Building with Exterior Rigid Foam

Tuesday, December 13, 2011 1:00PM

Presented by: Mike Turns, Associate Director, PHRC

PHRC

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www.engr.psu.edu/phrc

Three types of rigid foam

- **Expanded polystyrene (EPS)**
  - Insulfoam
  - R-Tech
  - Benchmark Foam

- **Extruded polystyrene (XPS)**
  - STYROFOAM
  - FOAMULAR
  - GreenGuard
  - CodeBord/Celfort 200

- **Polyisocyanurate (ISO)**
  - Thermax
  - Tuff-R
  - RMax

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Expanded Polystyrene (EPS)

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

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

Extruded Polystyrene

- **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

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

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 1 vapor retarder)
- **Durability:**
  - Facing can be more resistant to UV
  - Matrix is stronger than EPS beads

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

Summary of Insulation Properties

Material	Fire – Must be covered
EPS	Yes
XPS	Yes
ISO	Yes

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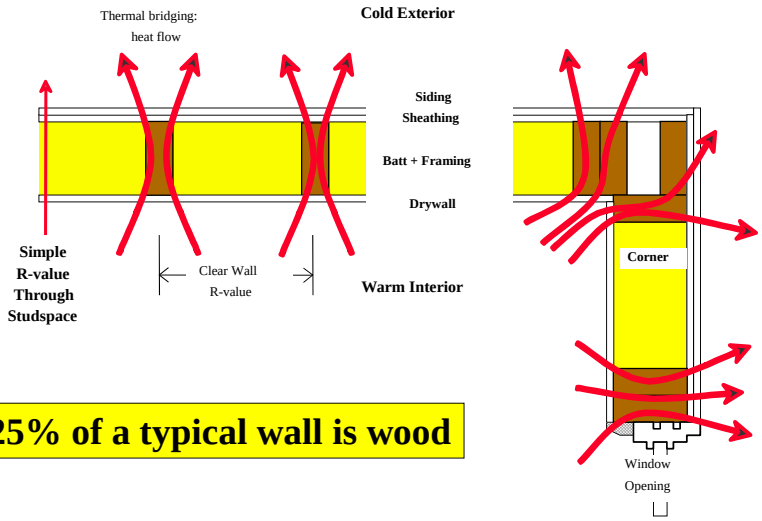
Unless tested and issued a specific approval

Foam and energy efficiency

7

Thermal Bridging



~25% of a typical wall is wood

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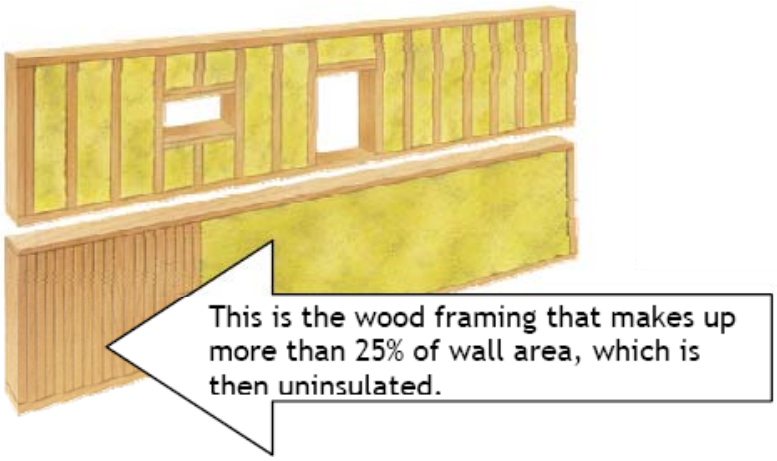
Thermal Bridging



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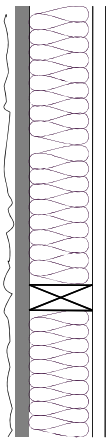
Courtesy of Foam Sheathing Coalition

Whole Wall R-Value

2x6 wall @ 16" o.c.



Component	Cavity R-value	Frame R-value
Outside air film	0.17	0.17
Lap siding	0.81	0.81
7/16" OSB	0.70	0.70
Batt insulation	21	--
2x6 stud	--	5.44
Gypsum board	0.45	0.45
Inside air film	0.68	0.68
Total R-values	**23.81**	**8.16**
Total U-factor (1/R-value)	0.0420	0.1225

$U_{overall} = (0.0420 \times 0.75) + (0.1225 \times 0.25) = 0.0621$

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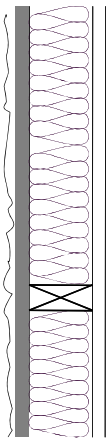
$R_{overall} = 1/0.0621 = \mathbf{16.1}$

Whole Wall R-Value

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



Component	Cavity R-value	Frame R-value
Outside air film	0.17	0.17
Lap siding	0.81	0.81
7/16" OSB	0.70	0.70
Batt insulation	13	--
Rigid foam	5	5
2x6 stud	--	5.44
Gypsum board	0.45	0.45
Inside air film	0.68	0.68
Total R-values	**20.81**	**13.23**
Total U-factor (1/R-value)	0.0481	0.0756

$U_{overall} = (0.0481 \times 0.75) + (0.0756 \times 0.25) = 0.0550$

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$R_{overall} = 1/0.0550 = \mathbf{18.2}$

