PHRC Webinar Series
Tuesday, October 14, 2014 1:00 pm

Insulating with Exterior Rigid Foam

Presented by: Chris Hine

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

This course is registered with AIA CES

Course Description

This webinar will focus on the benefits and obstacles of an exterior wall assembly constructed with rigid foam. Rigid foam can currently be used as an option in the prescriptive insulation design path for the 2009 IECC and 2009 IRC chapter 11. The installation of rigid foam to the exterior of the wall has added benefits such as the increase of overall wall assembly R-values, the reduction of thermal bridging and can be an added barrier for air infiltration. Along with the benefits come added obstacles. Some of these obstacles include the overall thickness of the wall assembly when used in conjunction with wood structural panels. This added thickness can deviate from industry standard extension jambs for doors and windows. The added insulation also directly affects the dew point with in the wall assembly. We will take a brief look into what happens to the dew point in standard wall assemblies when rigid foam is added. With the information included in this webinar, the decision to add rigid foam to the exterior of a residential home will be both educated and informed.

Learning Objectives

At the end of the this course, participants will be able to:

1. Understand the energy efficiency requirements for meeting the optional prescriptive path to the 2009 IECC and 2009 IRC Chapter 11 for insulating with exterior rigid foam.
2. Understand code regulations and different application methods for installing rigid foam. This will include adding foam over wood structural panels (WSP), adding foam under WSP, and adding standalone foam sheathing with the introduction of proprietary and nonproprietary let-in-bracing to achieve wall bracing requirements.
3. Identify the areas of concerns for increasing the overall thickness of the wall assembly and looking at solutions to those concerns. An example of this would include taking a look at the building design and reviewing the methods and details of exterior wall assemblies used to effectively install doors and windows with standard 4 9/16" and 6 9/16" extension jambs .
4. Understand how the added insulation changes the dynamic of the "building science" within the wall assembly. This includes the movement of the dew point based on R-values and cavity insulation and associated potential risks of having the dew point located within the wall cavity.

Poll #1 – Who's who?

Agenda

- Rigid Foam Sheathing
- Exterior Foam and Energy Efficiency
- Wall Bracing with Foam
- Foam and Water-Resistive Barriers
- Critical Framing Details
- Mitigating Moisture Risks
- Wrap-up & Questions

Rigid Foam Sheathing

Three types of foam

- **Expanded Polystyrene (EPS)**
  - Insulfoam
  - R-Tech
  - Benchmark Foam
- **Extruded Polystyrene (XPS)**
  - STYROFOAM
  - FOAMULAR
  - GreenGuard
- **Polyisocyanurate (ISO)**
  - Thermax
  - Tuff-R
  - RMax

Expanded Polystyrene (EPS)

- **Common uses**
  - Insulated concrete forms
  - SIPs
- **Typical thermal resistance:** R-4 per inch
- **Vapor permeability:** 5 perms (Class III vapor retarder
- **Durability**
  - Avoid prolonged exposure to UV
  - Requires care when cutting and handling (fragile edges)

Note: Vapor permeability varies with material thickness. Values listed are based on 1 inch.

Extruded Polystyrene (XPS)

- **Common uses**
  - Sheathing
  - Under-slab insulation
- **Typical thermal resistance:** R-5 per inch
- **Vapor permeability:** 1.1 perms (Class III vapor retarder
- **Durability**
  - Avoid prolonged exposure to UV
  - Matrix is stronger than EPS beads. More forgiving on the jobsite.

Note: Vapor permeability varies with material thickness. Values listed are based on 1 inch.

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Polyisocyanurate (ISO)

- **Common uses**
  - Sheathing
- **Typical thermal resistance:** R-6.5 per inch
- **Vapor permeability:**
  - < 1.0 perms with fiberglass facing (Class II vapor retarder
  - 0.03 perms with foil facing (Class I vapor retarder
- **Durability**
  - Facing can be more resistant to UV
  - Matrix is stronger than EPS beads. More forgiving on the jobsite.

Note: Vapor permeability varies with material thickness. Values listed are based on 1 inch.

