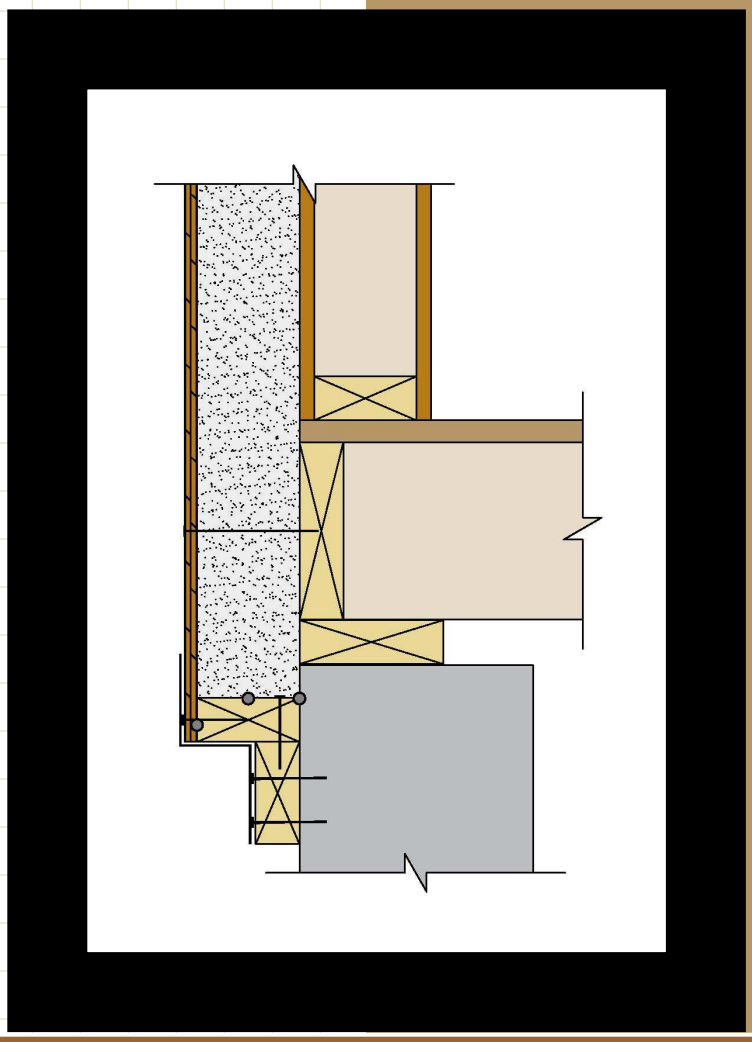

RETROFIT INSULATED WALL & ROOF PANEL INSTALLATION GUIDE

Retrofit Insulated Wall & Roof Panel Installation Guide

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Purchase Order #: ERDA1-0000027394

PON 24003

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Document No. 3337_20140404

April 2014

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The details, illustrations, and photographs in this guide are meant for illustrative purposes only. It is the responsibility of the installer to ensure that fastening specifications comply with all manufacturers' installation instructions and local building codes.

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Definitions

BPI	Building Performance Institute
EPS	Expanded polystyrene
IRC	International Residential Code
mph	Miles per hour
max.	Maximum
nailbase	Another name for a retrofit insulated panel
o.c.	On center; reference to spacing of fasteners, studs, etc.
OSB	Oriented strand board
psf	Pounds per square feet
PVC	Polyvinyl chloride
RESNET®	Residential Energy Service Network
R-value	Thermal resistance value
Retrofit Panel	Another name for a retrofit insulated panel
SIPA	Structural Insulated Panel Association
SPF	Spray polyurethane foam
UV	Ultra violet
WRB	Weather resistant barrier
XPS	Extruded polystyrene

Introduction

When major renovations are undertaken to modernize or add curb appeal to existing homes there is an opportunity to significantly increase energy efficiency by improving the thermal performance of the building enclosure. Retrofit insulated panels (or retrofit panels or nailbase) are an easy way to add continuous insulation and air sealing to older homes as part of a comprehensive energy retrofit plan or as an energy conservation measure when replacing siding. The composite panels consist of rigid insulating foam laminated to a single sheet of oriented strand board (OSB) structural sheathing as shown on the cover of this Guide.

Panels are cut to fit onsite and attached over the existing wall and/or roof sheathing, providing added insulation without disturbing the inside of the home. New cladding is then installed over the retrofit insulated panels. The OSB face serves as the fastening surface for siding or roofing (Figure 1).

Retrofit insulated panels are available from most structural insulated panel (SIP) manufacturers and distributors. To find a manufacturer in your area, visit www.sips.org.