Mitigating moisture risks

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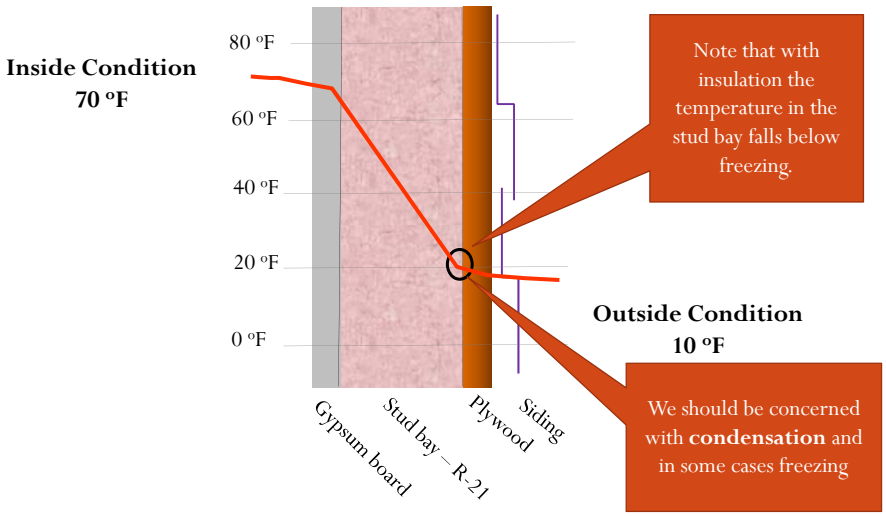
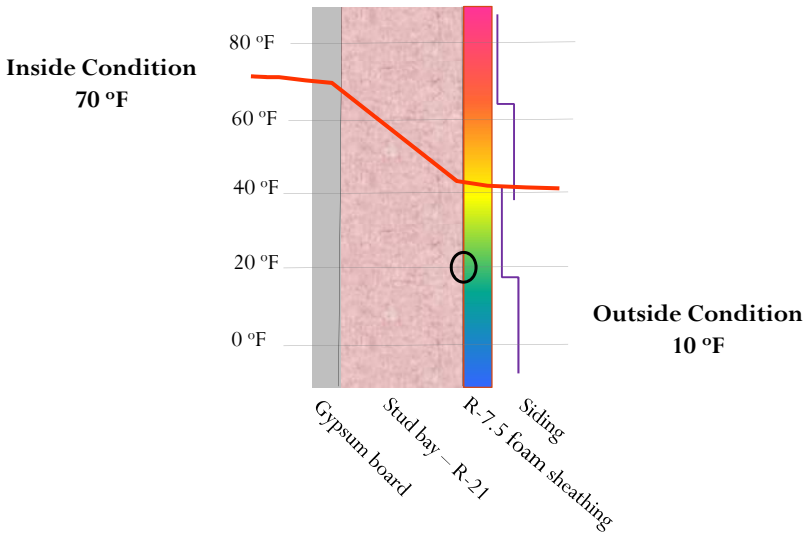
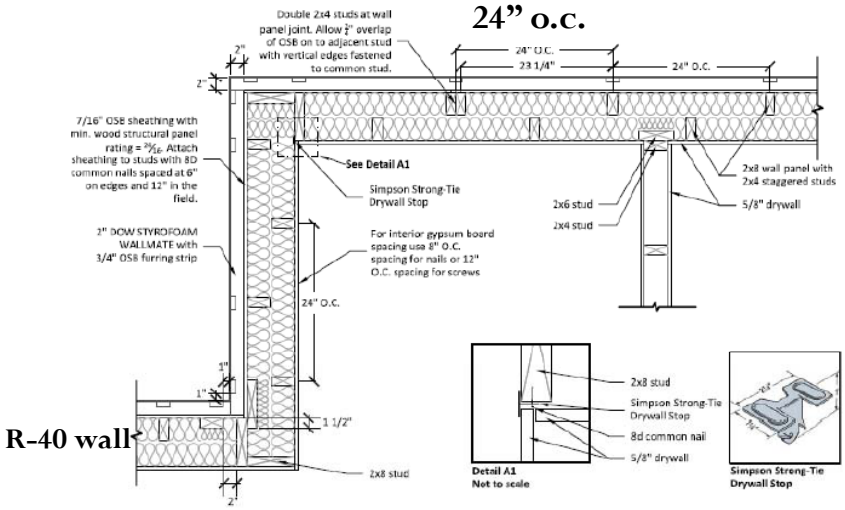
Temp gradient insulated wall



Temp gradient insulated wall



Thicker Framed Walls



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Source: IBACOS, Best Building Practices Research Alliance, Building America Project

Minimizing Condensation Risk

R-values required for Class III vapor retarder (latex or enamel paint):

IRC Table R601.3.1

Climate Zone	Minimum R-Value of Foam Sheathing
Marine 4	R-2.5 for 2x4 walls; R-3.75 for 2x6 walls
5	R-5 for 2x4 walls; R-7.5 for 2x6 walls
6	R-7.5 for 2x4 walls; R-11.25 for 2x6 walls

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Drying to the Inside

- Foam sheathing reduces ability of wall to dry to outside
- Moisture must be allowed to dry to the inside
- No poly vapor retarders
- No vinyl wallpaper

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Foam and water-resistive barriers