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Exterior Foam and Energy Efficiency

The Energy Code

- **2009 International Energy Conservation Code**
  - Chapter 4

- **2009 International Residential Code**
  - Chapter 11

The Energy Code

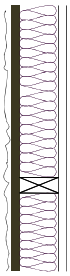
- **Three prescriptive options for wall insulation based on the 2009 ICC Codes** (Climate zone 5 & 6)
  - Cavity insulation only **(R-20)**
  - Cavity plus continuous **(R-13 + R-5)**[h]
    - h. R-13 cavity insulation plus R-5 insulated sheathing
  - Equivalent *U*-factor **(*U*-.060)**

Table N1102.1
Table 402.1.1

Table N1102.1.2
Table 402.1.3

R-value of total wall assembly

2x6 wall @ 16" o.c.



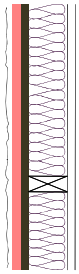
Component	Cavity R-value	Frame R-value
Outside air film	0.17	0.17
Lap siding	0.62	0.62
7/16" OSB	0.62	0.62
Batt insulation	21	--
2x6 stud	--	6.88
Gypsum board	0.45	0.45
Inside air film	0.68	0.68
Total R-values	**23.54**	**9.42**
Total U-factor (1/R-value)	**0.0425**	**0.1062**

$U_{overall}$ = (0.0425x.75)+(0.1062x.25) = 0.0584
$R_{overall}$ = 1/0.0584 = **17.1**

Data pulled from "Typical Thermal Properties of Common Building and Insulating Matererials": 2009 ASHRAE Handbook

R-value of total wall assembly

2x4 wall @ 16" o.c. & foam



Component	Cavity R-value	Frame R-value
Outside air film	0.17	0.17
Lap siding	0.62	0.62
7/16" OSB	0.62	0.62
Batt insulation	13	--
Rigid Foam	5	5
2x4 stud	--	4.38
Gypsum board	0.45	0.45
Inside air film	0.68	0.68
Total R-values	**20.54**	**11.92**
Total U-factor (1/R-value)	**0.0487**	**0.0839**

$U_{overall}$ = (0.0487x.75)+(0.0839x.25) = 0.0575
$R_{overall}$ = 1/0.0575 = **17.4**

Data pulled from "Typical Thermal Properties of Common Building and Insulating Matererials": 2009 ASHRAE Handbook

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Why?

- Total R-value for a 2x6 wall = **R-17.1**
- Total R-value for a 2x4 wall with exterior foam = **R-17.4**

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Principle of Thermal Bridging

- Thermal Conductivity @ ~ 70° F
  - Wood (pine) = 0.14 (W/mK)
  - Fiberglass insulation = 0.04 (W/mK)
  - Air = 0.023 (W/mK)
- Therefore, wood has more than **three times** the thermal conductivity of fiberglass insulation

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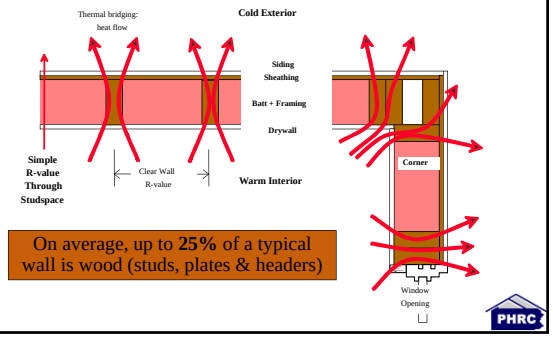
Thermal Bridging



On average, up to **25%** of a typical wall is wood (studs, plates & headers)

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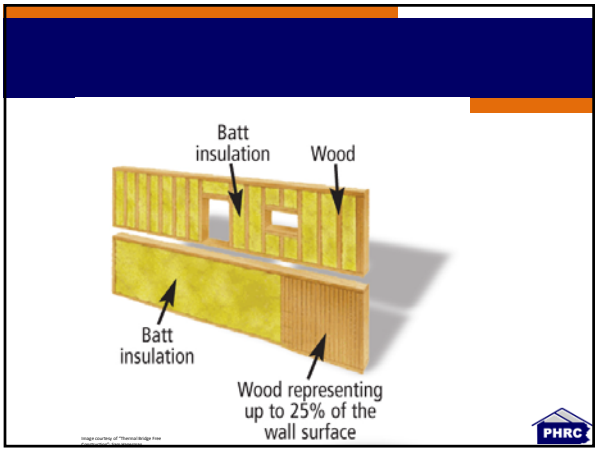

