	-	-	56,050
West	34,441	35,854	-	-	70,295
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

	NonStructural Tons Reported				Total
	Q1'19	Q2'19	Q3'19	Q4'19	2019
East	64,593	66,000	-	-	130,593
North Central	21,539	23,172	-	-	44,711
South Central	22,240	24,899	-	-	47,139
West	24,017	27,806	-	-	51,823
Total	132,389	141,877	0	0	274,266



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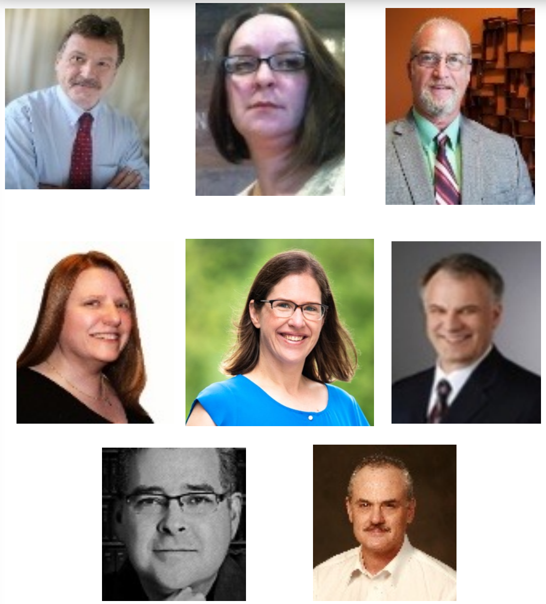

Architectural Services

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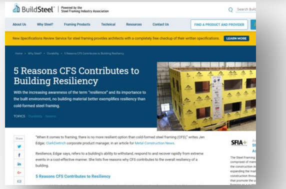
CONTINUING EDUCATION AIA

Sustainability



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INTRODUCING OUR SPEAKER!

Jay Crandell, PE
Over 30 years of experience in construction, engineering, and innovative building technology research for private and public sector clients.

Integration of Cladding, Windows, & Continuous Insulation on CFS Walls

Jay H. Crandell, P.E.
ABTG / ARES Consulting

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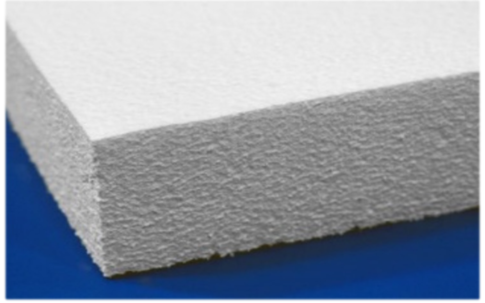
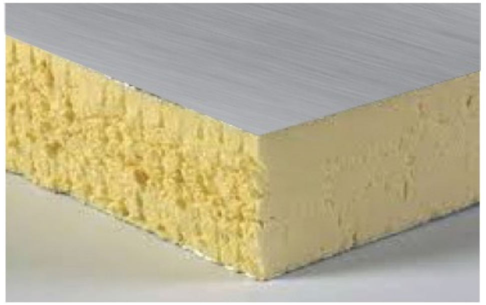
Outline

- What is continuous insulation (ci)?
- Building Science Fundamentals
- Water-Resistive Barrier & Flashing – Code Requirements
- Fenestration Installation & Performance on Walls with ci
- Cladding Installation & Performance on Walls with ci
- Conclusions
- Q & A

First, what is ci?

- IECC and ASHRAE 90.1 Definition:
  - **Continuous Insulation (ci):** 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.
- FPIS Material Types (10-100 psi compressive resistance; R4-R6 per in.):
  - ASTM C578 – Standard specification for rigid, cellular polystyrene thermal insulation
    - Extruded polystyrene (XPS)
    - Expanded polystyrene (EPS)
  - ASTM C1289 – Standard specification for faced rigid cellular polyisocyanurate thermal insulation board
    - Polyisocyanurate (Polyiso, PIC, etc)
- Others ci materials include Phenolic foam (R7+ per in.), mineral/glass fiber, wood fiber, spray foam, structural composite insulating sheathing, etc.





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Building Science Fundamentals

- 5 Concepts for Moisture Control
- 3 Rules to Never Break
- Practical Resources
- Wind-driven Rain Hazard

5 Building Science Concepts for Moisture Control

- Regardless of what materials you specify for a wall assembly, certain building science fundamentals are always necessary to address.
- Successful moisture control requires an integrated approach to 5 key building science concepts:
  1. Control Rain Water Intrusion (e.g., continuous water-resistive barrier)
  2. Control Air Leakage (e.g., continuous air barrier)
  3. Control Indoor Relative Humidity (e.g., building ventilation & de-humidification)
  4. Control Initial Construction Moisture (e.g., prevent enclosure of wet materials)
  5. Control Water Vapor (e.g., optimized balance of wetting and drying through strategic use of insulation and vapor retarders)
- All are important, all vary in significance, all have inter-dependencies.
- These 5 concepts are captured in the following 3 rules…

RULE #1 of 3

Moisture Control for Wall Assemblies:

Building Robust Walls with Foam Plastic Insulating Sheathing (FPIS) Continuous Insulation (ci)

07.27.21

RULE #1: Keep Water Vapor (Humid Air) Away from Cool Surfaces!

When installed in accordance with modern building code and energy code requirements for continuous insulation and water vapor control (see CI's Quick Guide: Water Vapor Control and wall calculators), FPIS ci keeps water-sensitive materials inside the wall dry by maintaining a temperature above the dew point. Simply use the right R-value of FPIS ci for the wall assembly based on the climate zone and an appropriately specified interior vapor retarder (or no interior vapor retarder) to control outward vapor diffusion in the winter and maintain inward vapor diffusion (drying) in the warmer seasons. This approach results in much dryer walls with a more stable moisture content throughout all seasons of the year in comparison to walls that rely exclusively on the traditional use of interior vapor retarders without any temperature control provided by FPIS ci, as shown in Figures 1 and 2. Learn more about the use of FPIS for water vapor control here.

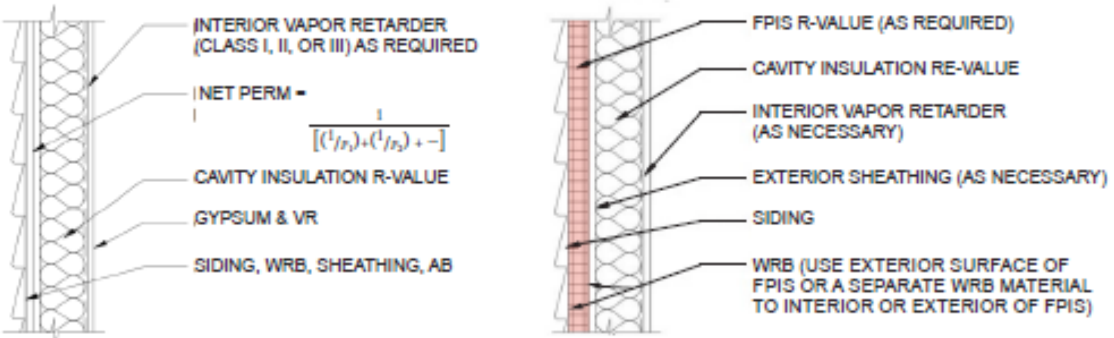
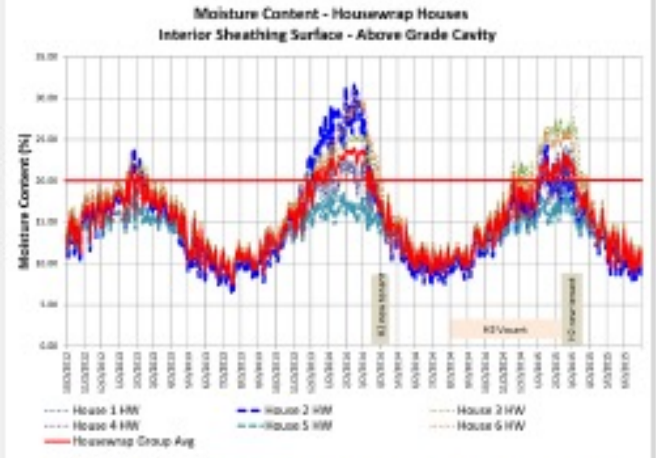
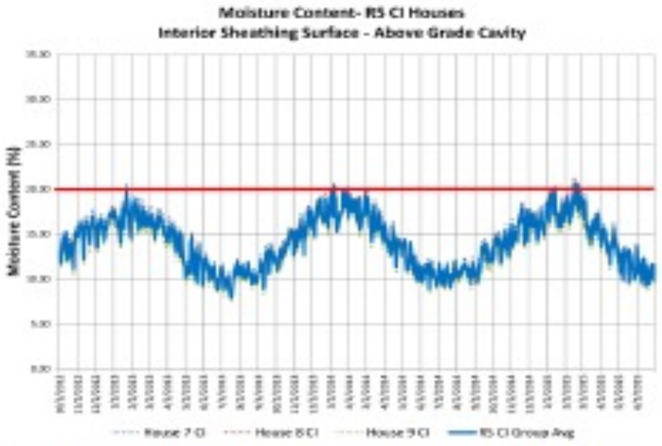


Figure 1. Cavity insulation only vs. wall with FPIS ci insulation (see Figure 2 for performance comparison)



(A) Walls with R20 cavity insulation only consistently experiencing wet OSB.

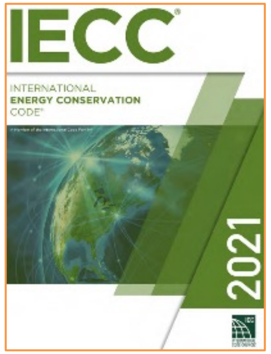


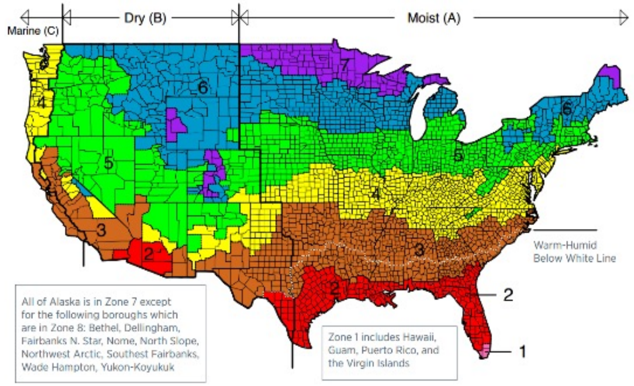
(B) Walls with R5 FPIS ci keeping OSB sheathing dry

Figure 2. Comparison of 12 actual walls with and without R5 FPIS ci

https://www.continuousinsulation.org/resources/facts-ci

Rule #1 requires coordination with the Energy Code...





IECC Commercial Provisions

Climate Zone	Building Use	Metal Framed 2018 IECC	Metal Framed 2021 IECC	Wood Framed 2018 IECC	Wood Framed 2021 IECC
0 and 1	All other	R13+5ci (U-0.077)	R13+5ci (U-0.077)	R13+3.8ci or R20 (U-0.064)	R13+3.8ci or R20 (U-0.064)
	Group R				
2	All other				
	Group R	R13+7.5ci (U-0.064)	R13+7.5ci (U-0.064)		
3	All other				
	Group R				
4 Except Marine	All other				
	Group R				
5 and Marine 4	All other		R13+10ci (U-0.055)		R13+7.5ci or R20+3.8ci (U-0.051)
	Group R			R13+7.5ci or R20+3.8ci (U-0.051)	
6	All other		R13+12.5ci (U-0.049)		
	Group R				
7	All other				
	Group R	R13+15.6ci (U-0.052)	R13+15.6ci (U-0.042)		
8	All other	R13+7.5ci (U-0.064)	R18+18.8ci (U-0.037)	R13+15.6ci or R20+10ci (U-0.036)	R13+18.8ci (U-0.032)
	Group R	R13+17.5ci (U-0.045)			

Note: Cavity insulation is only 40-50% effective on CFS walls, so ci is prescribed for all climate zones.

IECC Residential Provisions

Climate Zone	Wood Frame Walls 2018 IECC	Wood Frame Walls 2021 IECC
0, 1 and 2	R13 (U-0.084)	R13 or R0+10ci (U-0.084)
3	R20 or R13+5ci (U-0.060)	R20 or R13+5ci or R0+15ci (U-0.060)
4 except Marine		R30 or R20+5ci or R13+10ci or R20ci (U-0.045)
5 and Marine 4		
6	R20+5ci or R13+10ci (U-0.045)	
7 and 8		

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Rule #1 requires coordination with the Building Code…

QUICK GUIDE
Foam Plastic Applications for Better Building

3 STEPS FOR CODE-COMPLIANT USE OF WATER VAPOR RETARDERS and Foam Plastic Insulating Sheathing (FPIS) Continuous Insulation (ci)

07.27.21

This reference guide summarizes key requirements and options in the 2021 International Residential Code (IRC) and 2021 International Building Code (IBC) for design and construction of code-compliant and moisture-resistant frame walls using foam plastic insulating sheathing (FPIS) as continuous insulation (ci). When used in a code-compliant manner, FPIS ci protects walls against the effects of moisture by keeping walls warm to prevent condensation while maximizing drying to the interior with proper vapor retarder specification.

Follow the three steps below for code-compliant water vapor control. For greater flexibility and to automate the application of this reference guide, refer to these wall calculators. Various moisture control research reports and other practical guides are also available here.

For a summary of key concepts and principles for moisture control, refer to FACTS: Moisture Control for Wall Assemblies.

STEP 1: KNOW INTERIOR VAPOR RETARDER CLASSES

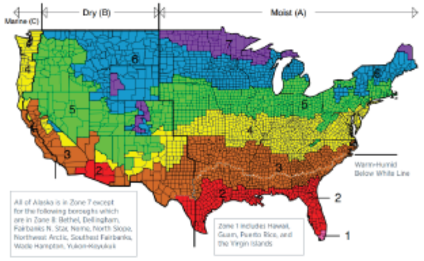
Use the following definitions for water vapor retarder classes when specifying interior vapor retarders in accordance with Steps 2 and 3:

TABLE R702.7(1) VAPOR RETARDER MATERIALS AND CLASSES

CLASS	ACCEPTABLE MATERIALS
I	Sheet polyethylene, nonperforated aluminum foil, or other approved materials with a perm rating of less than or equal to 0.1.
II	Kraft-faced fiberglass batts, vapor retarder paint, or other approved materials applied in accordance with the manufacturer's installation instructions for a perm rating greater than 0.1 and less than or equal to 1.0.
III	Latex paint, enamel paint, or other approved materials applied in accordance with the manufacturer's installation instructions for a perm rating of grater than 1.0 and less than or equal to 10.0.

STEP 2: CONSIDER PERMITTED INTERIOR VAPOR RETARDERS

Select a "permitted" vapor retarder for the interior side of frame walls based on the Climate Zones as outlined in IRC Table R702.7(2), paying attention to footnotes and other table references:



U.S. Climate Zones

TABLE R702.7(3) CLASS III VAPOR RETARDERS

CLIMATE ZONE	VAPOR RETARDER CLASS		
	CLASS I[a]	CLASS II[a]	CLASS III
1, 2	Not Permitted	Not Permitted	Permitted
3, 4 (except Marine 4)	Not Permitted	Permitted[c]	Permitted
Marine 4, 5, 6, 7, 8	Permitted[b]	Permitted[c]	See Table R702.7(3)

a. Class I and II vapor retarders with vapor permeance greater than 1 perm when measured by ASTM E96 water method (Procedure B) shall be allowed on the interior side of any frame wall in all climate zones.

b. Use of a Class I interior vapor retarder in frame walls with a Class I vapor retarder on the exterior side shall require an approved design.

c. Where a Class II vapor retarder is used in combination with foam plastic insulating sheathing installed as continuous insulation on the exterior side of frame walls, the continuous insulation shall comply with Table R702.7(4) and the Class II vapor retarder shall have a vapor permeance of greater than 1 perm when measured by ASTM E96 water method (Procedure B).

STEP 3: DETERMINE MINIMUM R-VALUE REQUIREMENTS FOR CI

For use of FPIS ci with Class II or III interior vapor retarders (per Step 2), determine the minimum ci R-value required to control water vapor using IRC Tables R702.7(3) or R702.7(4) as applicable. The ci and cavity insulation amounts provided must also comply with the local energy code.

TABLE R702.7(3) CLASS III VAPOR RETARDERS
(only requirements for ci are shown)

CLIMATE ZONE	CLASS III VAPOR RETARDERS PERMITTED FOR:
4 Marine	ci with R-value ≥ 2.5 over 2 x 4 wall
	ci with R-value ≥ 3.75 over 2 x 6 wall
5	ci with R-value ≥ 5 over 2 x 4 wall
	ci with R-value ≥ 7.5 over 2 x 6 wall
6	ci with R-value ≥ 7.5 over 2 x 4 wall
	ci with R-value ≥ 11.25 over 2 x 6 wall
7	ci with R-value ≥ 10 over 2 x 4 wall
	ci with R-value ≥ 15 over 2 x 6 wall
8	ci with R-value ≥ 12.5 over 2 x 4 wall
	ci with R-value ≥ 20 over 2 x 6 wall

TABLE R702.7(4) CONTINUOUS INSULATION (ci) WITH CLASS II VAPOR RETARDER

CLIMATE ZONE	CLASS II VAPOR RETARDERS PERMITTED FOR:
3	ci with R-value ≥ 2
4, 5, 6	ci with R-value ≥ 3 over 2 x 4 wall
	ci with R-value ≥ 5 over 2 x 6 wall
7	ci with R-value ≥ 5 over 2 x 4 wall
	ci with R-value ≥ 7.5 over 2 x 6 wall
8	ci with R-value ≥ 7.5 over 2 x 4 wall
	ci with R-value ≥ 10 over 2 x 6 wall

NOTE: When using a Class II interior vapor retarder, it must comply with the "smart" vapor retarder requirements of footnote 'c' of IRC Table R702.7(2) above (e.g., coated kraft paper facer complies). Use of a Class I "smart" vapor retarder will provide equal or better performance. Smart vapor retarders prevent OUTWARD moisture movement into walls in the winter and become vapor permeable for increased INWARD drying potential in the summer, which compliments the "warm wall" water vapor control provided by FPIS ci. A Class III interior vapor retarder is sufficiently vapor permeable at all times such that it is not required to be a "smart" vapor retarder but it requires more FPIS ci (i.e., a warmer wall) to prevent condensation in the winter.