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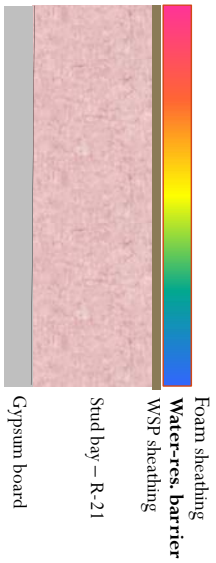
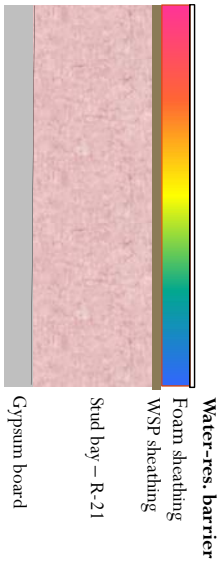
Water-Resistive Barrier Strategy 1



WSP + WRB + foam

- Most durable
  - WRB is supported by WSP
  - WRB is protected by foam
- Recommended for areas with:
  - High exposure
  - High rainfall
- Best for "innie" windows

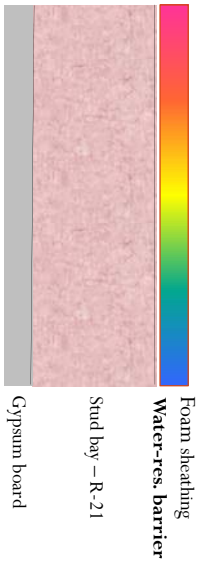
Water-Resistive Barrier Strategy 2



WSP + foam + WRB

- Best for "outie" windows
- More exposure to the elements
- Longer fasteners required for housewrap

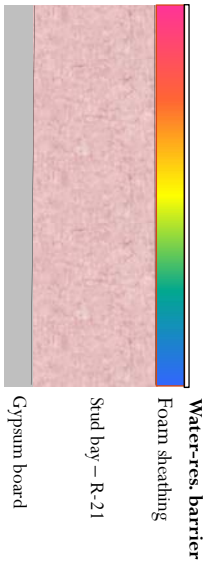
Water-Resistive Barrier Strategy 3



WRB under foam

- No structural sheathing
- Housewrap stretched across studs
- WRB is protected by foam
- Take care 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

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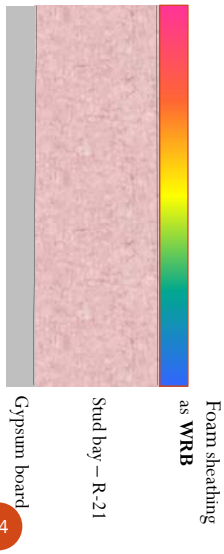
Water-Resistive Barrier Strategy 5



Foam as WRB

- Check ES Report
- Tape all seams
- Carefully detail flashing at openings

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Inset Window Exterior Jamb Details

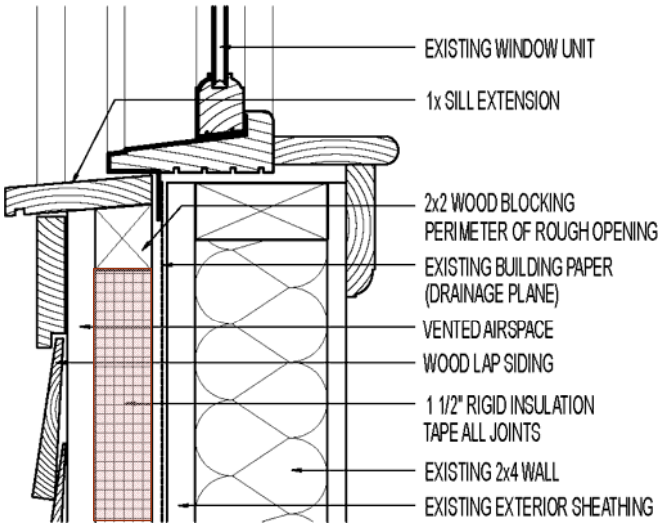
Courtesy of the Cold Climate Housing Research Center

Inset Windows

Azek | Stucco | Steel

Courtesy of the Cold Climate Housing Research Center

Innie Window Sill Detail



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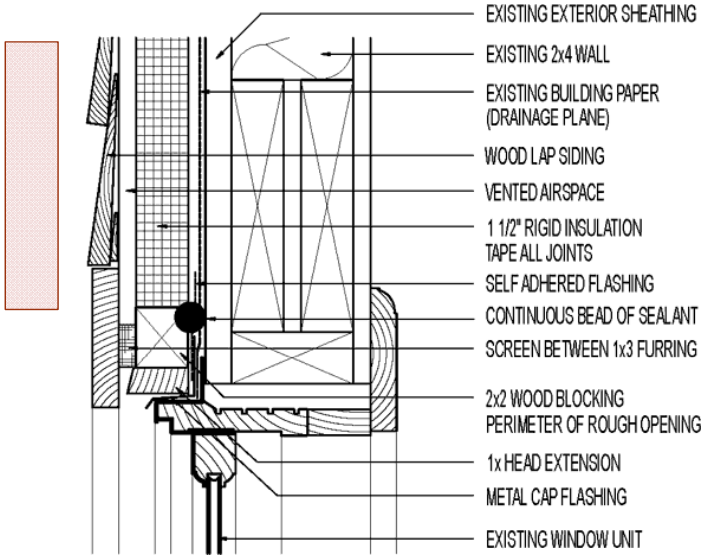
Source: www.greenbuildingadvisor.com