Batt insulation
Wood
Batt insulation
Wood representing up to 25% of the wall surface

Poll #2 – Head Count

Certificate Password:
Foam1014

(Note – password is case sensitive)

Wall Bracing with Foam

Options for Bracing with Foam

- **Let in Bracing – LIB**
- **Hybrid – Wood Structural Panel and Foam**
- **Wood Structural Panels**
- **Proprietary Systems**

Let in Bracing

- Let in bracing - 2006 IRC
  - **R602.10.3 Braced wall panel construction methods.**
    - **Method**
    1. Nominal 1-inch-by-4-inch continuous diagonal braces let in to the top and bottom plates and the intervening studs or approved metal strap devices installed in accordance with the manufacturer's specifications. The let-in bracing shall be placed at an angle not more than 60 degrees or less than 45 degrees from the horizontal

Where can LIB be used?

- **Method #1 – Let in bracing (LIB)**

TABLE R602.10.1
WALL BRACING

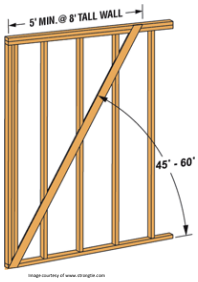
SEISMIC DESIGN CATEGORY OR WIND SPEED	CONDITION	TYPE OF BRACE[b,c]	AMOUNT OF BRACING[a,b,c]
Category A and B ($S_s \leq 0.35g$ and $S_{ds} \leq 0.33g$) or 100 mph or less	One story Top of two or three story	Methods 1, 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 16% of braced wall line for Methods 2 through 8.
	First story of two story Second story of three story	Methods 1, 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 16% of braced wall line for Method 3 or 25% of braced wall line for Methods 2, 4, 5, 6, 7 or 8.
	First story of three story	Methods 2, 3, 4, 5, 6, 7 or 8	Located in accordance with Section R602.10 and at least every 25 feet on center but not less than 25% of braced wall line for Method 3 or 35% of braced wall line for Methods 2, 4, 5, 6, 7 or 8.

What qualifies as LIB?

- Let in bracing - 2006 IRC
  - **R602.10.3 Braced wall panel construction methods.**
    - **Method**
    1. Nominal 1-inch-by-4-inch continuous diagonal braces let in to the top and bottom plates and the intervening studs or approved metal strap devices installed in accordance with the manufacturer's specifications. The let-in bracing shall be placed at an angle not more than 60 degrees or less than 45 degrees from the horizontal

1x4 LIB

- 1x4 Let in bracing - 2006 IRC

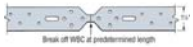


What else qualifies?

- Approved metal strap - 2006 IRC
  - **R602.10.3 Braced wall panel construction methods.**
    1. *Nominal 1-inch-by-4-inch continuous diagonal braces let in to the top and bottom plates and the intervening studs* or approved metal strap devices installed in accordance with the manufacturer's specifications. The let-in bracing shall be placed at an angle not more than 60 degrees or less than 45 degrees from the horizontal

Metal strap Bracing (Simpson)

WB



WBC

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TABLE 5—WB AND WBC WALL BRACING[1,2,3]

MODEL NO.	STRAP LENGTH (feet – inches)	WALL HEIGHT (feet)	REQUIRED INSTALLATION ANGLE OF THE WB AND WBC BRACES FROM THE HORIZONTAL[4] (degree)	FASTENERS (Quantity, Type)	
				Top and Bottom Plates	Each Stud
WB106	9' – 5⅞"	8	60°	2–16d	1–8d
WB126	11' – 4⅞"	8	45°	2–16d	1–8d
WB106C	9' – 6"	8	60°	2–16d	1–8d
WB126C	11' – 4⅞"	8	45°	2–16d	1–8d
WB143C	14' – 3"	10	45°	2–16d	1–8d

For SI: 1 inch = 25.4 mm, 1lbs = 4.45 N.