TIP: While not required, using more than the code minimum ci R-values shown above will further improve water vapor control and protection of the building envelope.

YOU'RE DONE! For additional guidance on details and options for code-compliant moisture control, refer to this wall assembly illustration.

Owned and operated by the Applied Building Technology Group with support from a grant provided by the Foam Sheathing Committee (FSC) of the American Chemistry Council, **continuousinsulation.org** provides informational resources intended to assist the foam plastic insulating sheathing industry, using sound science to develop research supporting the reliable, efficient, and economic design and installation of foam sheathing.

Contact us.

https://www.continuousinsulation.org/resources/quick-guides

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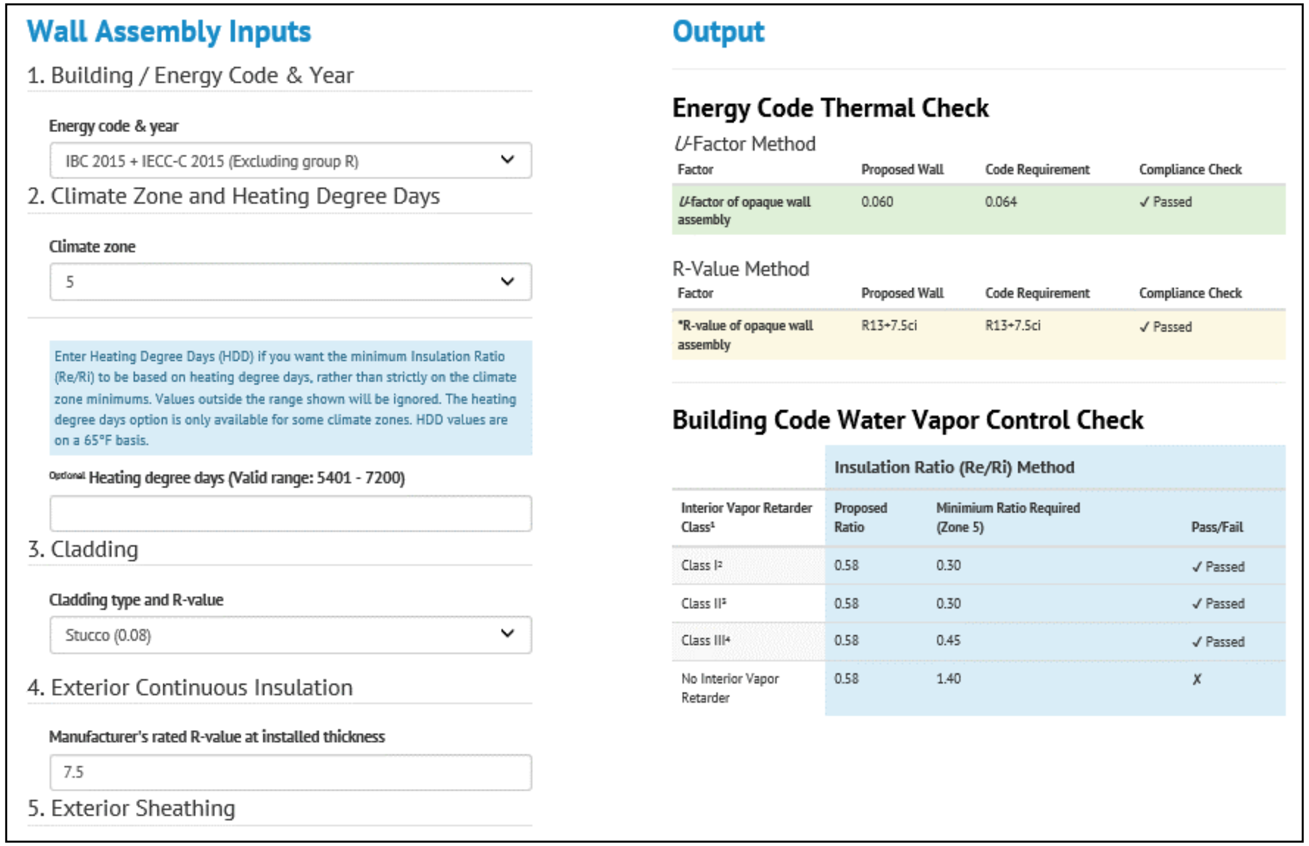
Rule #1 – Wall Calculator to Simplify Energy and Building Code Compliance, Coordination, and Optimization…

- Implements R-value and U-factor checks per IECC & ASHRAE 90.1
- Moisture control check per IBC/IRC (including insulation and permeance ratio checks)
- Flexible, More Solutions than Code, More Precise
- Wood and Steel framing



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	✗

https://www.continuousinsulation.org/calculators

Rule #2 of 3

RULE #2: Minimize Air Leakage!

Leakage of moist air from the indoors or outdoors into or through a building assembly can easily override the function of vapor retarders. Minimize air leakage by following energy code requirements for use of continuous air barriers and sealing of joints and gaps. It's not just an energy code concern (although it does save a lot of energy).

When RULE #1 is followed and the FPIS ci is installed per Figure 3 as a code compliant air barrier, walls are less vulnerable to the consequence of air leakage for two reasons: (1) the FPIS ci will help limit air infiltration from the exterior (especially if it is also used as the WRB system, see RULE #3), and (2) it will also reduce the potential for moist air to condensate on or be adsorbed by moisture-sensitive materials inside the wall because it controls the temperature of those materials. Find more information on use of FPIS as an air barrier here.

https://www.continuousinsulation.org/resources/facts-ci

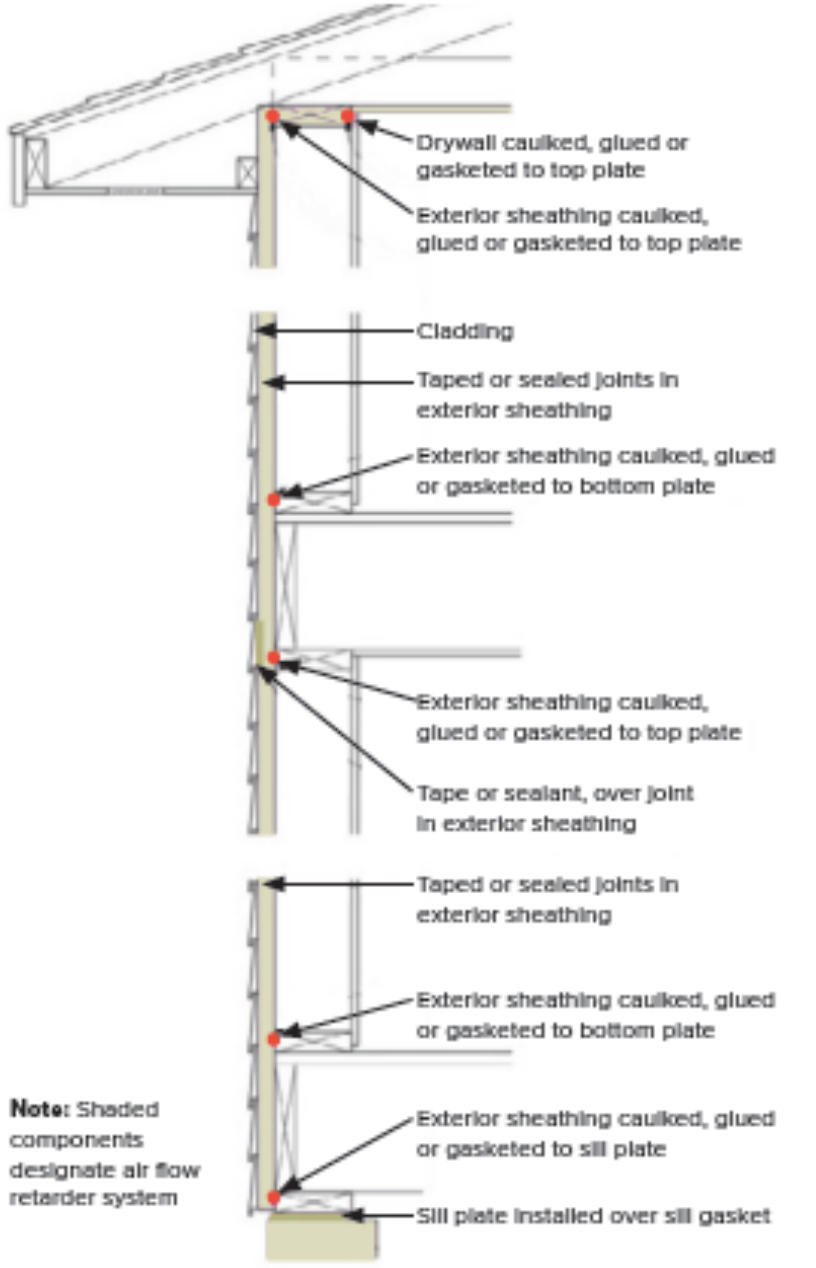


Figure 3. FPIS ci installed as an air barrier exterior sheathing.

Rule #3 of 3

RULE #3: Avoid Rain Water Intrusion!

Most importantly, keep rain water out of walls by proper use of cladding, drainage, water-resistive barrier (WRB), and flashing as required by the building code and good practice. Many FPIS ci products can be used as a code-approved WRB system when installed in accordance with the manufacturer's installation instructions. Approved FPIS WRB systems use durable joint treatments (e.g., joint tapes) and flashing materials (e.g., adhered or fluid-applied flexible flashings) as shown in Figure 4. FPIS WRB systems are subject to some of the most stringent wall assembly water-resistance test requirements. Find more information on FPIS WRB systems here.

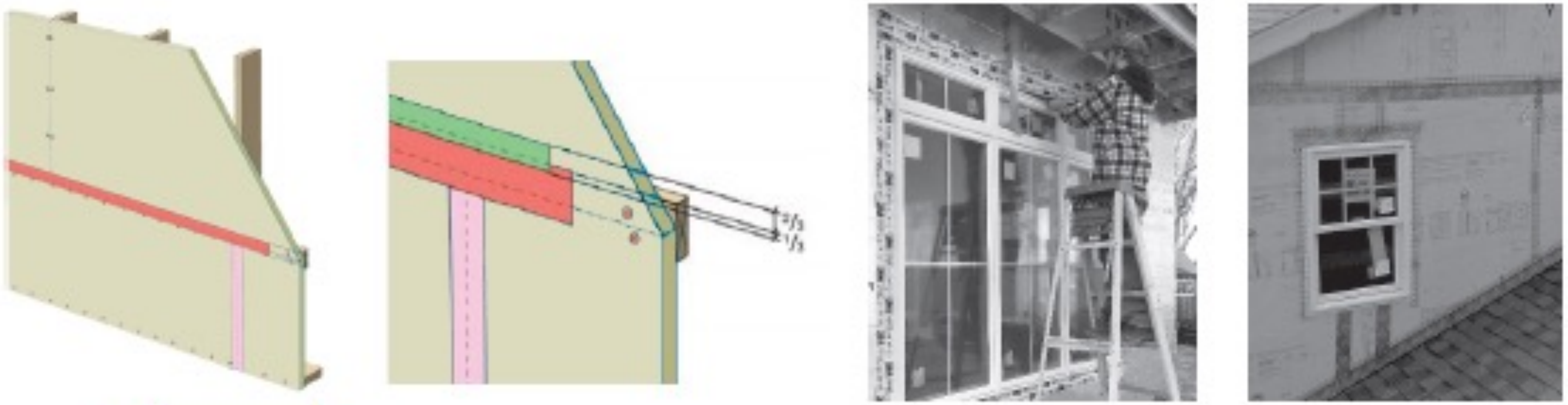
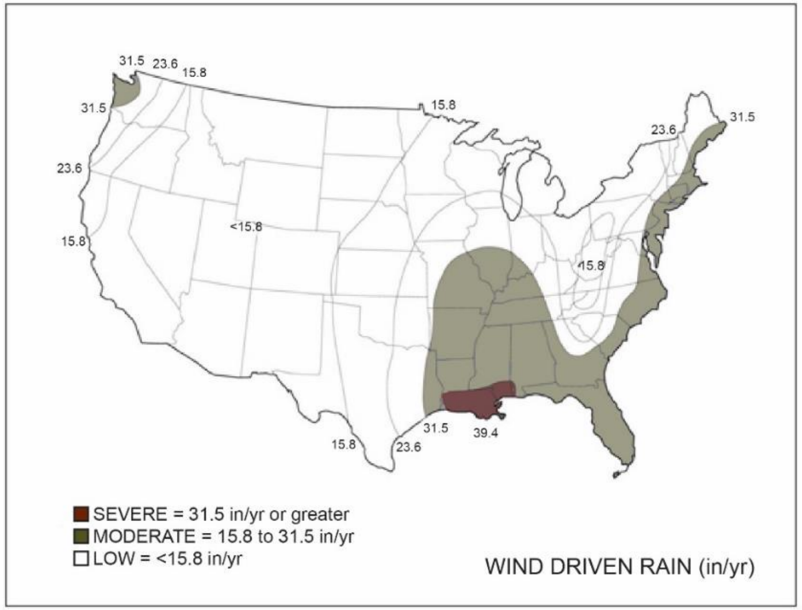


Figure 4. **FPIS WRB System installation using joint tapes and adhered flashings; refer to manufacturer installation instructions for specific details.**

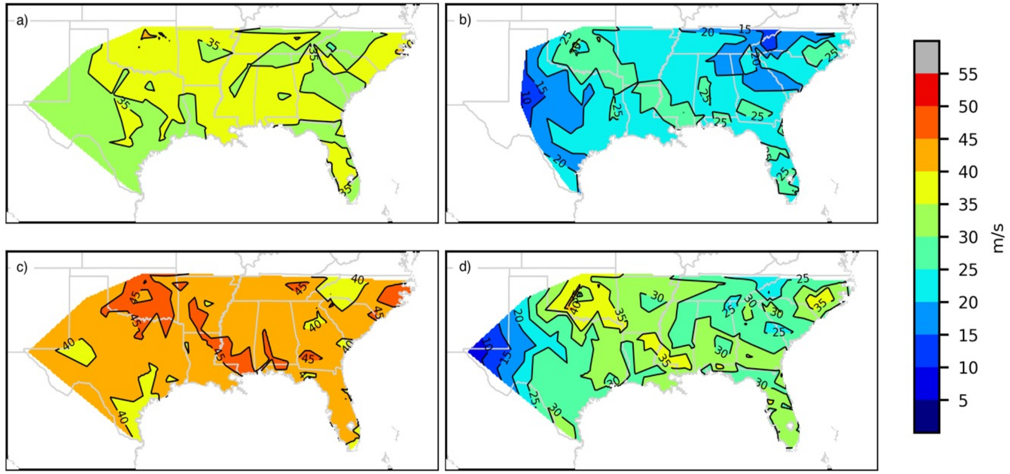
https://www.continuousinsulation.org/resources/facts-ci

Control of Water Intrusion

- Rain water intrusion is often the primary factor associated with observed failure or success of moisture control
  - Wind driven rain (WDR) is the primary hazard
- If rain water is not adequately controlled, other building science measures can be rendered ineffective (air barriers, vapor retarders, drying potential, etc.)
- Concept is simple:
  Keep water out!



Annual Average Wind Driven Rain Receipt (in/yr)
(map based on UofGA research)
(http://www.huduser.gov/portal/publications/reports/Guide-Durability-by-Design.html)



See supplemental slides on WDR and latest research in progress

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MOISTURE CONTROL FOR FRAME WALLS
Code Compliant Wall Detailing

Integration of code-compliance requirements and best practices for moisture control of frame wall assemblies (based on 2021 IRC).

07.27.21

FIGURE KEY:
ci – continuous insulation
VR – vapor retarder
AB – air barrier
WRB – water-resistive barrier
FPIS – foam plastic insulating sheathing
EIFS – exterior insulation & finish system
ccSPF – closed-cell spray foam

Flashing (IRC Section R703.4): Flashing at siding transitions, fenestration, and other wall penetrations or details not shown; flash to the designated WRB layter (location in wall may vary) and kick-out to exterior or cladding where required at weeps, etc.

Cladding Connections (IRC Section R703.3): For connections through FPIS refer also to IRC Section R703.15.

Structural Sheathing

Specify and install structural sheathing per IRC Chapter 6 where used for wall bracing. Examples include OSB, plywood, gypsum sheathing, fiberboard, diagonal wood boards, etc. (Wood let-in and metal brace options not shown.)

Lap Sidings (vinyl, wood, aluminum, fiber-cement, etc.)

Specify and install lap sidings per IRC Section R703. In Climate Zones 4-8 where using a Class III interior VR, two options to control water vapor are provided in Table R702.7(3):

(1) Without exterior ci – siding must be back-vented (e.g., furred) or vented siding (e.g., vinyl).

(2) With exterior ci – siding not required to be back-vented or vented siding.

Back venting or vented siding is otherwise not required but is a recommended best practice, especially in in moist or marine climate regions.

Stucco, Adhered Masonry Veneer, Cement Panel Siding, etc.

Specify and install WRB per IRC Section R703.7.3. In Moist/Marine climate regions, a minimum 3/16" drainage space is required. See drainage space location options based on WRB location specified.

Alternative drainage methods include drainage matt, drain wrap, or channeled back of FPIS with separate WRB on its interior side. All alternatives must have minimum 90% drainage efficiency per ASTM E2273 or E2925.