Innie Window Head Detail



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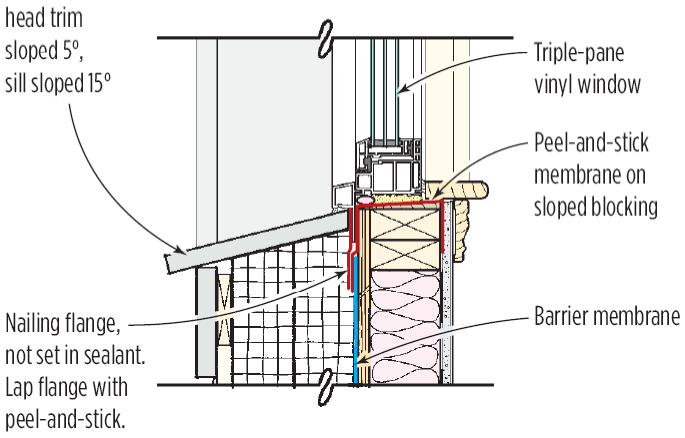
Source: www.greenbuildingadvisor.com

Innie Window Sill Detail



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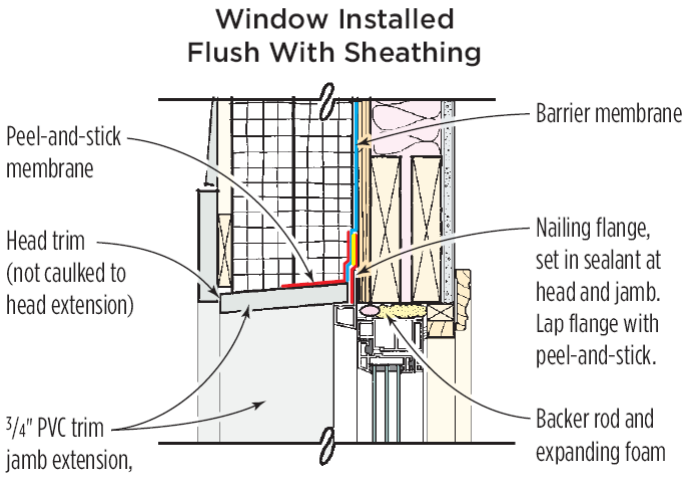
Source: Journal of Light Construction

Innie Window Head Detail



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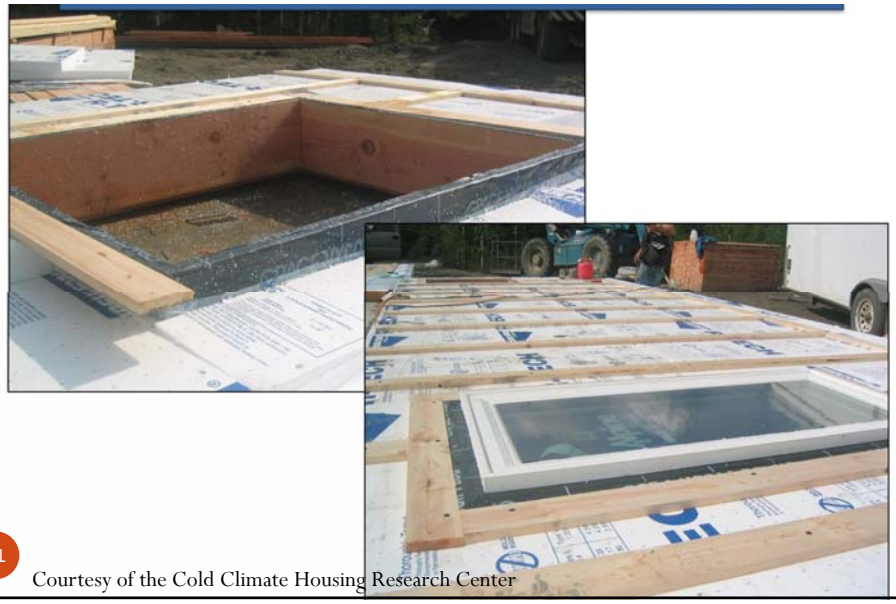
Source: Journal of Light Construction

Outie Windows



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Courtesy of the Cold Climate Housing Research Center

Outies – Window Bucks

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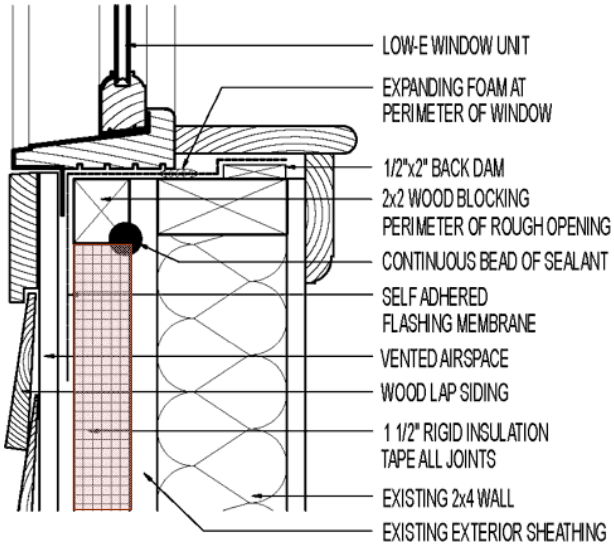
Courtesy of the Cold Climate Housing Research Center