[1] The WB and WBC wall bracing straps can be used as alternates only to the code prescribed braced wall panel construction identified as a nominal 1x4 diagonal wood brace let into studs. The WB and WBC wall bracing straps are not recognized to replace or be used as alternates to other braced wall construction methods described in the code.

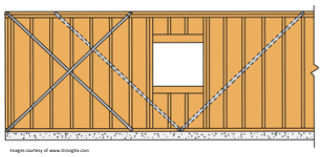
[2] The WB and WBC must tension loads only. Consequently, the WB and WBC straps must be installed in pairs, as shown in Figure 5c. The allowable in-plane racking shear load of a wall braced with the CWB strap installed in "X" pairs or in opposing "V" fashion is 180 lbs, and must not be combined with other shear resisting elements or components. This allowable racking shear load must not be increased for short term loading. Summing shear capacities of the WB or WBC wall braces with dissimilar materials applied to either side of the same wall is not allowed.

[3] The wall studs may be spaced 16 inches on center or 24 inches on center.

[4] The WB and WBC wall bracing straps must be installed at the installation angle specified in the table.

Metal strap Bracing (Simpson)

- Simpson WB & WBC installation application
  - Must be installed in either a “V” or “X” pattern



Metal strap Bracing (Simpson)

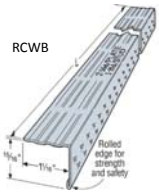


TABLE 3—RCWB WALL BRACING[1,2,3,4]

MODEL NO.	STRAP LENGTH (feet - inch)	WALL HEIGHT (feet)	REQUIRED INSTALLATION ANGLE OF THE RCWB BRACE FROM THE HORIZONTAL[5] (degree)	FASTENERS (Quantity-Type)	
				Top and Bottom Plates	Each Stud
RCWB10	9' - 9"	8	55°	2-10d	1-8d
RCWB12	11' - 4"	8	45°	2-10d	1-8d
RCWB14	14' - 2"	10	45°	2-10d	1-8d

For SI: 1 inch = 25.4 mm, 1 lbs = 4.45 N.

RCWB wall bracing strap can be used as an alternate only to the code prescribed braced wall panel construction identified as a nominal 1x4 diagonal wood brace let into studs. The RCWB wall bracing strap is not recognized to replace or be used as an alternate to other braced wall construction methods described in the code.

[1]The allowable in-plane racking shear load of a wall braced with the RCWB strap installed in accordance with this table is 290 lbs. The RCWB strap resists tension and compression loads. The allowable 290 lbs racking shear load must not be increased for short term loading, and must not be combined with other shear resisting elements or components. Summing shear capacities of the RCWB wall brace with dissimilar materials applied to either side of the same wall is not allowed.

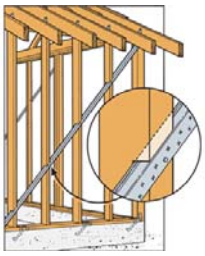
[2]The wall studs must be spaced 16 inches on center, maximum.

[3]A minimum 2x6 stud is required for exterior walls and interior load bearings that are braced with the RCWB strap. For interior, nonload-bearing walls braced with the RCWB strap, minimum 2x4 studs may be used.

[4]The RCWB wall bracing strap must be installed at the installation angle specified in the table.

Metal strap Bracing (Simpson)

- Simpson RCWB installation application
  - Maximum 1 1/8” deep saw kerf in stud



Metal strap Bracing (Simpson)

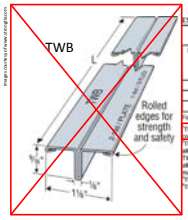


TABLE 6—TWB (T-TYPE) WALL BRACING[1,2,3]

MODEL NO.	BRACE LENGTH (L) (feet – inches)	WALL HEIGHT (feet)	REQUIRED INSTALLATION ANGLE OF THE TWB (T-TYPE) BRACE FROM THE HORIZONTAL[4] (degree)	FASTENERS (Quantity-Type)	
				Top and Bottom Plates	Each Stud
TWB10	9' – 9"	8	55°	2–16d	1–8d
TWB12	11' – 4"	8	45°	2–16d	1–8d
TWB14	14' – 2"	10	45°	2–16d	1–8d

For SI: 1 inch = 25.4 mm, 1lbs = 4.45 N.