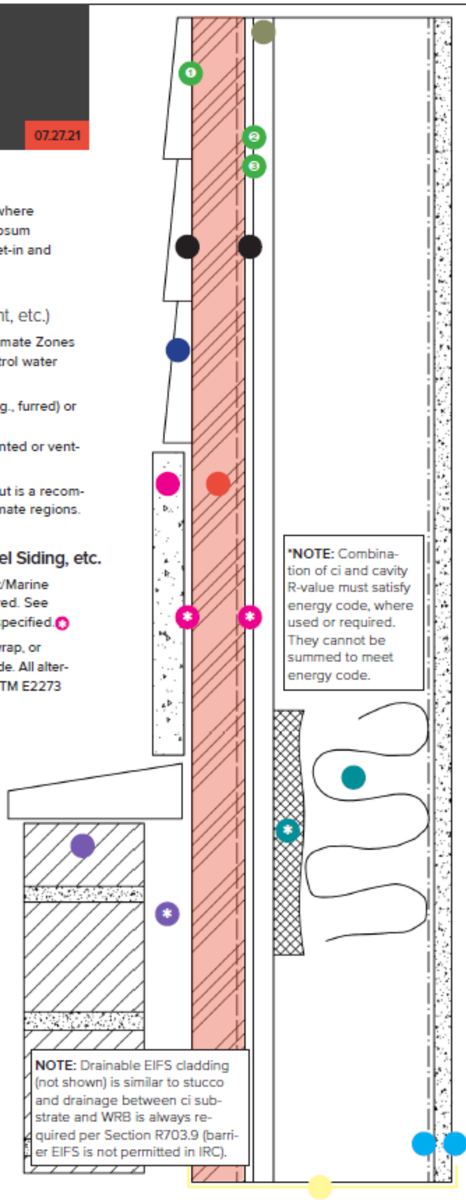
Anchored Masonry Veneer (stone & brick)

1" ventilation and draining space required for all anchored stone or brick veneer in all climate zones (see Section R703.8).

Also qualifies as vented cladding for use of Class III VR on walls without exterior ci per Table R702.7(3).

Air Barrier (AB)

A continuous AB is used in all climate zones to achieve required whole building air-change-per-hour (ACH) limits per energy code and to protect wall from moist air intrusion. The designated AB material layer must have joints, seams, gaps, intersections, and penetrations sealed. AB material can be the WRB, the ci, the structural sheathing, the ccSPF cavity insulation, the VR, or gypsum wallboard. Any material or combination thereof must meet energy code requirements for AB material properties (i.e., essentially air impermeable). Recommended best practice is to provide AB on both sides of air-permeable insulation materials (i.e., on exterior and interior sides of wall cavity) for improved thermal performance and moisture control.



Water-Resistive Barrier (WRB)

Specify and install a WRB in accordance with IRC Section R703.2. WRB material and location options include:

1. Surface of FPIS WRB System w/ taped joints - FPIS surface used as WRB
2. Separate WRB behing ci - Any ci insulation type not used as WRB
3. Membrane (wrap), spray-applied, or WRB wall sheathing (no ci)

Drainage Space (location based on WRB option used)

Where required, located between cladding and WRB (see above). See requirements for reservoir cladding types (brick, stucco, adhered veneer, etc.).

Where not required, use as recommended best practice.

Continuous Insulation (ci)*

Where used, ci R-value must meet IRC Table R702.7(2) and Table R702.7(3) or (4) as applicable based on Climate Zone and the interior VR Class specified. The required minimum ci R-values ensure adequate temperature control to prevent condensation and moisture accumulation within the wall. Increasing ci R-values above code-minimums will further improve thermal performance and moisture control.

Where non-vapor permeable (< 5 perm) ci is used (e.g., FPIS), it will mitigate inward vapor drive from reservoir claddings (e.g., stucco, adhered veneer, brick, etc.). For similar reasons, it is recommended to use a moderate to low perm WRB (e.g., < 20 perm) behind a vapor permeable ci material.

Cavity Insulation*

If ccSPF is used at thickness to achieve 1.5 perms or less, the R-value can be combined with ci R-value to meet ci requirements of Tables R702.7(3) or (4) to decrease the exterior ci thickness/R-value required, but ccSPF must still be treated as cavity insulation for energy code compliance.

Interior Vapor Retarder (VR)[1,2]

Use of a Class I interior VR (that is not "smart") in frame walls with a Class I exterior VR is not permitted without an approved design. Double vapor "barriers" should be avoided.

An interior vapor retarder is not required in Climate Zones 1, 2, and 3. Responsive ("smart") Class I or II VRs are allowed on interior side of any frame wall in all Climate Zones.

If ci used or required: Specify VR per Table R702.7(2) in coordination with ci and cavity insulation R-values per Tables R702.7(3) or (4) as applicable. Class I/II VR must be "smart" VR if ci is FPIS (e.g., non-vapor permeable), otherwise use Class III VR.

If ci not used: Specify VR per Table R702.7(2) with best practice recommendation to specify Class I "smart" VR in Climate Zones 5-8 and install as an air barrier. Use of a Class III VR without ci is not recommended even though permitted.

NOTES ON VAPOR RETARDER CLASSES AND RESPONSIVE VAPOR RETARDERS:

1. Vapor retarder classes are defined in Table R702.2(1) and include Class I (e.g., poly), Class II (e.g., coated kraft paper facer), and Class III (e.g., vapor retarder latex paint per manufacturer's instructions). Class I has vapor permeance of 0.1 of less, Class II is 0.1 to 1 perms, and Class III is 1 to 10 perms.
2. A responsive or "smart" vapor retarder is Class I or II (i.e., 1 perm or less) that becomes more vapor open in a humid environment such that drying occurs when needed. Regular vapor retarders are classified on the basis of "dry cup" vapor permeance measurements at low humidity conditions. Responsive vapor retarders are additionally required to have a permeance of greater than 1 perm when measured by the "wet cup" method of ASTM E96 at a moderately high humidity condition. Coated kraft paper facer is a Class II responsive vapor retarder. Class I responsive vapor retarders are typically proprietary films or membrane products.

Owned and operated by the Applied Building Technology Group with support from a grant provided by the Foam Sheathing Committee (FSC) of the American Chemistry Council, **continuousinsulation.org** provides informational resources intended to assist the foam plastic insulating sheathing industry, using sound science to develop research supporting the reliable, efficient, and economic design and installation of foam sheathing.

Contact us.

"Cheat Sheet"

Integrated, Code-Compliant Moisture Control

https://www.continuousinsulation.org/moisture-control-frame-walls

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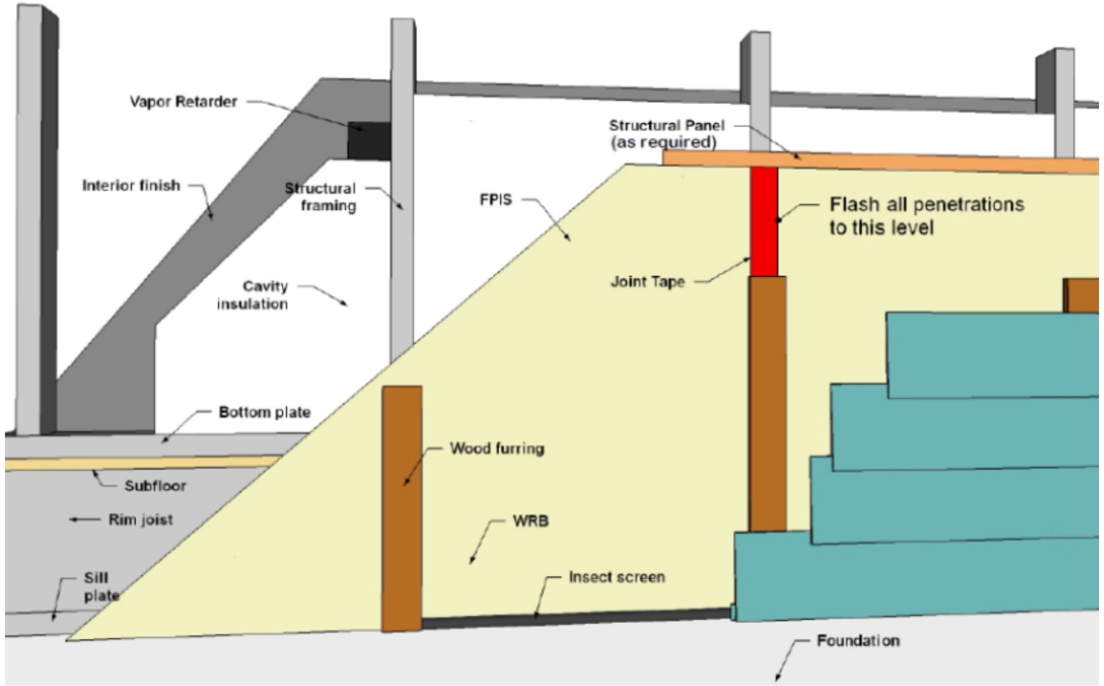
WRB & Flashing Code Requirements

- Use of a code-compliant water-resistive barrier (WRB) and flashing details are required by code (since the 2006 IRC/IBC) because we learned that claddings and windows leak.
- FPIS WRB systems are now code-recognized; refer to FPIS manufacturer for code compliance data and installation instructions.



For guidance on use of FPIS ci as a WRB, refer to:
https://www.continuousinsulation.org/applications/WRB

For listing of code-compliant FPIS WRB systems refer to:
https://www.drjengineering.org/drr/1410-05

WRB & Flashing Code Requirements

2024 IBC WRB provisions:

1403.2 Water-resistive barrier. Not fewer than one layer of *water-resistive barrier* material shall be attached to the studs or sheathing, with flashing as described in Section 1404.4, in such a manner as to provide a continuous *water-resistive barrier* behind the exterior wall *veneer*. The intersection between the water-resistive barrier materials and fenestration openings shall be flashed and assembled in accordance with the fenestration manufacturer's installation instructions, or other approved methods for applications not addressed by the fenestration manufacturer's instructions. The water-resistive barrier material shall be continuous to the top of walls and terminated at penetrations and building appendages in a manner to meet the requirements of the exterior wall envelope as described in Section 1402.2.

Water-resistive barriers shall comply with one of the following:

1. No. 15 felt complying with ASTM D226, Type 1.
2. ASTM E2556, Type I or II.
3. Foam plastic insulating sheathing water-resistive barrier systems complying with Section 1402.2 and installed in accordance with manufacturer's installation instructions.
4. ASTM E331 in accordance with Section 1402.2.
5. Other approved materials installed in accordance with the manufacturer's installation instructions.

No.15 asphalt felt and water-resistive barriers complying with ASTM E2556 shall be applied horizontally, with the upper layer lapped over the lower layer not less than 2 inches (51 mm), and where joints occur, shall be lapped not less than 6 inches (152 mm).

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WRB & Flashing Code Requirements

- WRB performance criteria vary widely from no installed performance test (material water resistance test only) to full installation system testing (e.g., FPIS WRB systems)

For information on WRB performance testing requirements refer to:
https://www.appliedbuildingtech.com/rr/1504-03

WRB & Flashing Code Requirements

2024 IBC Flashing provisions:

1404.4 Flashing. Flashing shall be installed in such a manner so as to prevent moisture from entering the *exterior* wall or to redirect that moisture to the surface of the exterior wall *covering* or to a *water-resistive barrier* complying with Section 1403.2 and that is part of a means of drainage complying with Section 1402.2.

Flashing shall be installed at the perimeters of exterior door and window assemblies in accordance with Section 1404.4.1, penetrations and terminations of *exterior wall* assemblies, *exterior wall* intersections with roofs, … etc.

1404.4.1 Fenestration flashing. Flashing of the fenestration to the wall assembly shall comply with the fenestration manufacturer's instructions **or**, for conditions not addressed by the fenestration manufacturer's instructions, shall comply with one of the following:

1. The water-resistive barrier manufacturer's flashing instructions;
2. The flashing manufacturer's flashing instructions;
3. A flashing design or method of a registered design professional; or,
4. Other approved methods.

- Window flashing with pan flashing is a recommended best practice (but not required by code)
- Flashing instructions may vary from one source to another in scope of materials and methods addressed, limitations, conditions of use, and performance basis.

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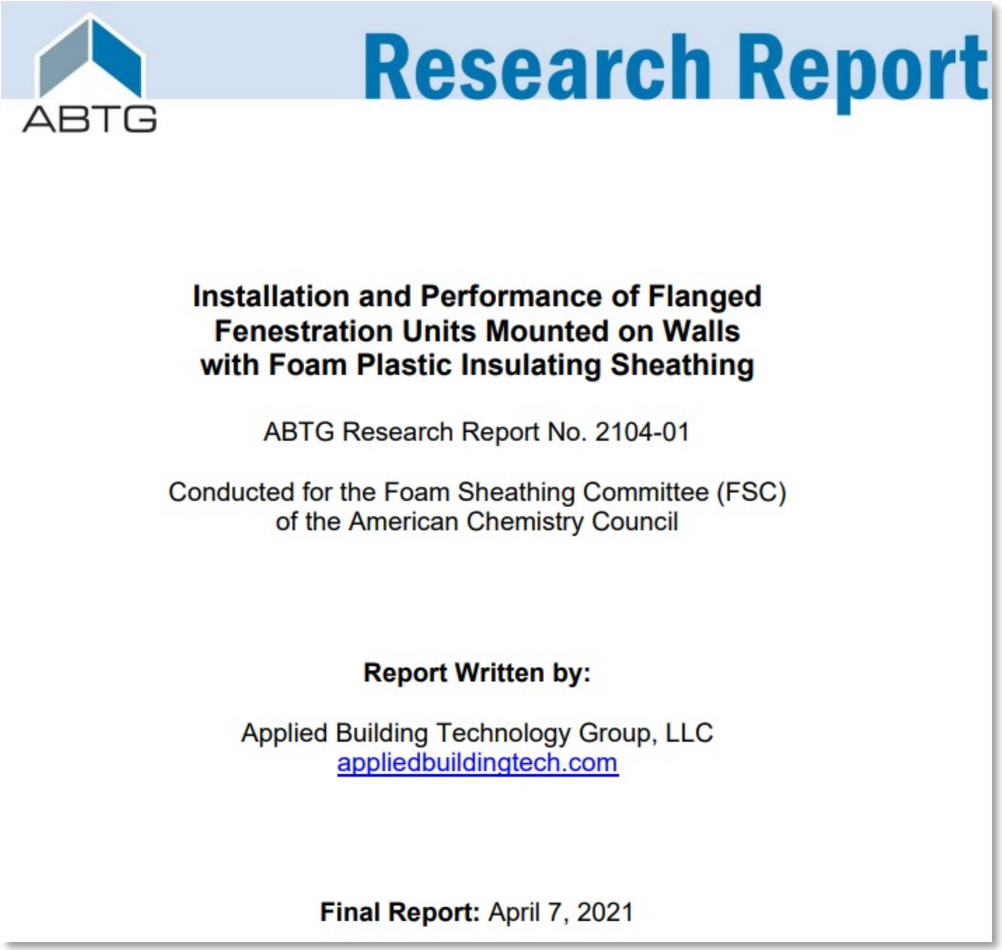
Fenestration Installation & Performance on Walls with ci

- FPIS ci Timeline
- Field Installation Experience
- Installed Performance Testing
- Recommended installation instructions

For more information, refer to:
https://www.continuousinsulation.org/window-installation



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Research Report

Installation and Performance of Flanged Fenestration Units Mounted on Walls with Foam Plastic Insulating Sheathing

ABTG Research Report No. 2104-01

Conducted for the Foam Sheathing Committee (FSC) of the American Chemistry Council

Report Written by:

Applied Building Technology Group, LLC
appliedbuildingtech.com

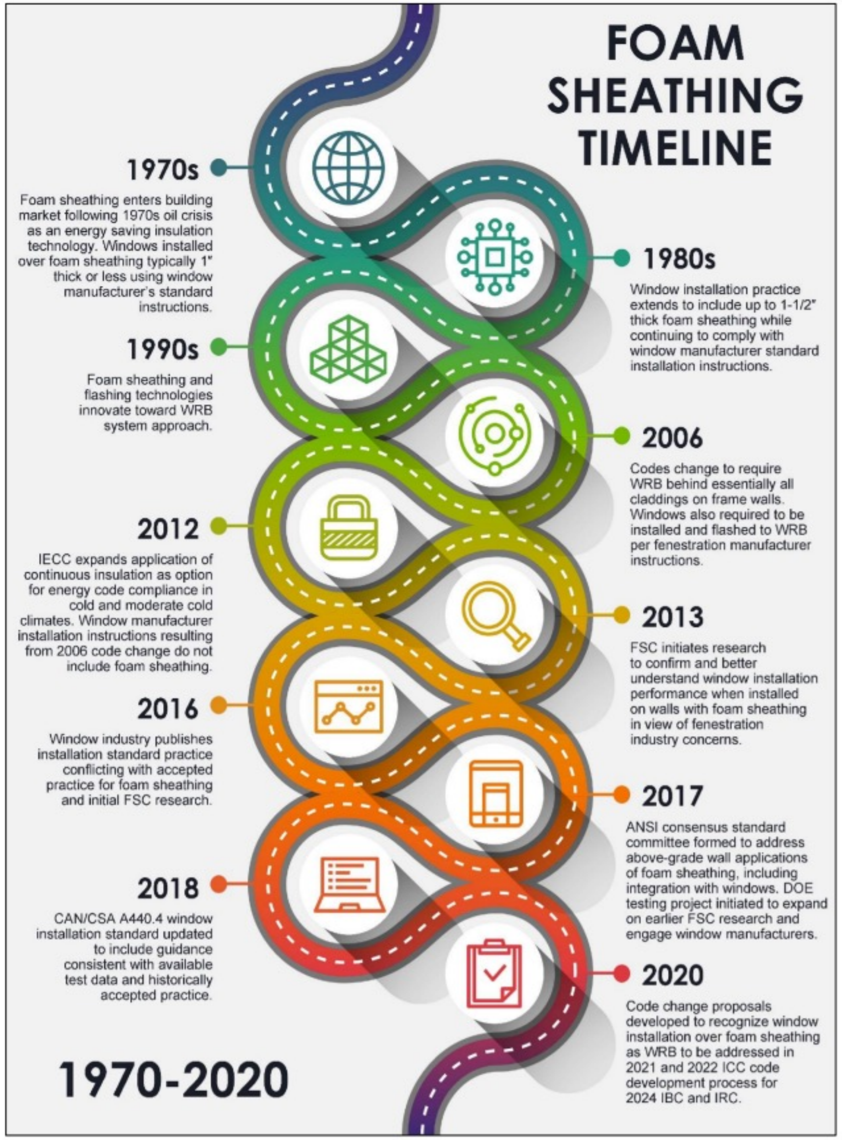
Final Report: April 7, 2021

https://www.appliedbuildingtech.com/rr/2104-01

FPIS ci Timeline

- 1970s – FPIS ci introduced
- 1980s –flanged window install over FPIS progresses from 1" to 1½" (window buck used for thicker foam)
- 1990s –FPIS ci WRB systems evolve
- 2006 – IRC & IBC codes change to require WRBs and fenestration manufacturer instructions
- 2012 – IECC expands use of ci for R-value compliance use of ci
- 2013 – Present – Increased use of FPIS ci, but differing opinions and experience with how to integrate with windows, conflicting requirements, conflicting instructions, conflicting standards, conflicting opinions, etc.