Outie Window Sill Detail



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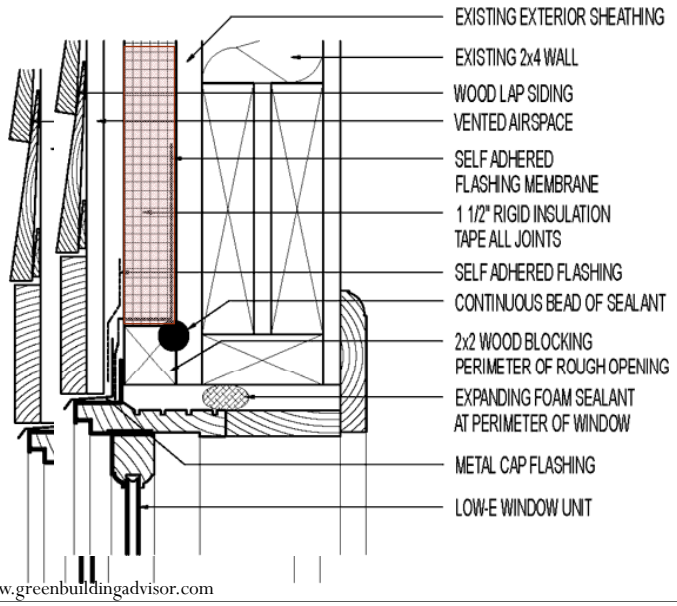
Source: www.greenbuildingadvisor.com

Outie Window Head Detail



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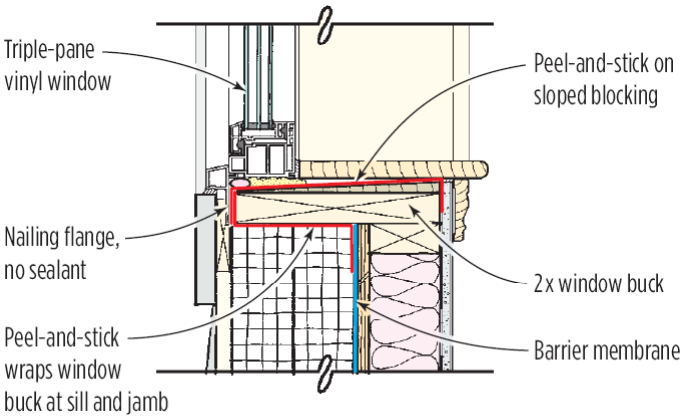
Source: www.greenbuildingadvisor.com

Outie Window Sill Detail



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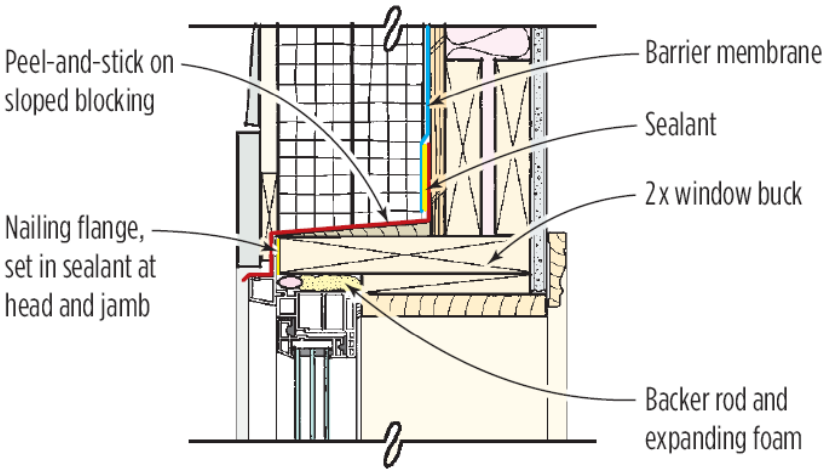
Source: Journal of Light Construction

Outie Window Head Detail



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Source: Journal of Light Construction

Wall bracing and wind resistance

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Let-in-bracing

TABLE R602.10.2
INTERMITTENT BRACING METHODS

METHOD	MATERIAL	MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA
LIB	Let-in-bracing	1 × 4 wood or approved metal straps at 45° to 60° angles for maximum 16″ stud spacing		Wood: 2-8d nails per stud including top and bottom plate metal: per manufacturer
DWB	Diagonal wood boards	$^3/_4$″ (1″ nominal) for maximum 24″ stud spacing		2-8d ($2^1/_2$″ × 0.113″) nails or 2 staples, $1^3/_4$″ per stud
WSP	Wood structural panel (see Section R604)	$^3/_8$″		For exterior sheathing see Table R602.3(3) For interior sheathing see Table R602.3(1)

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ICC EVALUATION SERVICE

Most Widely Accepted and Trusted

ICC-ES Evaluation Report

ESR-2608*

Issued April 1, 2008

This report is subject to re-examination in two years.

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DIVISION: 06—WOOD AND PLASTICS
Section: 06090—Wood and Plastics Fastenings

REPORT HOLDER:

SIMPSON STRONG-TIE COMPANY, INC.
5956 WEST LAS POSITAS BOULEVARD
PLEASANTON, CALIFORNIA 94588
(800) 925-5099
www.strongtie.com

EVALUATION SUBJECT:

SIMPSON STRONG-TIE STUD SHOES, PLA
WALL BRACING, AND JOIST BRIDGING FO
CONSTRUCTION

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2006 *International Building Code®* (IBC)
- 2006 *International Residential Code®* (IRC)
- Other Codes (see Section 8.0)

Property evaluated:

Structural

2.0 USES

Simpson Strong-Tie stud shoes, plate ties, wa
and joist bridging are used as wood framing con
accordance with applicable sections of the IBC a
follows:

2.1.1 Stud Shoe Connectors: Simpson Stron
shoes described in this report are used to
structural studs in exterior walls or interio
partitions that have been cut, notched or drilled
to Sections 2308.9.10 and 2308.9.11 of the
Section R602.6 of the IRC. When the size of the
or drill hole exceeds the maximums specified in
the Simpson Strong-Tie stud shoes may be use
an engineered design is submitted in accord
Section 2301.2 of the IBC or Section R301.1.3
as applicable.