The TWB wall bracing strap is not recognized to replace or be used as an alternate to braced wall construction methods described in the code.

[1]The allowable in-plane racking shear load of a wall braced with the TWB10 strap installed in accordance with this table is 160 lbs. The allowable in-plane racking shear load of a wall braced with the TWB12 or TWB14 strap installed in accordance with this table is 190 lbs. The TWB straps resist tension and compression loads, and must not be combined with other shear resisting elements or components. The allowable racking shear load must not be increased for short term loading. Summing shear capacities of the TWB wall brace with dissimilar materials applied to either side of the same wall is not allowed.

[2]The wall studs must be spaced 16 inches on center, maximum.

[3]The TWB wall bracing strap must be installed at the installation angle specified in the table.

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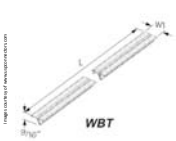
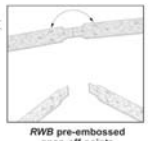
Metal strap Bracing (USP)





RWB pre-embossed snap-off points

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Foam with structural sheathing

- 2009 IRC

TABLE N1102.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT[b] U-FACTOR	GLAZED FENESTRATION SHGC	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE[i]	FLOOR R-VALUE	BASEMENT[c] WALL R-VALUE	SLAB[d] R-VALUE AND DEPTH	CRAWL SPACE[c] WALL R-VALUE
1	1.2	0.75	0.35	30	13	3/4	13	0	0	0
2	0.65	0.75	0.35	30	13	4/6	13	0	0	0
3	0.50	0.65	0.35[e]	30	13	5/8	19	5/13	0	5/13
4 except Marine	0.35	0.60	NR	38	13	5/10	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.35	0.60	NR	38	20 or 13 + 5[h]	13/17	30[f]	10/13	10, 2 ft	10/13
6	0.35	0.60	NR	49	20 or 13 + 5[h]	15/19	30[f]	10/13	10, 4 ft	10/13
7 and 8	0.35	0.60	NR	49	21	19/21	30[f]	10/13	10, 4 ft	10/13

a. *R*-values are minimums. *U*-factors and solar heat gain coefficient (SHGC) are maximums. R-19 batts compressed in to nominal 2 × 6 framing cavity such that the *R*-value is reduced by R-1 or more shall be marked with the compressed batt *R*-value in addition to the full thickness *R*-value.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

c. The first *R*-value applies to continuous insulation, the second to framing cavity insulation, either insulation meets the requirement.

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less, in zones 1 through 3 for heated slabs.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure N1101.2 and Table N1101.2.

g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

h. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25% or less of the exterior, R-5 sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25% of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

i. For impact-rated fenestration complying with Section R301.2.1.2, the maximum *U*-factor shall be 0.3 in zone 2 and 0.65 in zone 3.

j. For impact-resistant fenestration complying with Section R301.2.1.2 of the *International Residential Code*, the maximum SHGC shall be 0.40.

k. The second *R*-value applies when more than half the insulation is on the interior.

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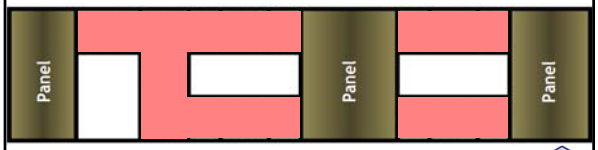
Foam with structural sheathing

- **IECC Table 402.1.1 – Footnote h**
  - R-13+5 means R-13 cavity insulation plus R-5 insulated sheathing
  - If structural sheathing covers 25% or less of the exterior, insulating sheathing is not required where structural sheathing is used
  - If structural sheathing covers more than 25% of the exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2



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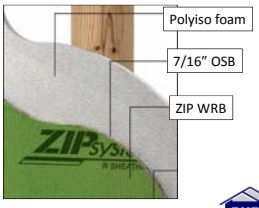
Proprietary systems