➔ Research and testing to resolve confusion
➔ Code improvements initiated



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Field Installation Experience

- Historically accepted practice (survey actual experience)
- Typical builder experienced with FPIS ci:

  "We have been installing vinyl double pane windows over 1½" XPS foam with no OSB for over six years and before that over 1" foam for almost 30 years and have seen no issues with window movement."

- Other sources indicate similar experience
- Experience from Canada also imported to U.S.

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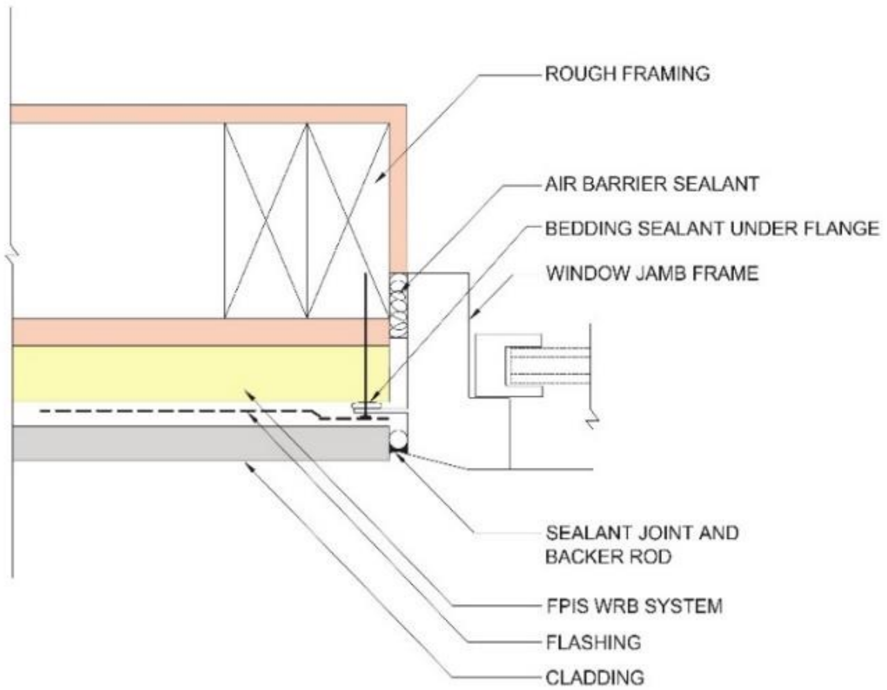
Examples of Historically Accepted Practice (≤ 1.5" FPIS ci)



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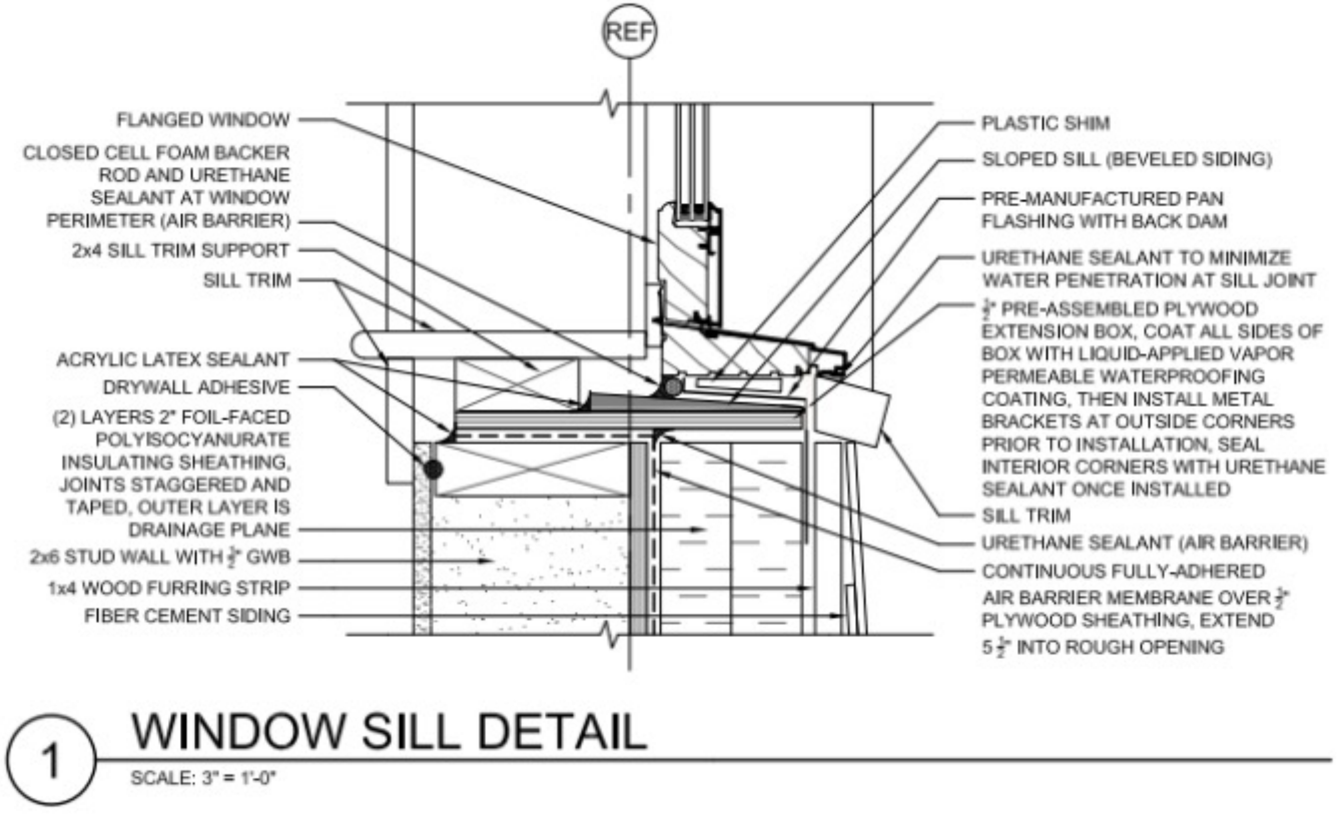
Examples of Historically Accepted Practice (> 1.5" FPIS ci)

- Plywood window buck with 4"-thick FPIS ci
- 2x wood bucks also used (especially for masonry/concrete construction)
- NOTE: For Type I-IV construction (IBC), the window-wall interface also must comply with NFPA 285 tested assembly and engineering analysis.
  - Applies regardless of FPIS thickness.
  - See examples next slide.



Source: www.nist.gov/system/files/nzertf-architectural-plans3-june2011.pdf

Example NFPA 285 Fenestration Rough Opening Details

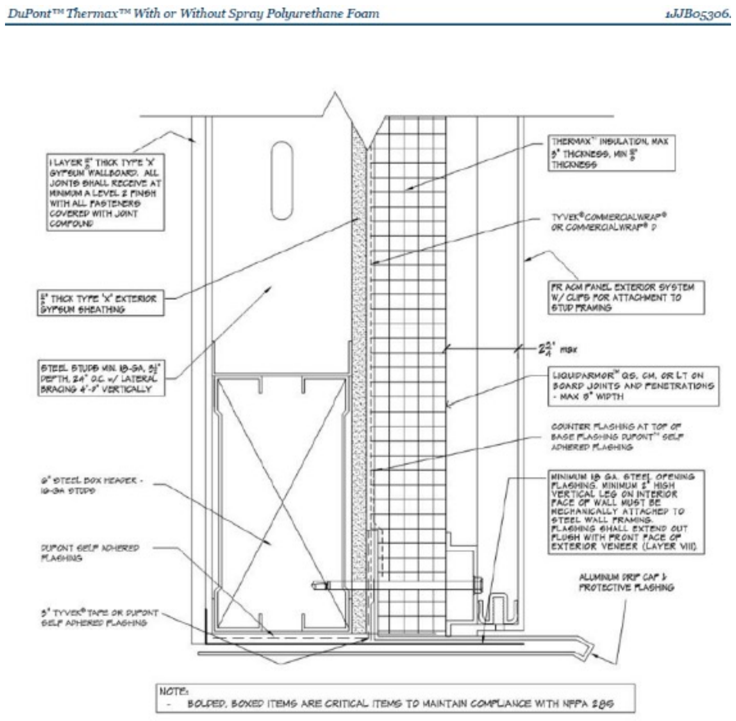


Figure 7. Use of Tyvek® CommercialWrap® or CommercialWrap® D WRB behind Thermax™ insulation

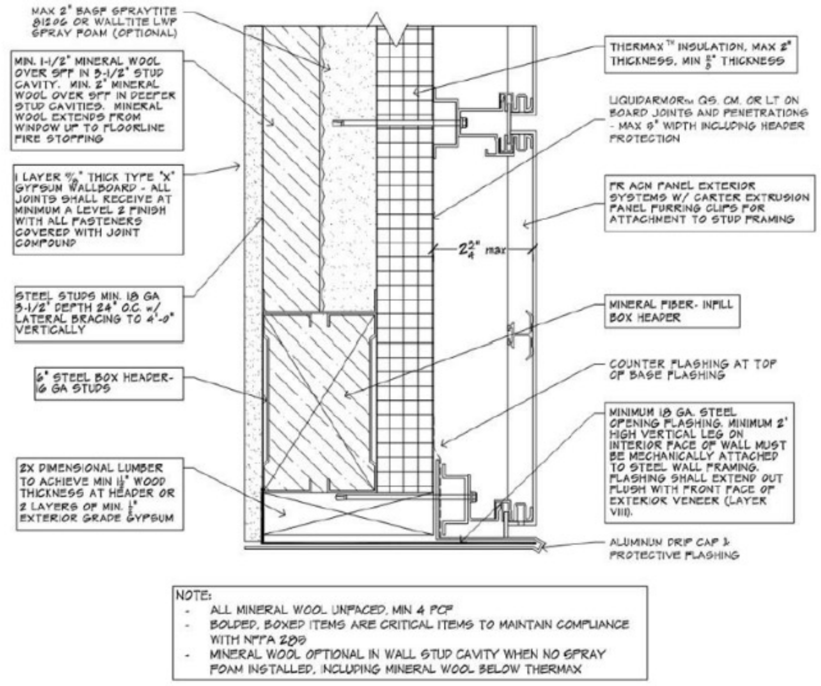
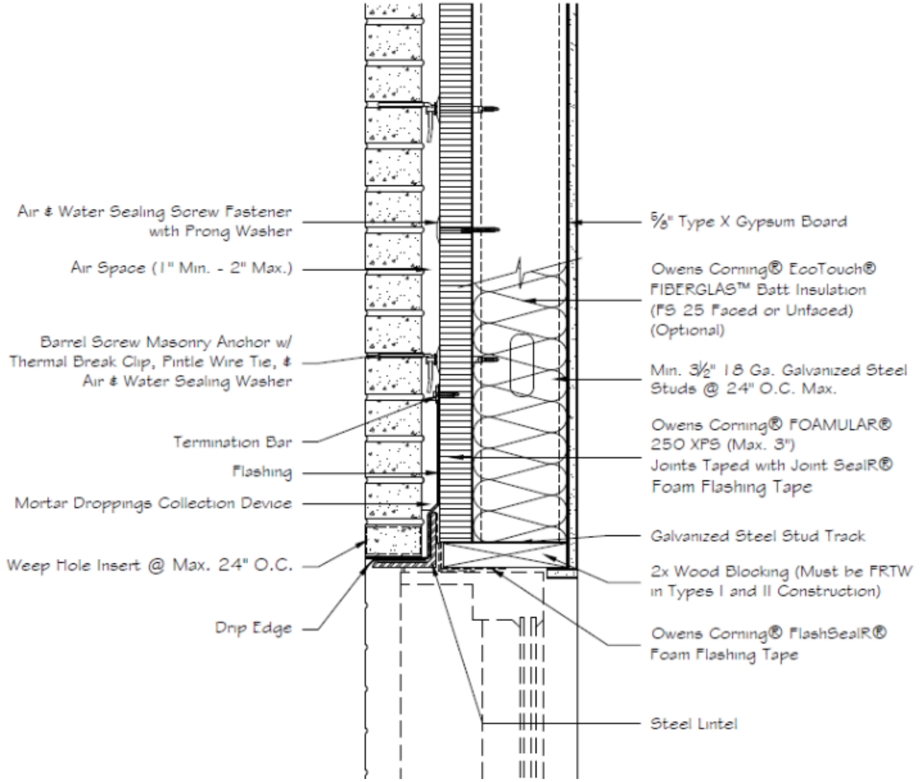


Figure 4 – Required Opening Head Protection When BASF SPRAYTITE® 81206 or Walltite LWP Spray Foam Is Used in the Cavity – OPTION 2

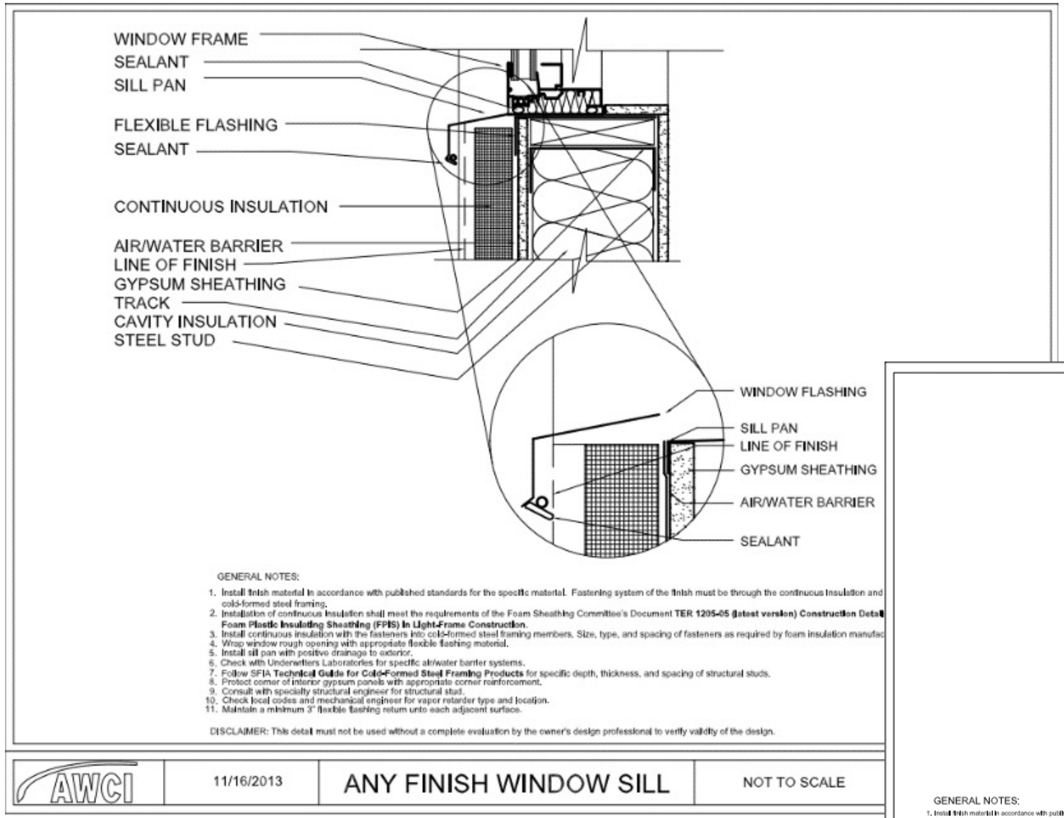


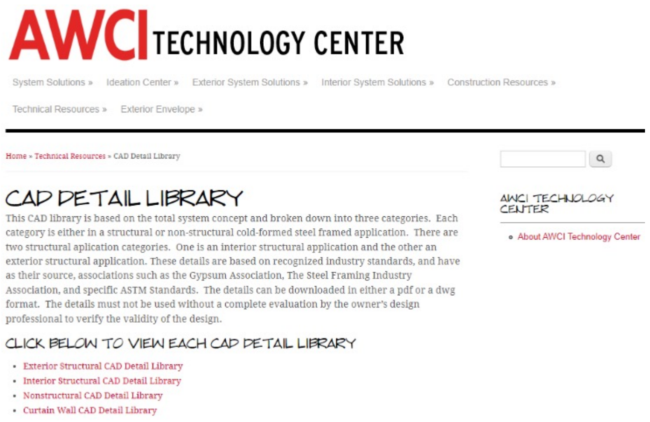
Source: DuPont Building Performance Solutions, Jensen Hughes Engineering Analysis, February 4, 2022