2.1.2 Plate Tie Connectors: Simpson Strong
ties described in this report are used to connect
bottom plates that have been cut to acc
plumbing, heating or other pipes placed in or pa
wall or partition in accordance with Section 2308
IBC and Section R602.6.1 of the IRC.

2.1.3 Wall Bracing Straps: The Simpson Strong-Tie wall bracing straps described in this report are designed to be

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3.1.3.3 WB and WBC Wall Bracing: The WB and WBC wall braces are fabricated from $1^1/_4$ inch-wide (31.7 mm) No. 16 gage galvanized steel with a series of prepunched nail holes used to fasten the metal braces to the wood wall studs spaced either 16 or 24 inches (406 or 610 mm) on center. The WB and WBC wall braces resist tension loads only. Consequently, these wall braces must be installed in pairs to resist in-plane racking shear loads applied to the top of the wall. The WBC wall bracing is similar to the WB wall bracing except that it packaged in a coil, and the coil has V-shaped notches indicating where to cut the steel strap for use as wood wall bracing. See Table 5 for the WB and WBC models recognized in this report, brace lengths, wall heights and brace angles measured from the horizontal [8 feet (2438 mm) at 45 degrees and 60 degrees, and 10 feet (3048 mm) at 45 degrees], and the fastener schedule. See Figure 5a for a drawing of the WB brace, Figure 5b for the WBC brace, and Figure 5c for wall braces installed X-pairs or in opposing V-pairs.

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' – $5^5/_8$"	8	60°	2–16d	1–8d
WB126	11' – $4^3/_8$"	8	45°	2–16d	1–8d
WB106C	9' – 6"	8	60°	2–16d	1–8d
WB126C	11' – $4^{13}/_{16}$"	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 resist 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.

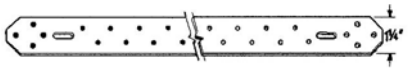

Figure 5a—WB Wall Brace Strap

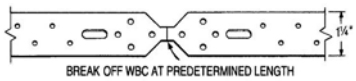

Figure 5b—WBC Wall Brace Strap

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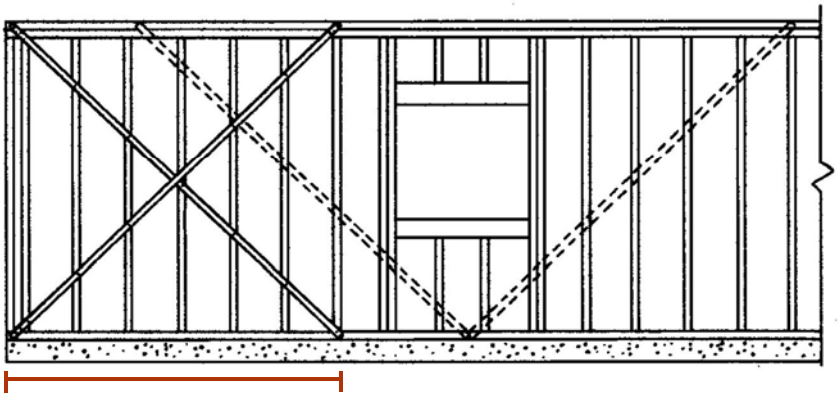
8 ft.



~ 5-8 ft.

(depending on the product)

41 Horizontal wall distance required for let-in braces

Intermittent Wood Structural Panels

TABLE R602.10.2
INTERMITTENT BRACING METHODS

METHOD	MATERIAL	MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA
LIB	Let-in-bracing	1 × 4 wood or approved metal straps at 45° to 60° angles for maximum 16″ stud spacing		Wood: 2-8d nails per stud including top and bottom plate metal: per manufacturer
DWB	Diagonal wood boards	3/4″ (1″ nominal) for maximum 24″ stud spacing		2-8d (2 1/2″ × 0.113″) nails or 2 staples, 1 3/4″ per stud
WSP	Wood structural panel (see Section R604)	3/8″		For exterior sheathing see Table R602.3(3) For interior sheathing see Table R602.3(1)

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Intermittent Wood Structural Panels

- 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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Structural Insulated Sheathing

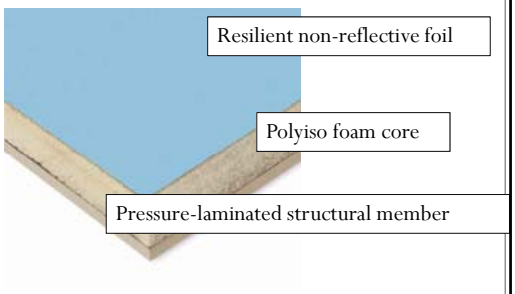
Dow SIS

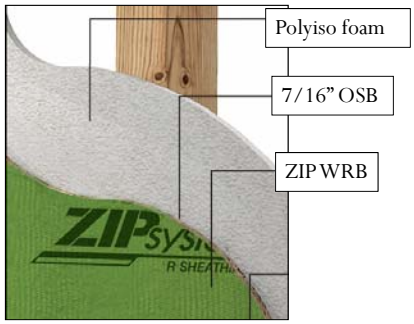
- R-3 @ 0.5”
- R-5 @ 1.0”