Huber Zip R-Sheathing

- **R-3.6 @ 1”**
- **R-6.6 @ 1.5”**

BOTH:
- Structural sheathing
- Water resistive barrier

Installation:
- Use compatible tape
- Follow MII for nailing



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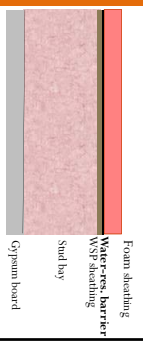
Foam and Water-Resistive Barriers

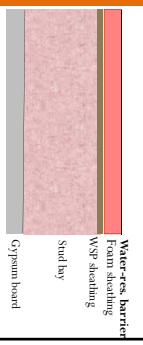
Water-Resistive Barrier Strategy 1

- **WSP + WRB + Foam**
  - Improved durability
    - WRB is supported by WSP
    - WRB is protected by foam
  - Recommended for areas with:
    - High exposure
    - High rainfall
  - Best for "innie" windows



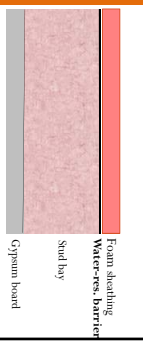
Water-Resistive Barrier Strategy 2

- **WSP + Foam + WRB**
  - Best for "outie" windows
  - More exposure to the elements
  - Longer fasteners required for housewrap



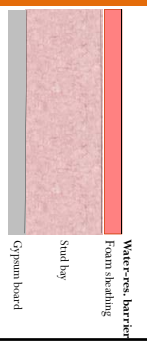
Water-Resistive Barrier Strategy 3

- **WRB under foam**
  - No structural sheathing
  - Housewrap stretched across stud
  - WRB is protected by foam
  - Care must be taken when installing WRB
  - Best for "innie" windows



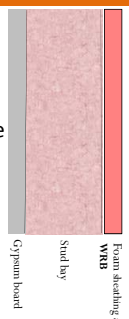
Water-Resistive Barrier Strategy 4

- **WRB over foam**
  - No structural sheathing
  - More exposure to the elements
  - Best for "outie" windows



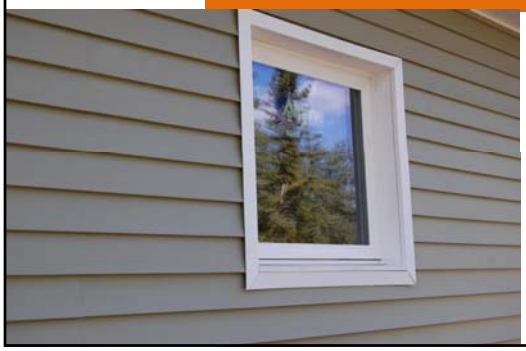
Water-Resistive Barrier Strategy 5

- **Foam as WRB**
  - Check ES Report
  - All seams must be taped
  - Flashing details at openings are critical



Critical Framing Details

Inset Window Exterior Jamb Details

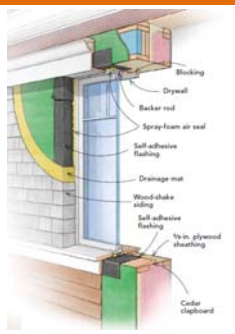


Inset Window Exterior Jamb Details

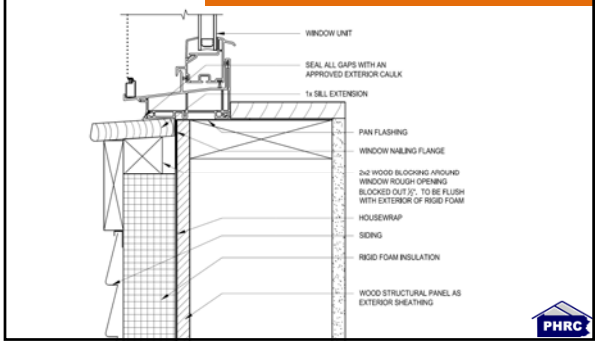
Azek Stucco Steel

Window installation (innie)

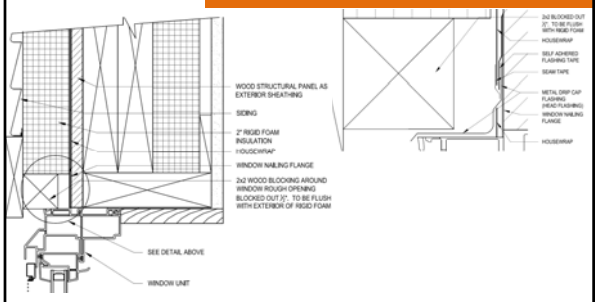
- Example of an "innie" window installation. The window is set to the inside standard location.