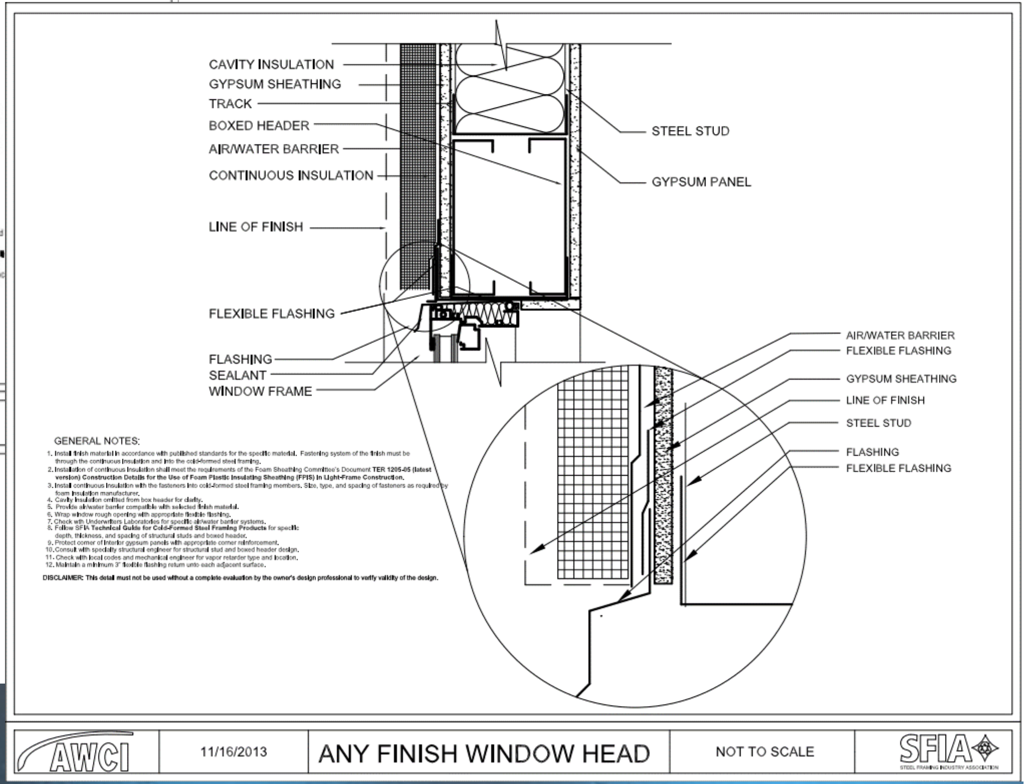
Source: Owens Corning, Enclosure Solutions NFPA 285 Guide, May 2019

Example Details from AWCI/SFIA

- Various CAD details for ci on steel frame wall assemblies







http://www.awcitechnologycenter.org/content/cad-detail-library

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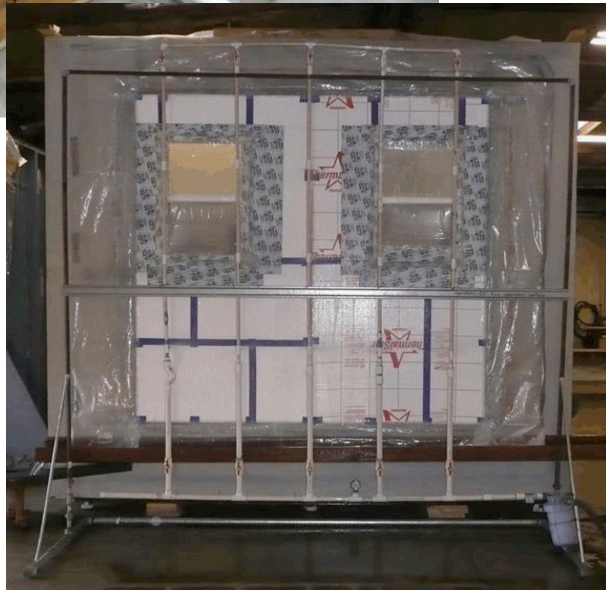
Installed Performance Testing

- ~150 tests on ~30 wall assembly specimens by independent sources
- Four integrally-flanged window types (SH, DH, C, and HS)
- Two frame material types (vinyl and wood)
- Two installation configurations (single 1-wide, mulled 2-wide)
- Range of fenestration unit weights (~30 lbs to ~400 lbs)
- Rough opening sizes up to 6-feet wide
- Wall configurations with and without FPIS ci of three material types (XPS, EPS, and PIR), up to 2" thick, and 15 or 25 psi compressive resistance per ASTM C578 or ASTM C1289
- FPIS detailed to serve as WRB system and flashed per WRB manufacturers' specifications

Installed Performance Testing

- Test method generally followed FGIA/AAMA TIR-504-2020:
  1. Initial air leakage resistance per ASTM E283
  2. Initial water resistance per ASTM E331
  3. Thermal cycling per ASTM E2264 Method A (level 1)
  4. Repeat air and water resistance testing (steps 1 and 2)
  5. Design pressure (DP) load test per ASTM E330
  6. Repeat water penetration test (step 2)
  7. Structural test pressure (STP) = 1.5 x DP load test per ASTM E330



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Installed Performance Testing

- Performance criteria:
  - Report air leakage (Steps 1 and 4)
  - No water penetration (Steps 1, 4, and 6)
  - Design pressure (DP) – no damage that prevents normal operation
  - Structural test pressure (STP) – no damage that results in failure to sustain load; any operability impact reported.
- Several later tests were focused only on DP and STP testing as allowed by FGIA/AAMA TIR-504-2020 to address specific questions regarding structural support and anchorage.
- Other tests to evaluate special loading conditions also conducted (shear load tests and long term creep/movement tests)

Installed Performance Testing

- Water Penetration Resistance Tests
  - Tested per ASTM E331 using a 5.4psf pressure differential (just above 15% of the max 35 psf DP rated window unit used in testing)
  - Window units “masked” because not re-testing window unit rating itself
  - All used joint tapes and adhered flashing specified per the WRB manufacturer’s instructions
  - None of the flanges used bedding sealant to the WRB surface (removed redundancy)
  - Sill pan flashing used (but without air sealing)

  - **RESULTS:** No water-penetration of assemblies with and without FPIS ci
    - As expected, some water movement onto sill pan behind unsealed bottom flange
    - Consequence of E331 testing without air sealing rough opening gap and flange providing only 1” lap down from surface of pan flashing

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Installed Performance Testing

- Uniform Pressure (Wind Load) Resistance
  - Tested per ASTM E330 at DP and STP = 1.5 x DP loading
    - — Most tested to 1.58 x DP (conservatively above STP target)
  - Positive pressure then negative pressure tested
  - Two specimens ramped to failure (>> STP load)
  - Many window installations included weakening variances:
    - — Flange bedding sealant omitted in all cases
    - — Some flange fastener groups omitted
    - — Air sealing of rough opening omitted
    - — Some shims omitted (e.g., at head of HS window)
  - Tests also repeated without weakening variances

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Installed Performance Testing

- Uniform Pressure (Wind Load) Resistance
  - **RESULTS:** No structural failures related to installation over foam sheathing when adhering to window manufacturer anchorage and support instructions (1" and 2" FPIS thickness, 15psi and 25 psi)
    - Some operability impacts observed with missing fastener groups (e.g., sash pin dislodge from brake/balance mechanism discovered after STP test level)
    - One structural failure related to missing shims (resulting in premature dislodging of sash from frame)
    - One structural failure caused by wood sash cross rail split out at end notch for sash bracket
  - As with any window installation with or without FPIS, following manufacturer shimming and flange fastener patterns (i.e., fastener groups) is important
    - Casement windows appeared most robust, double hung and horizontal slider appeared most sensitive to non-compliant (weakening) installation variances

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Installed Performance Testing

- Sustained Dead Load & Creep Resistance
  - Evaluated movement of fenestration under sustained dead load (weight of fenestration unit)
  - Monitoring periods of 1 month to 6 months
  - Up to 2” thick foam (15 psi minimum)
  - Fenestration weights from 27 lbs to 384 lbs
  - Included same installation weakening variances mentioned previously
  - **RESULTS:** Recorded movement of 0.000” to -0.032” (~1/32nd inch). Periods of upward movement also observed. No relationship to installation conditions discerned. All movement considered negligible or typical due to environmental changes (not creep).

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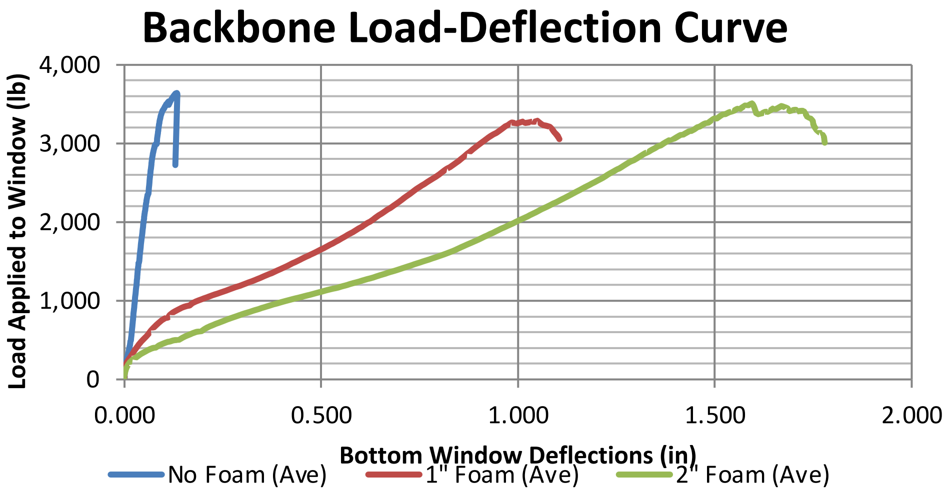
Installed Performance Testing

- Flange Fastener Shear Resistance
  - Test shear capacity and stiffness of flange fasteners through 1” and 2” thick FPIS (15 psi)
  - Windows installed with no shims and no bedding sealant so flange fasteners resist all shear load
  - **RESULTS:** <u>Ultimate shear capacity changed little (~3,300 to 3,600 lbs)</u>; stiffness was affected very predictably; foam sheathing added ductility while providing adequate stiffness for support of fenestration weight.
    - Consistent with fastener shear testing and design methodology developed for cladding and furring attachments through FPIS



Installed Performance Testing

- Fenestration Size Effect on Installed Performance
  - Window size effect on DP rating permitted by code to be evaluated per AAMA 2502, Comparative Analysis Procedure
  - Comparative analysis by ASTM E330 testing of SH integral flange vinyl window as installed (positive pressure only) – see Table below.
  - **RESULTS:** Even with significant installation non-compliances (e.g., no shims and larger r.o. gap) and up to 2" of FPIS ci, a moderate-size fenestration unit can have more than 3 times the wind pressure rating of the largest ("gateway") size used for fenestration rating and labeling

Size	STP	DP	Safety Factor	Adjusted DP (min 1.5 safety factor)	Installation Notes*
42x66 (gateway)	37.5 psf	**25 psf**	1.5	n/a	Wood substrate + shims + ¼" r.o. gap
30x42	151 psf	25 psf	6.0	**80 psf**	Wood or up to 2" foam (15 psi) substrate, no shims, and 3/8" r.o. gap
30x42	118 psf	25 psf	4.7		

*Fasteners installed in every flange hole for all cases per manufacturer instructions

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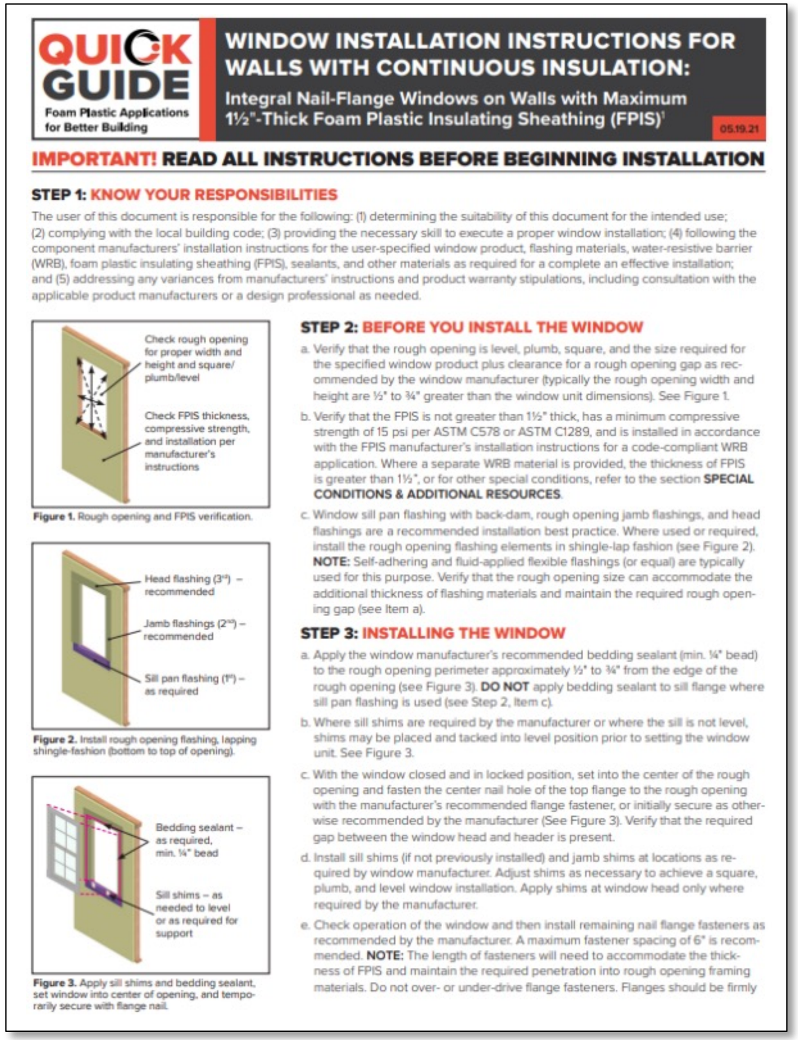
Recommended Installation Instructions

- For FPIS of minimum 15 psi compression resistance and maximum 1.5" thickness:
  - Use fenestration manufacturer shim and fastener schedule
    - Adjust fastener length to maintain embedment in framing
  - Use WRB or window manufacturer flashing instructions
- For FPIS > 1.5" thick:
  - Use window buck or similar support method
    - Some manufacturers offer specialty support brackets
  - Otherwise, same as above for remaining installation details
- If window manufacturer instructions address the specific application with FPIS, use those instructions.
- NOTE: If NFPA 285 applies (Type I-IV construction), the window-wall interface must comply with the FPIS manufacturer's tested assembly and engineering analysis, regardless of FPIS thickness.
  - Refer to the manufacturer data and standard details



QUICK GUIDE
Foam Plastic Applications for Better Building

WINDOW INSTALLATION INSTRUCTIONS FOR WALLS WITH CONTINUOUS INSULATION:
Integral Nail-Flange Windows on Walls with Maximum 1½"-Thick Foam Plastic Insulating Sheathing (FPIS)[1]

05.19.21

IMPORTANT! READ ALL INSTRUCTIONS BEFORE BEGINNING INSTALLATION

STEP 1: KNOW YOUR RESPONSIBILITIES

The user of this document is responsible for the following: (1) determining the suitability of this document for the intended use; (2) complying with the local building code; (3) providing the necessary skill to execute a proper window installation; (4) following the component manufacturers' installation instructions for the user-specified window product, flashing materials, water-resistive barrier (WRB), foam plastic insulating sheathing (FPIS), sealants, and other materials as required for a complete an effective installation; and (5) addressing any variances from manufacturers' instructions and product warranty stipulations, including consultation with the applicable product manufacturers or a design professional as needed.

Check rough opening for proper width and height and square/ plumb/level

Check FPIS thickness, compressive strength, and installation per manufacturer's instructions

Figure 1. Rough opening and FPIS verification.

Head flashing (3rd) – recommended

Jamb flashings (2nd) – recommended

Sill pan flashing (1st) – as required

Figure 2. Install rough opening flashing, lapping shingle-fashion (bottom to top of opening).

Bedding sealant – as required, min. ¼" bead

Sill shims – as needed to level or as required for support

Figure 3. Apply sill shims and bedding sealant, set window into center of opening, and temporarily secure with flange nail.

STEP 2: BEFORE YOU INSTALL THE WINDOW

a. Verify that the rough opening is level, plumb, square, and the size required for the specified window product plus clearance for a rough opening gap as recommended by the window manufacturer (typically the rough opening width and height are ½" to ¾" greater than the window unit dimensions). See Figure 1.

b. Verify that the FPIS is not greater than 1½" thick, has a minimum compressive strength of 15 psi per ASTM C578 or ASTM C1289, and is installed in accordance with the FPIS manufacturer's installation instructions for a code-compliant WRB application. Where a separate WRB material is provided, the thickness of FPIS is greater than 1½", or for other special conditions, refer to the section **SPECIAL CONDITIONS & ADDITIONAL RESOURCES**.

c. Window sill pan flashing with back-dam, rough opening jamb flashings, and head flashings are a recommended installation best practice. Where used or required, install the rough opening flashing elements in shingle-lap fashion (see Figure 2). **NOTE:** Self-adhering and fluid-applied flexible flashings (or equal) are typically used for this purpose. Verify that the rough opening size can accommodate the additional thickness of flashing materials and maintain the required rough opening gap (see Item a).