Huber Zip R-Sheathing

- Launched Sept. in PA
- R-3.6 @ 1”
- R-6.6 @ 1.5”

Both:
- Structural sheathing
- Water resistive barrier
- Use compatible tape
- Follow MII for nailing





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Wind Resistance

- For Wind Resistance (when used in place of structural sheathing)
  - Foam thick enough to achieve R-5 is generally OK for 90 mph, exposure B
    - 1" XPS
    - ~3/4" Polyiso
    - 1.5" EPS

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Attachment of Foam to Framing

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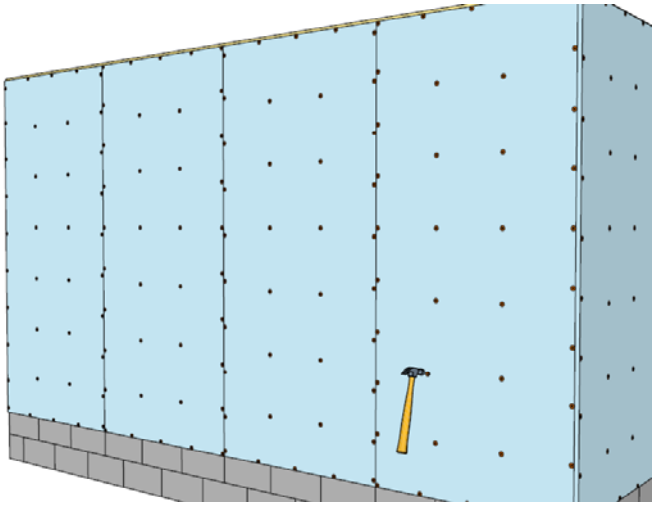
Fastening
Follow Manufacturer's Instructions

- Use 1" diameter plastic cap nails, 3/8" head roofing nails, or staples with a minimum ¾" crown
- All fasteners should be long enough to penetrate wood studs at least ¾"
- Secure the boards 12" o.c. around the perimeter and 16" o.c. in the field



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Foam as a WRB

- Check product's ES Report
  - Look for a water-resistive barrier section
  - Product X may be used as an alternate water-resistive barrier as prescribed in Section 1404.2 of the IBC and Section 703.2 of the IRC, when installed on exterior walls as prescribed in this section
  - Broad head/crown fasteners – not overdriven
  - Windows
    - Nailing flange set in bedding of sealant
    - Sill, head, and jamb flashing
  - Joints and seams sealed with compatible tape of specified width
  - Penetrations sealed

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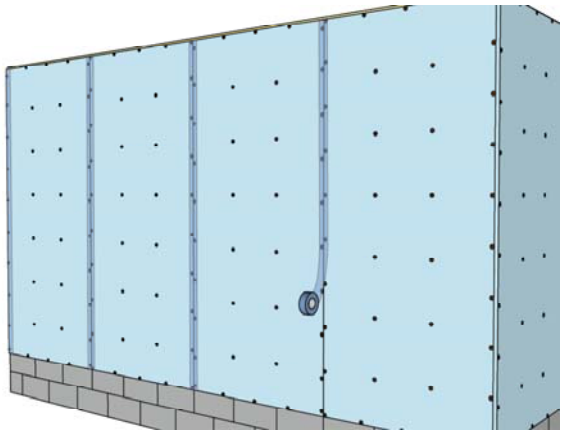
Taping the Joints

Follow Manufacturer's Instructions

- Tape joints with 2-7/8" Weathermate Construction tape
- Note: 2-7/8" tape must be used if installing foam as a Water Resistive Barrier
- Center the tape over the joint to cover nails
- Note: tape must be installed in temperatures from 15^0 to 120^0F



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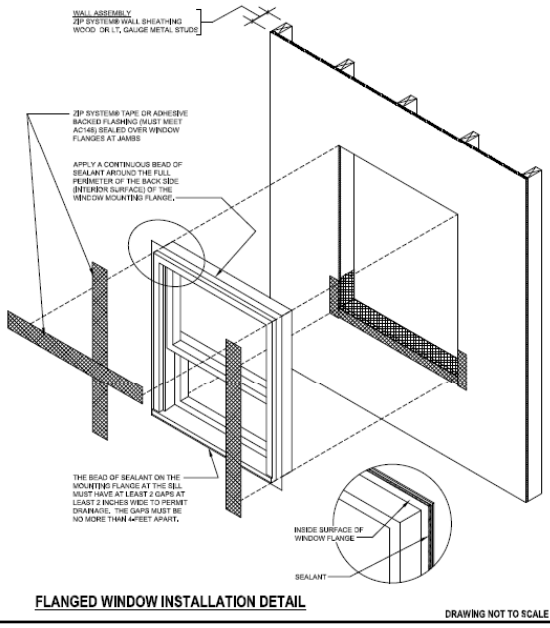
Window Flashing



Source: Huber Engineered Wood Products

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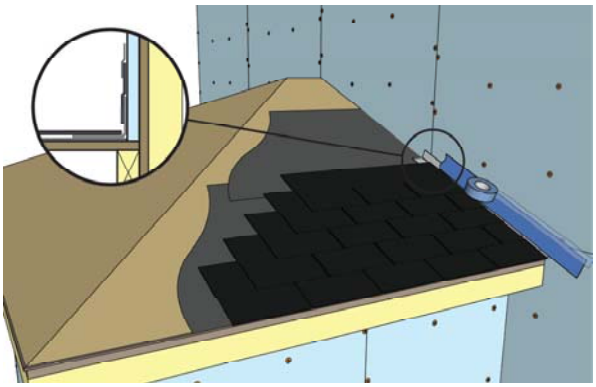
Roof/Wall Flashing
Follow Manufacturer's Instructions