"Innie" window sill detail



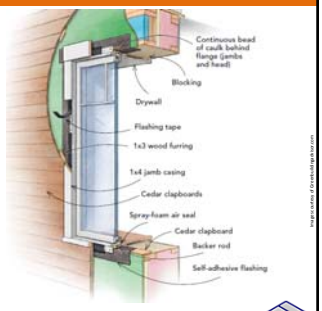
"Innie" window head detail



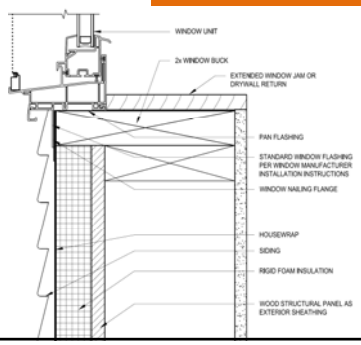
Outset Window Exterior/Interior Jamb Details

Window installation (outie)

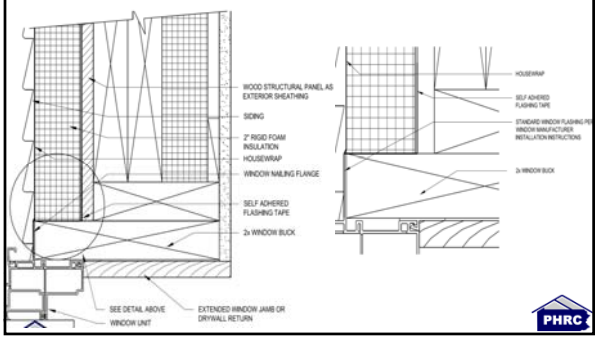
- Example of an "outie" window installation. The window is set to the outside standard location.



"Outie" window sill detail



"Outie" window head detail

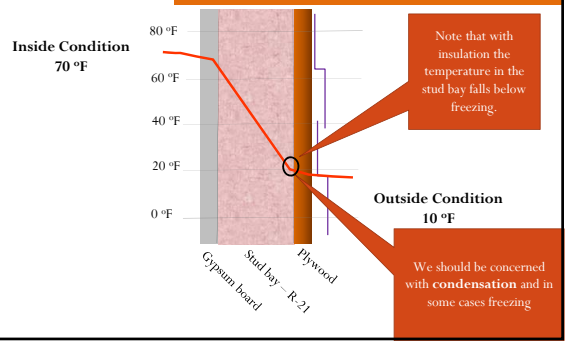


How to install siding over foam?

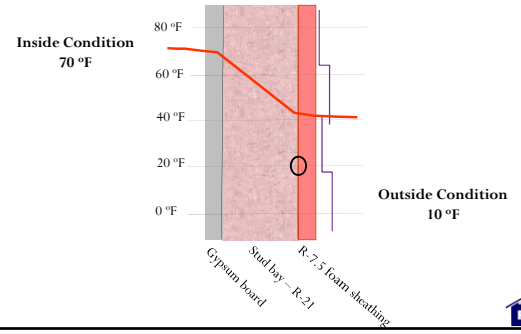
- Foam is not a substrate for nail holding and therefore does not have nail withdrawal capacity.
  - Extend the fastener length by the thickness of the continuous insulation being used.

Mitigating Moisture Risks

What happens to the temperature inside a wall assembly? (OSB sheathing)



What happens to the temperature inside a wall assembly? (foam sheathing)



Wrap-up

- Identify the type of foam to be used
- Attach foam to framing per manufacturer's instructions
- Consider wall bracing options at the design phase
- Proper flashing at openings

Questions & Evaluations

Link for certificate:
http://www.cvent.com/d/q4qtpb/4W

Next webinar:
Tuesday, November 11 at 1:00pm
The Appraisal Process

PHRC
www.engr.psu.edu/phrc