STEP 3: INSTALLING THE WINDOW

a. Apply the window manufacturer's recommended bedding sealant (min. ¼" bead) to the rough opening perimeter approximately ½" to ¾" from the edge of the rough opening (see Figure 3). **DO NOT** apply bedding sealant to sill flange where sill pan flashing is used (see Step 2, Item c).

b. Where sill shims are required by the manufacturer or where the sill is not level, shims may be placed and tacked into level position prior to setting the window unit. See Figure 3.

c. With the window closed and in locked position, set into the center of the rough opening and fasten the center nail hole of the top flange to the rough opening with the manufacturer's recommended flange fastener, or initially secure as otherwise recommended by the manufacturer (See Figure 3). Verify that the required gap between the window head and header is present.

d. Install sill shims (if not previously installed) and jamb shims at locations as required by window manufacturer. Adjust shims as necessary to achieve a square, plumb, and level window installation. Apply shims at window head only where required by the manufacturer.

e. Check operation of the window and then install remaining nail flange fasteners as recommended by the manufacturer. A maximum fastener spacing of 6" is recommended. **NOTE:** The length of fasteners will need to accommodate the thickness of FPIS and maintain the required penetration into rough opening framing materials. Do not over- or under-drive flange fasteners. Flanges should be firmly

For additional information, refer to:
https://www.continuousinsulation.org/applications/window-installation

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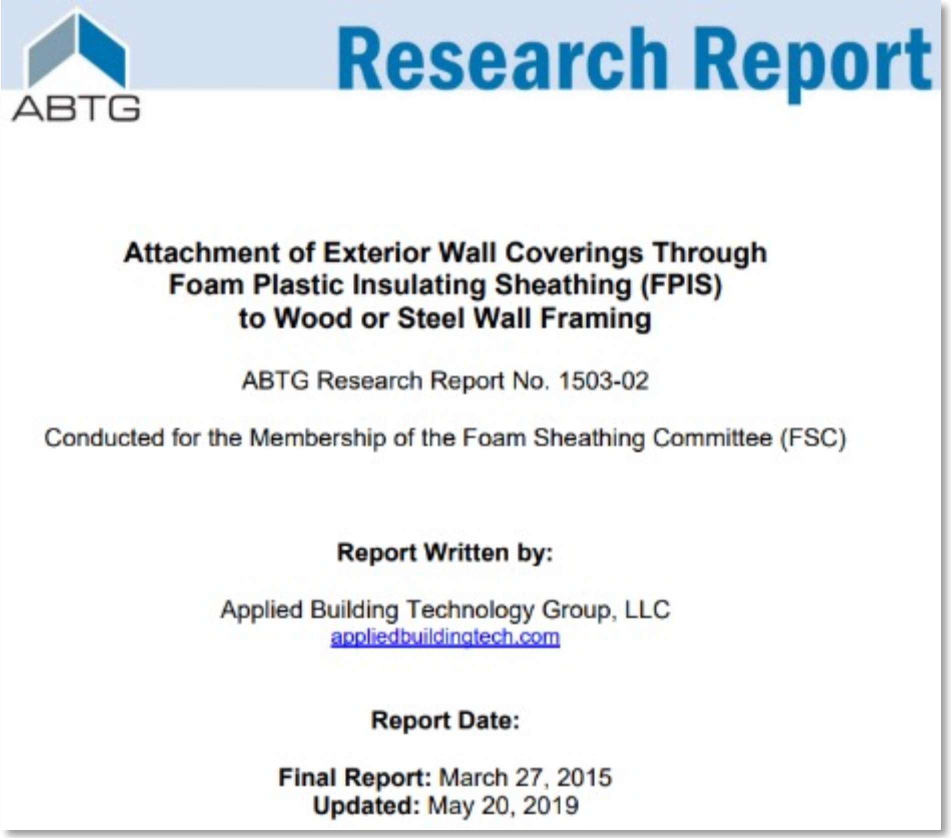
Cladding Installation & Performance on Walls with ci

- Performance Research & Testing
- Prescriptive Solutions
- Design Procedure

Performance Research & Testing

- Basis for prescriptive requirements in:
  - Section 2603, International Building Code (IBC) – 2012 through 2024 editions
    - Moved into Chapter 14 in 2024 IBC
  - Section R703, International Residential Code (IRC) – 2012 through 2024 editions
- Basis for engineering design procedure supporting the above code provisions



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Research Report

Attachment of Exterior Wall Coverings Through Foam Plastic Insulating Sheathing (FPIS) to Wood or Steel Wall Framing

ABTG Research Report No. 1503-02

Conducted for the Membership of the Foam Sheathing Committee (FSC)

Report Written by:

Applied Building Technology Group, LLC
appliedbuildingtech.com

Report Date:

Final Report: March 27, 2015
Updated: May 20, 2019

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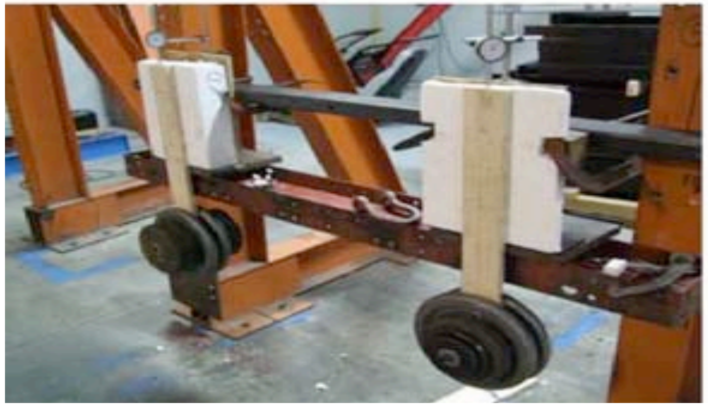
Performance Research & Testing

- Based on test program conducted for NYSERDA, FSC, AISI/SFA, and DOE projects, each by independent sources/labs.
- Evaluated both short term load resistance and stiffness of connections through FPIS (15 psi min.) up to 4-inches thick as well as long term creep behavior and stabilization (1 month to 1 year duration).
- Limit short-term deflection to 0.015" maximum and stabilized creep

Short-term load-deflection test



Long-term (sustained) load-deflection test

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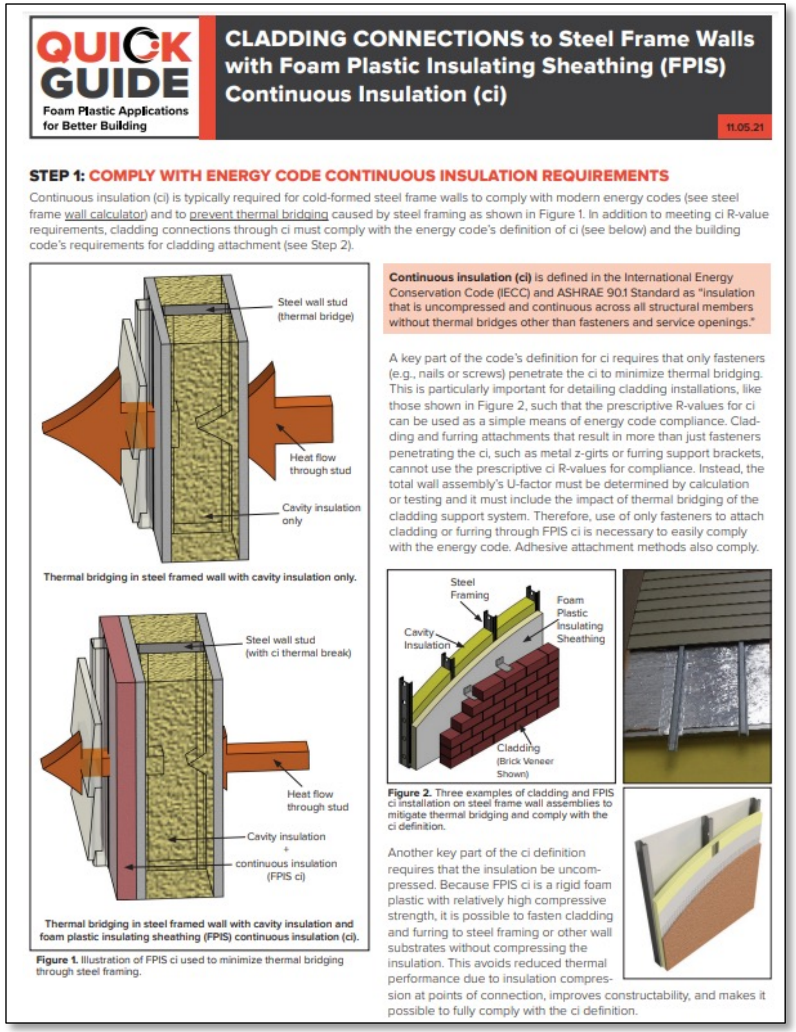
Prescriptive Solutions

- Prescriptive "Quick Guide"
- Available at: https://www.continuousinsulation.org/cladding-connections
- Applications to CFS steel framing:
  1. Direct Cladding Attachment through FPIS ci
  2. Furring Attachment through FPIS ci
  3. Cladding Attachment through FPIS ci to a Wood Structural Panel Substrate
- Not required for separately supported cladding (e.g., anchored masonry veneer); use thermally efficient brick ties



QUICK GUIDE
Foam Plastic Applications for Better Building

CLADDING CONNECTIONS to Steel Frame Walls with Foam Plastic Insulating Sheathing (FPIS) Continuous Insulation (ci)

11.05.21

STEP 1: COMPLY WITH ENERGY CODE CONTINUOUS INSULATION REQUIREMENTS

Continuous insulation (ci) is typically required for cold-formed steel frame walls to comply with modern energy codes (see steel frame wall calculator) and to prevent thermal bridging caused by steel framing as shown in Figure 1. In addition to meeting ci R-value requirements, cladding connections through ci must comply with the energy code's definition of ci (see below) and the building code's requirements for cladding attachment (see Step 2).

Thermal bridging in steel framed wall with cavity insulation only.

Thermal bridging in steel framed wall with cavity insulation and foam plastic insulating sheathing (FPIS) continuous insulation (ci).

Figure 1. Illustration of FPIS ci used to minimize thermal bridging through steel framing.

Continuous insulation (ci) is defined in the International Energy Conservation Code (IECC) and ASHRAE 90.1 Standard as "insulation that is uncompressed and continuous across all structural members without thermal bridges other than fasteners and service openings."

A key part of the code's definition for ci requires that only fasteners (e.g., nails or screws) penetrate the ci to minimize thermal bridging. This is particularly important for detailing cladding installations, like those shown in Figure 2, such that the prescriptive R-values for ci can be used as a simple means of energy code compliance. Cladding and furring attachments that result in more than just fasteners penetrating the ci, such as metal z-girts or furring support brackets, cannot use the prescriptive ci R-values for compliance. Instead, the total wall assembly's U-factor must be determined by calculation or testing and it must include the impact of thermal bridging of the cladding support system. Therefore, use of only fasteners to attach cladding or furring through FPIS ci is necessary to easily comply with the energy code. Adhesive attachment methods also comply.

Figure 2. Three examples of cladding and FPIS ci installation on steel frame wall assemblies to mitigate thermal bridging and comply with the ci definition.

Another key part of the ci definition requires that the insulation be uncompressed. Because FPIS ci is a rigid foam plastic with relatively high compressive strength, it is possible to fasten cladding and furring to steel framing or other wall substrates without compressing the insulation. This avoids reduced thermal performance due to insulation compression at points of connection, improves constructability, and makes it possible to fully comply with the ci definition.

Prescriptive Solutions

- General Requirements
  - FPIS minimum 15 psi compressive strength; compliant with ASTM C578 or C1289
  - Solutions address fastener shear capacity and stiffness to support cladding weight
  - Must also check cladding attachment requirements for wind load, etc. (the more stringent fastening schedule will control)
  - Fastener length must be long enough to accommodate FPIS thickness and maintain required fastener embedment in wood/steel
  - Fastener tightened to draw connected materials together but not distort
  - Fastening schedule will depend on FPIS thickness and cladding weight supported
  - Only connections to wood framing or cold-formed steel framing are addressed; connections to masonry/concrete must be approved by alternate means (often proprietary fasteners are used)

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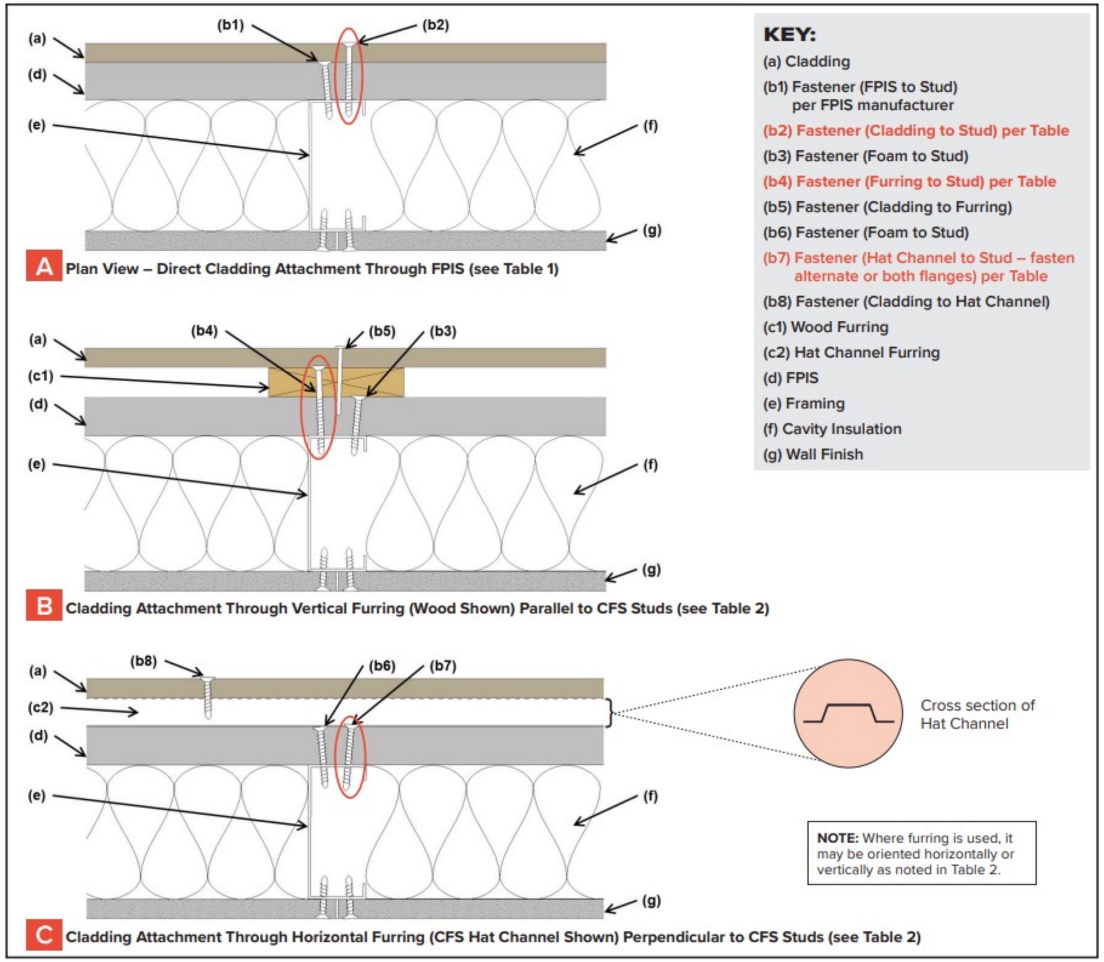
Prescriptive Solutions (CFS wall framing)

- Applications 1 and 2:
  - Direct cladding attachment
  - Wood or steel furring attachment
- Requirements vary by cladding weight:

Typical cladding materials included in the weight classes listed in Tables 1, 2, and 3 are as follows (verify with cladding manufacturer data):[1]

- 3 psf – e.g., wood lap and panel siding, vinyl siding, and most fiber-cement sidings
- 11 psf – e.g., 3-coat Portland cement stucco
- 18 psf – e.g., medium weight adhered stone veneer
- 25 psf – e.g., heavy weight adhered stone veneer



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Prescriptive Solutions

Table 1. Siding Minimum Fastening Requirements to Cold-formed Steel Framing for Direct Cladding Attachment Over FPIS to Support Cladding System Weight [1,2,3,4]

CLADDING FASTENER THROUGH FPIS INTO:	Siding Fastener Type & Minimum Size	Siding Fastener Vertical Spacing (in.)	MAXIMUM THICKNESS OF FPIS (IN.)							
			16" o.c. Fastener Horizontal Spacing				24" o.c. Fastener Horizontal Spacing			
			CLADDING SYSTEM WEIGHT				CLADDING SYSTEM WEIGHT			
			3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Steel Framing (minimum penetration of steel thickness + 3 threads)	#8 screw (0.285" head) 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 (0.333" head) 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 (0.333" head) 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

For SI: 1" = 25.4 mm; 1 pound per square foot [psf] = 0.0479 kPa

1. Tabulated values are based on minimum 33 ksi steel for 33 mil and 43 mil steel and 50 ksi steel for 54 mil steel or thicker.
2. Screws shall comply with the requirements of ASTM C1513.
3. FPIS shall have a minimum compressive strength of 15 psi in accordance with ASTM C578 or ASTM C1289.
4. DR = Design Required

- Application 1 – Direct Cladding Attachment
- Foam sheathing thickness limit based on:
  - Framing thickness
  - Screw size
  - Screw spacing
  - Cladding weight

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Prescriptive Solutions

Table 2. Furring Minimum Fastening Requirements to Cold-formed Steel Framing for Application Over FPIS to Support Cladding System Weight [1,2,3,4,5]