- Turn up roofing paper at the wall behind the foam sheathing about 12"
- After foam sheathing is in place, install L-shaped step flashing at the wall
- Install 4" Straight flashing to cover the top edge of the step flashing
- Install Construction Tape to cover the top edge of the Straight Flashing
- Install shingles per manufacturer's recommendations



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Foam as a WRB

- Potential concerns:
  - Dimensional instability over time (shrinkage)
  - Reliance on adhesive tapes, sealants, self-adhering flashing, rather than shingling
  - Look for 3rd party testing and warranties
  - Tape characteristics
    - UV resistance
    - Temperature range
    - Temperature at installation
    - Cohesion strength
    - Flexibility

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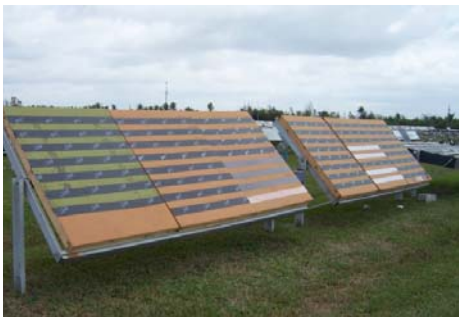
ernate flashing details found in *EEBA Water Management Guide*

Testing of Tape



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Siding Attachment

- Vinyl, wood, hardcoat stucco, and manufactured stone veneer directly through foam sheathing up to 2 inches thick
- Fiber cement siding limited to 1.5-inch foil-faced polyiso
- Thicker foam requires furring strips

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Furring Strips for Siding

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Vinyl Siding Over Foam (No WSP)

- For the follow conditions:
  - Basic wind speed ≤ 90 mph
  - Exposure Category B
  - Gypsum board installed on interior
- Siding fasteners:
  - Penetration into wood framing ≥ 1.25-inch
  - Nail shank diameter ≥ 0.12-inch (1/8")
  - Nail head diameter ≥ 0.313-inch (5/16")
  - Spacing ≤ 16-inch o.c.
- Foam sheathing thickness
  - XPS and ISO: ≥ 0.5-inch
  - EPS: ≥ 1-inch

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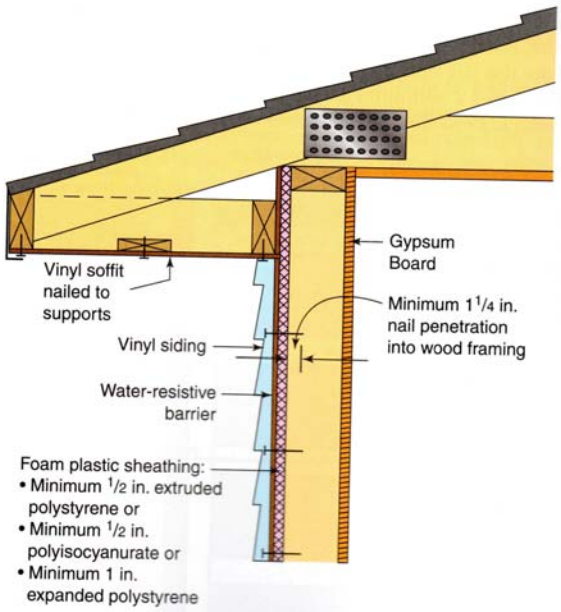
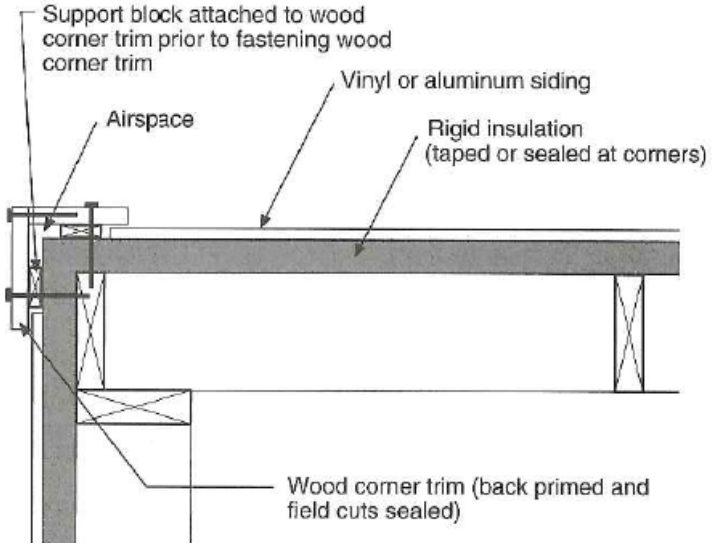
Vinyl Siding Over Foam



Vinyl siding installed over foam plastic sheathing, wind speed ≤90 mph, Exposure B

Exterior Corner Detail



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Source: Builder's Guide to Cold Climates, Joe Lstiburek

Summary

- Identify type of foam to be used/has been used
- Specify foam thick enough to avoid condensation
- Decide where to locate water-resistive barrier
- Consider wall bracing options at the design phase
- Innie or outie windows
  - Jamb extensions for innies
  - Window bucks for outies
- Proper flashing at openings
- Attach foam to framing per manufacturer's instructions
- Tape seams for air barrier and WRB
- Fasten siding through foam to framing or use furring strips

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