FURRING MATERIAL	Framing Member	Fastener Type & Min. Size	Minimum Penetration into Wall Framing (in.)	Fastener Spacing in Furring (in.)	MAXIMUM THICKNESS OF FPIS (IN.)							
					16" o.c. Furring				24" o.c. Furring			
					CLADDING SYSTEM WEIGHT				CLADDING SYSTEM WEIGHT			
					3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Minimum 33mil Steel Hat Channel or Minimum 1x3 Wood Furring	33 mil Cold-formed Steel Stud	#8 screw (0.285" head)	Steel thickness +3 threads	12	3.00	1.80	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		#10 screw (0.333" head)	Steel thickness +3 threads	12	4.00	2.25	0.70	DR	3.70	1.05	DR	DR
				16	3.85	1.45	DR	DR	3.40	DR	DR	DR
				24	3.40	DR	DR	DR	2.70	DR	DR	DR
	43 mil or thicker Cold-formed Steel Stud	#8 screw (0.285" head)	Steel thickness +3 threads	12	3.00	1.80	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		#10 screw (0.333" head)	Steel thickness +3 threads	12	4.00	3.85	2.80	1.80	4.00	3.05	1.50	DR
				16	4.00	3.30	1.95	0.60	4.00	2.25	DR	DR
				24	4.00	2.25	DR	DR	4.00	0.65	DR	DR

For SI: 1" = 25.4 mm; 1 pound per square foot [psf] = 0.0479 kPa

1. Table values are based on:
   a. Wood furring of Spruce-Pine-Fir or any softwood species with a specific gravity of 0.42 or greater per NDS.
   b. Minimum 33 mil steel hat channel furring of 33 ksi steel. Steel hat channel shall have a minimum 7/8" (22.2 mm) depth, 1¼" (32 mm) web width, and ½" (12.7 mm) wide flanges with web or flanges bearing on FPIS surface.
   c. Cold-formed steel framing of indicated nominal steel thickness and minimum 33 ksi steel for 33 mil and 43 mil steel and 50 ksi steel for 54 mil steel or thicker.
2. Screws shall comply with the requirements of ASTM C1513.
3. Furring shall be spaced a maximum of 24" o.c. in a vertical or horizontal orientation.
   a. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing.
   b. In a horizontal orientation, furring shall fastened at each stud with a number of fasteners equivalent to that required by the fastener spacing. If the required fastener spacing is 12" o.c. and the studs are 24" o.c., then two (2) fasteners would be required at each stud (24/12=2). In no case shall fasteners be spaced more than 24" (0.6 m) apart.
4. FPIS shall have a minimum compressive strength of 15 psi, in accordance with ASTM C578 or ASTM C1289.
5. DR = Design Required

- Application 2 – Wood or steel furring attachment

Prescriptive Solutions

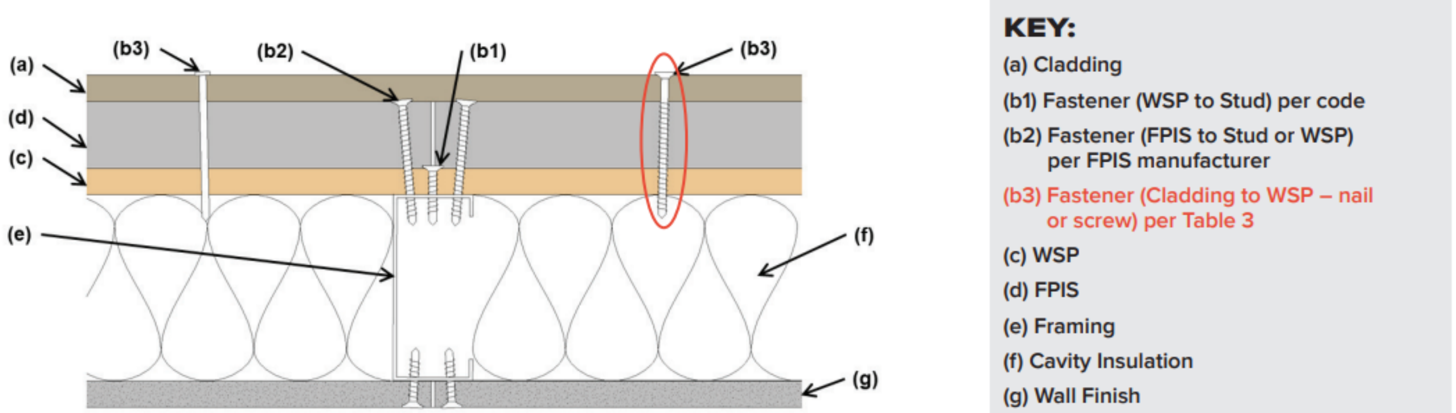


Figure 4. Illustration of light-weight cladding (≤3 psf) attachment through maximum 2"-thick FPIS to minimum 7/16"-thick wood structural panel (WSP) sheathing.

Table 3. Light-weight Cladding (≤3 psf) Minimum Fastening Requirements for Attachment Through Maximum 2"-thick FPIS to Minimum 7/16"-thick Wood Structural Panel [1,2,3]

TYPE AND SIZE OF FASTENER	HORIZONTAL SPACING OF FASTENERS ALONG SIDING
Roof sheathing ring shank nail (0.120" min. shank; 0.281" head)	12" oc
Post frame ring shank nail (0.148" min. shank; 5/16" head)	15" oc
No. 6 screw (0.138" min. shank; 0.262" head)	12" oc
No. 8 screw (0.164" min. shank; 0.312" head)	16" oc

For SI: 1" = 25.4 mm

1. Horizontal spacing of fasteners along siding is based on a siding width (distance between horizontal rows of fasteners) of 12 inches. For other siding widths, multiply required horizontal spacing by 12/w where w is the siding width in inches.
2. This table is based on IRC Table R703.3.3. Use of this table is limited to the wind load scope limits for cladding attachments in accordance with Section R703.3.2 of the IRC (i.e., maximum 30 psf negative design wind pressure).
3. The cladding fastener must be of sufficient length to penetrate a minimum of ¼" beyond the back side of the wood

- Application 3 – Attachment to wood structural panel sheathing (not to studs)
  - Limited to light-weight cladding (3psf or less)
  - Limited to max. 2" thick FPIS (min. 15 psi)
  - Limited to max -30 psf wind load (per scope of IRC)

Design Procedure (CFS wall framing)

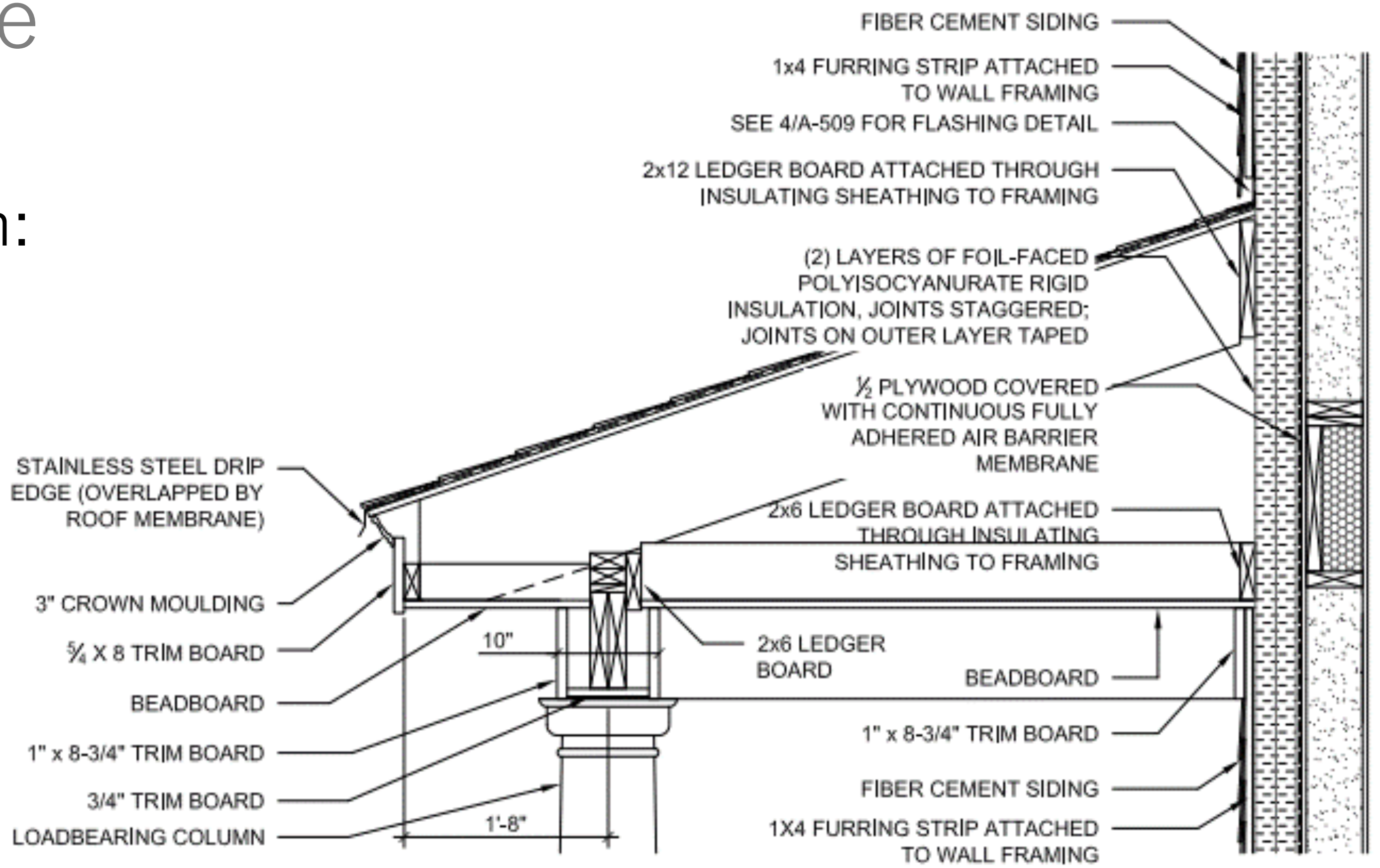
- Design of Connections through FPIS to Cold-formed Steel
  - Tension allowable design values: Follows same procedure in AISI S100 for screw withdrawal capacity (just use longer screws)
  - Shear allowable design values: Follows the same procedure in AISI S100, Section J4.3.1, but modifies Eq. J4.3.1.-1 by a gap reduction factor, Gr, as follows:
    - For #10 screw in 54mil and 50 ksi steel: $Gr = 0.17 – 0.0048\ r$
    - For #10 screw in 43mil and 33 ksi steel: $Gr = 0.19 – 0.0066\ r$
    - For #8 or #10 screw in 33mil and 33 ksi steel: $Gr = 0.16 – 0.0064\ r$
      - Where,
        - r = d_sep/d
        - d_sep = thickness of FPIS separating connected steel parts
        - d = nominal screw diameter (0.164” for #8, 0.190” for #10)
      - Value of r shall not exceed 21.
      - For 0<r<2, Gr need not be less than (1 – r/2)
      - Material against screw head shall be minimum 33mil and 33ksi steel or minimum 3/8” thick wood or wood-based material with specific gravity of 0.42 or greater.

Design Procedure

- Example Applications:
  - Cladding and furring connections using alternative fasteners
  - Load bearing structural component connections through FPIS (e.g., deck and roof ledgers attached to wall surface)
  - Architectural component connections through FPIS (e.g., awning frames, shading devices, etc.)
  - Structural sheathing connections through FPIS (placed under sheathing rather than over sheathing)
  - Window and door frame anchorages where passing through a rough opening gap or through a layer of foam sheathing (e.g., conditions not addressed in fenestration manufacturer instructions)

Design Procedure

- Example Application:



6 FRONT PORCH ROOF DETAIL

SCALE: 3/4" = 1'-0"

ANSI Standard for Continuous Insulation Applications

- Scope
  - Above-grade frame walls
  - Labeling & Quality Assurance
  - Wind resistance
  - WRB (water resistance)
  - Vapor Control
  - Window installation
  - Cladding installation
- Addresses
  - Performance criteria (design)
  - Evaluation/testing criteria by application
  - Prescriptive criteria ("cook-book" design and installation)
- Exclusions
  - Refer to locally applicable code for fire safety requirements (e.g., IBC Chapter 14 and 26; IRC Section R316)
  - Use FPIS manufacturer data to demonstrate compliance (ASTM E84, ASTM E119, NFPA 285, etc. – as applicable)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608-310-6710

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Applied Building
Technology Group, LLC

ANSI/ABTG FS200.1 – 2022

Standard for Use of Foam Plastic Insulating Sheathing (FPIS) in Building Envelopes: Above-grade Walls

Approved American National Standard
ANSI

https://www.appliedbuildingtech.com/standards

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Conclusions

- **Building science fundamentals** are important, are now addressed in newer model building codes, and are facilitated by various resources and on-line tools.
- **New wind-driven rain research** holds promise to better coordinate risk-consistent building envelope design and product evaluation for variation in U.S. climate hazard.
- **Fenestration installation practices** have been evaluated & confirmed for use with FPIS ci (with appropriate limitations) and enabled in U.S. model codes.
  - Provides means to minimize thermal bridging around fenestration openings.
  - Fenestration interface with wall and ci must comply with NFPA 285 test data and engineering analysis for Type I – IV buildings.
- **Cladding connection design and fastening requirements** have been extensively researched, design methods developed, and prescriptive solutions enabled in U.S. model codes.
- **New ANSI/ABTG FS200.1 standard** available to provide comprehensive design and installation guidance in code-enforceable language for FPIS above-grade wall applications.
- **For more information** on FPIS ci applications, guidance, and design tools for code compliance refer to www.continuousinsulation.org.

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Thank you!

Questions?

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DECEMBER WEBINAR

Join us Wednesday, December 13th at 11 a.m. ET

Register in the Steel Framing Learning Portal

Speaker: Patrick Ford, SFIA Technical Director

SUPPLEMENTAL SLIDES – Wind Driven Rain Hazard

- Characterization
- Implications
- Research
    - Southeastern US
    - Entire US pending

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Characterizing the Wind-driven Rain Hazard

- Wind-driven rain (WDR) hazard varies significantly across U.S. and is crucial in specifying building enclosures, components, and installation practices.
- Wind-driven rain hazard must consider annual extreme wind speed at a given coincidental rainfall rate threshold sufficient to generate a leak
- Wind-driven rain resistance test criteria (e.g., ASTM E331) must then be correlated to observed performance in real wind flow and rain conditions
- Understanding the wind-driven rain hazard as it varies across the U.S. is critical to risk-consistent design of building envelopes and specification of component performance criteria.
- Current U.S. codes and standards do not address variation in WDR hazard in a risk-consistent fashion.

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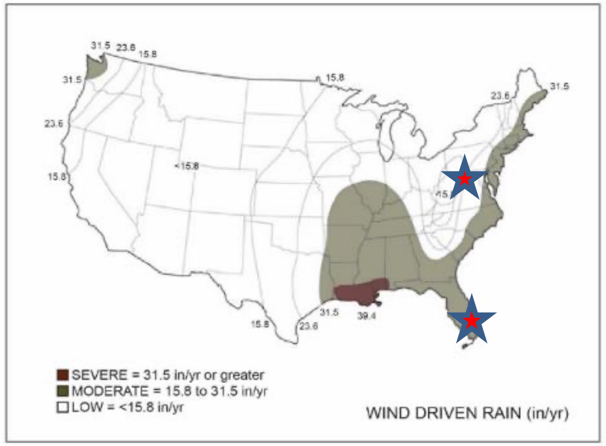
Wind-driven Rain Implications Vary

- The implications (risk and consequences) vary by wind-driven rain climate (hazard) and vulnerability (site exposure and even a specific component's exposure).
- Ultimately, the selected hazard level and performance criteria for design and product evaluation must align with past successful practice, reasonably discriminate against unacceptable practice, and consider consequences of different types or causes of leaks.

Extreme Wind-Driven Rain Hazard (Tropical) – Hurricane Andrew, 1992 (~600 yr MRI wind event); Contents water damage in South Florida due to breach of building envelope

South Florida vs. Western Virginia



Typical Wind-Driven Rain Hazard Exposure (non-tropical, t-storms, etc.); 35-year old one-story building; only minor water staining below window with no WRB, flashing, or bedding sealant

Wind-driven Rain Research

“Development of an Extreme Wind-Driven Rain Climatology for the Southeastern United States Using 1-Min Rainfall and Peak Wind Speed Data”

- Art DeGaetano & Brian Belcher, NOAA Northeast Regional Climate Center, Cornell University
- Forrest Masters, PhD, PE, University of Florida
- Jay Crandell, PE, ARES Consulting
- Murray Morrison, PhD, Institute for Business and Home Safety
- Published at: https://journals.ametsoc.org/view/journals/apme/62/7/JAMC-D-22-0156.1.xml

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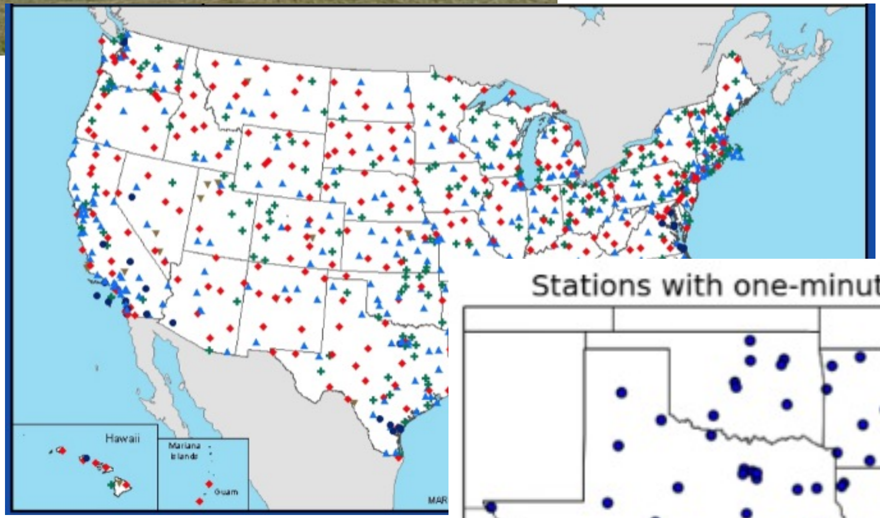
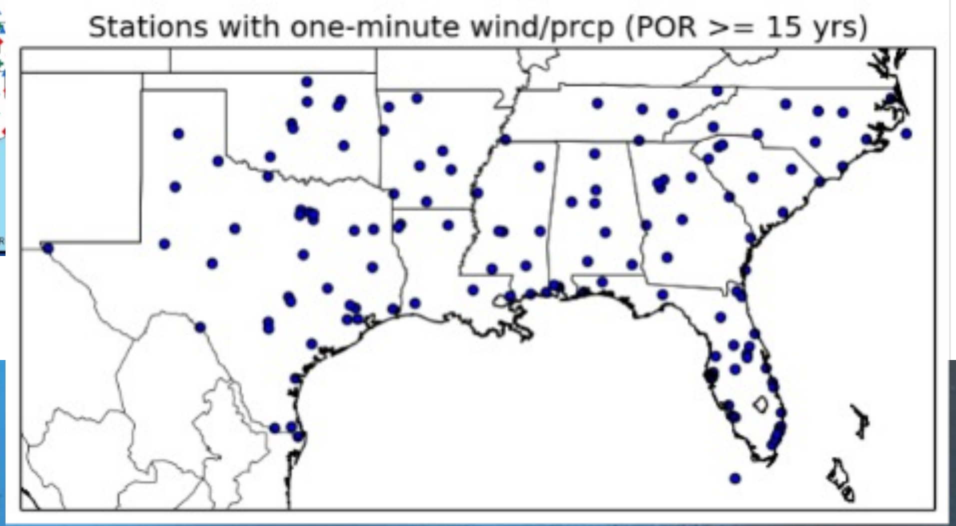
Wind-driven Rain Research

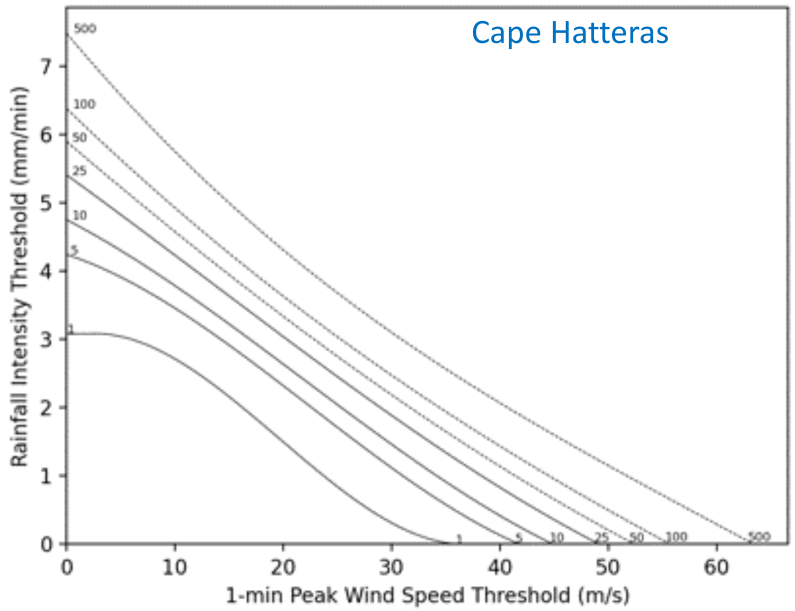


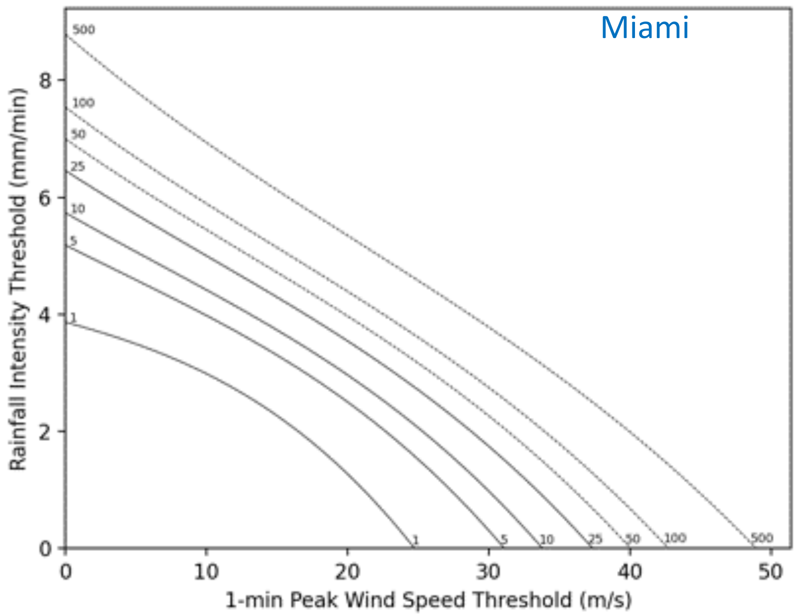


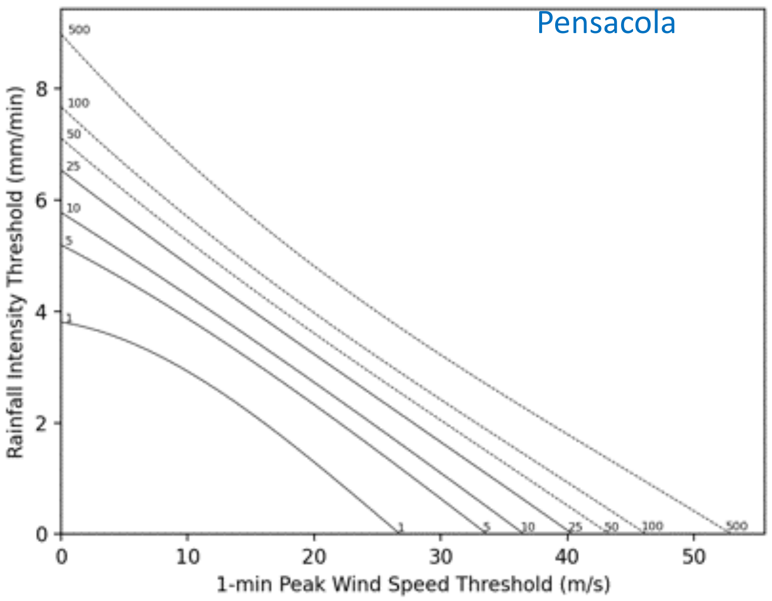
- ASOS weather stations:
  - max wind gust for every 1-minute
  - 1-minute rainfall accumulation
  - Horizontal surface receipt
  - Up to 20 years of record
  - = 10 MILLION observations/station

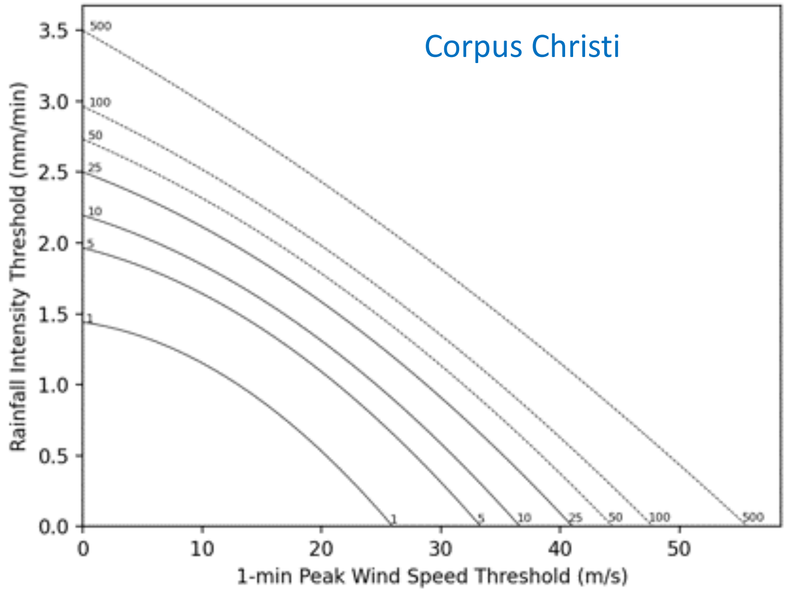
Study focused on **southeast region** of US due to funding from Florida DCA based on research recommendation of its Hurricane Research Advisory Council

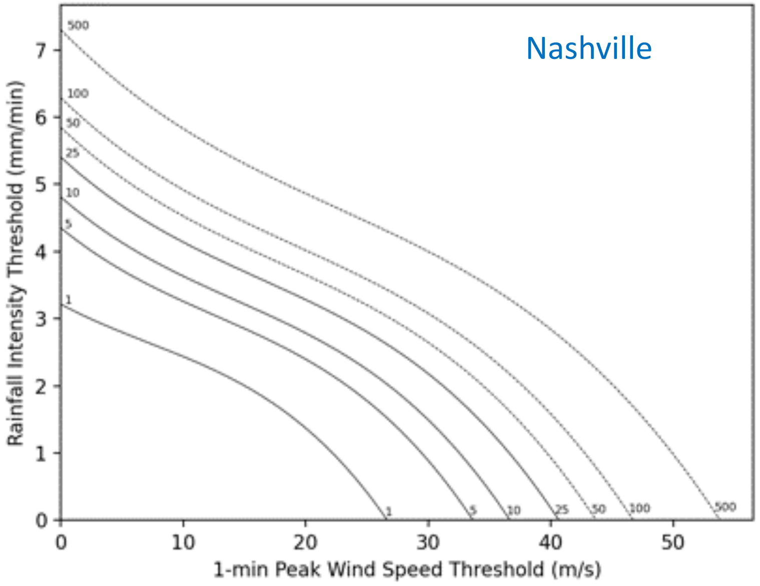
MRI Results for Select Southeast Region Stations











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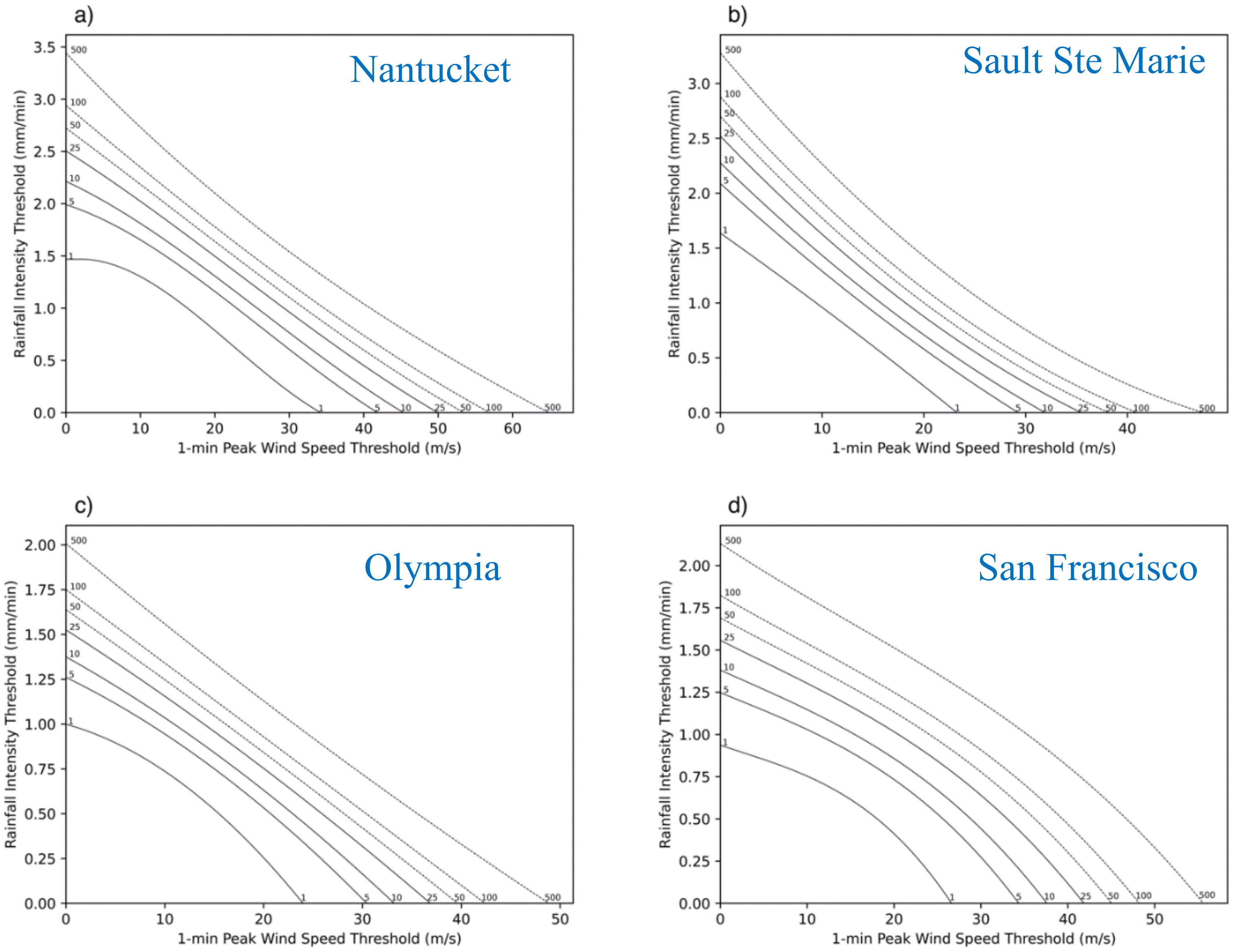
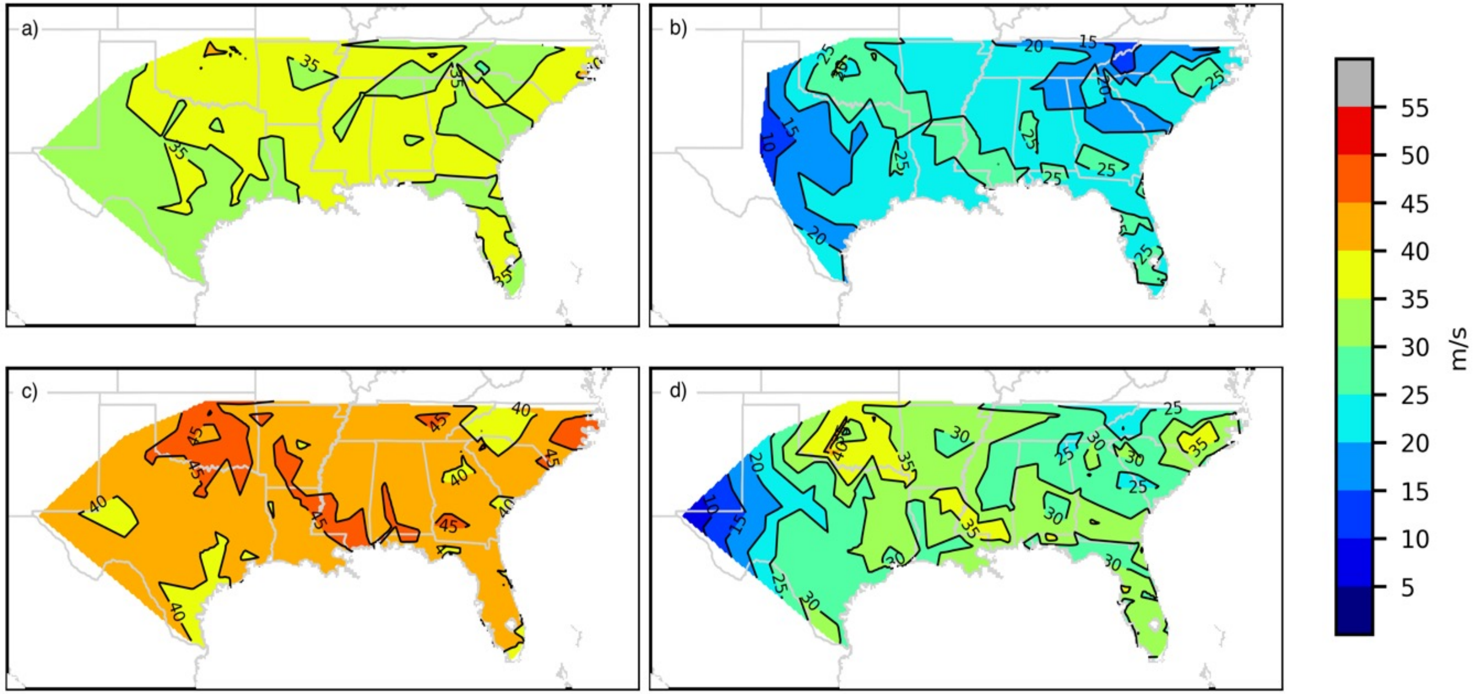
MRI Results for Small Sample Outside Southeast



Example of Mapped WDR Hazard for SE Region

- Depending on MRI annual extreme gust wind speed and coincidental rainfall rate threshold selected as basis for design, the positive pressure differential for water penetration resistance (at leak initiation) can range from about **20 psf** (40 m/s or 90 mph wind speed) to **1.33 psf** (10 m/s or 22 mph)
- Calibration is needed to align with past successful practice
  - Current ASTM E331 test pressure criteria have typically ranged from 3 psf (minimum default) to 12 psf (e.g., hurricane regions).
  - The high thunderstorm hazard region (also high tornado hazard region) tends to have greater WDR hazard than hurricane prone region (diagonal from southern AL to OK).
  - Note also regions of much lower WDR hazard (e.g., southwest VA and west TX).
  - For on-set of water penetration (leak initiation) as the failure mode for ASTM E331 testing, a 1 to 5-yr MRI annual extreme gust wind speed with coincidental rainfall rate threshold of 0.25mm/min (0.6 in/hr) may better align with past successful practice.
- More work needed to analyze entire U.S.



1 m/s = 2.24 mph (e.g., 40 m/s = 88 mph)

a) 10 yr MRI gust wind speed at 0.254 mm/min rainfall intensity threshold (based on receipt on horizontal surface, not converted vertical building surface)
b) 10 yr MRI V with RI ≥2.54 mm/min
c) 50 yr MRI V with RI ≥0.254 mm/min
d) 50 yr MRI V with RI ≥2.54 mm/min