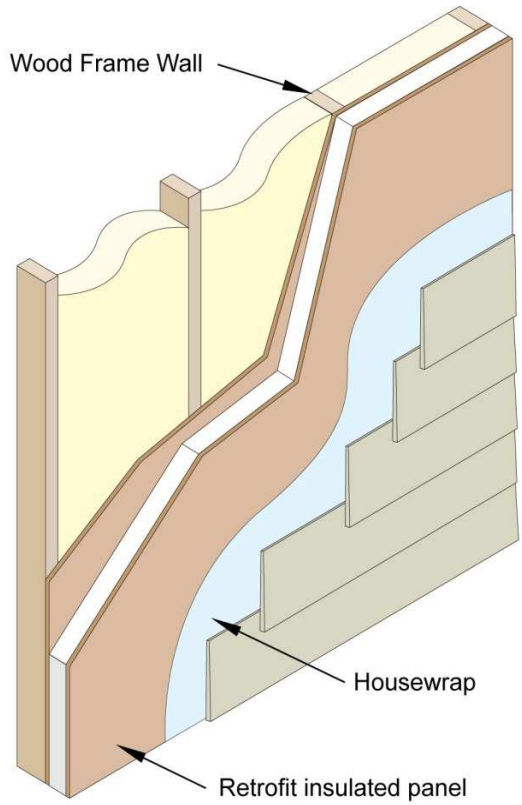

Figure 1.
Retrofit Insulated Panel Installed Over Existing Sheathing

Developing a Retrofit Strategy

Improving the thermal performance of a home with retrofit insulated panels can be one part of a comprehensive energy retrofit. The project can include adding new windows, additional roof insulation, air sealing, and upgrading heating and cooling equipment, or merely be an energy-efficient component of a re-siding job. Some homeowners choose to upgrade lighting, water heating, HVAC, and appliances to achieve even greater gains in energy efficiency.

The proper installation of retrofit insulated panels greatly reduces air infiltration in older homes; therefore, controlled mechanical ventilation is usually installed with this type of energy conservation measure to assure good indoor air quality. When a whole house thermal and air sealing effort is planned, a Building Performance

Institute (BPI) or Residential Energy Services Network (RESNET) certified professional can collaborate on the whole-house strategy before installation. These professionals can conduct an energy audit to identify the most cost effective energy-efficient improvements and test existing and post-retrofit conditions to assure continued occupant safety and comfort.

Panel Size and Thickness

Retrofit insulated panels are available in a variety of thicknesses and sizes. Thicker panels have a higher R-value or thermal resistance. The R-value of a retrofit panel per inch varies with the type of foam insulation that is used in the panel. Table 1 covers the R-values for expanded polystyrene (EPS) retrofit panels; the most common insulation type. Panel R-value will vary by density of the EPS or other type of foam that makes up the retrofit panel.

Table 1. Expanded Polystyrene (EPS) Retrofit Insulated Panel R-values

Total Panel Thickness	R-Value Per ASTM C 578[A], EPS Type VIII	R-Value Per ASTM C 578[B], Neopor®
2"	6.4	7.5
4"	14.0	16.5
6"	21.6	25.5
7 ¾"	28.3	33.3
9 ¾"	35.9	42.3
11 ¾"	43.5	51.3

[A] Stated R-value includes EPS at thickness plus 7/16" OSB R-value from ASHRAE Fundamentals.

[B] Stated R-value includes graphite enhanced EPS, per manufacturer's ICC-ES report at thickness, plus 7/16" OSB R-value from ASHRAE Fundamentals, rounded.

Determining the appropriate panel thickness is a function of the home's existing insulation and the local climate conditions. Selecting the correct panel thickness begins with determining the desired total R-value of the wall or roof system by adding the existing cavity insulation to the values in Table 1. Verify that the R-value of the retrofit insulated panel selected meets the requirements of the International Residential Code (IRC) listed in Appendix I or local code requirements.

Table 2 and Table 3 below provide general guidelines for the minimum thickness of retrofit insulated panels by climate zone to prevent condensation inside the wall or roof assembly.

Table 2. Minimum Retrofit Insulated Panel R-Values for Walls

Climate Zone	Recommended R-value of Retrofit Insulated Panel	
	2x4 walls w/R-11 cavity	2x6 walls w/R-19 cavity
Marine 4	R-7.5	R-5
5	R-14	R-7.5
6	R-14	R-14
7 and 8	R-21.6	R-21.6

Table 3. Minimum Retrofit Insulated Panel R-Values for Roofs*

Climate Zone	Recommended Retrofit SIPS R-Value
2B and 3B, tile roof only	R-7.5
1, 2A, 2B, 3A, 3B, 3C	R-14
4C	R-21.6
4A, 4B	R-21.6
5	R-21.6
6	R-28.3
7	R-35.9
8	R-43.5

* With air permeable insulation below sheathing, assumes R-19 existing.

Compared to the cost of replacing and painting siding, increasing the thickness of retrofit insulated panels is relatively inexpensive, so many builders opt to exceed the minimum specification in favor of increased energy efficiency. If conducting an energy audit, a BPI or RESNET certified professional can provide a cost-benefit analysis to help determine the best panel thickness for a specific project.

Panels are commonly available in 4' x 8' size, and many suppliers offer larger formats such as 4' x 12' or 4' x 16' that can be used to extend over rim joists and complete walls as seamlessly as possible. Panel foam thickness is usually matched to dimensional lumber sizes, i.e., 3 ½", 5 ½", etc., as 2 x 4s or 2 x 6s (etc.) are used at panel edges around window and door openings and at outside corners to complete the air seal that is provided by the OSB.

Structure Assessment

The first step in an energy retrofit is assessing the existing structure. Retrofit insulated panels can be installed over most types of wood-frame residential and block structures after the existing siding or roofing has been removed. Keep in mind that retrofit panels will increase the thickness of the wall or roof by the dimension of the panel's thickness. Existing roof overhangs should be greater than

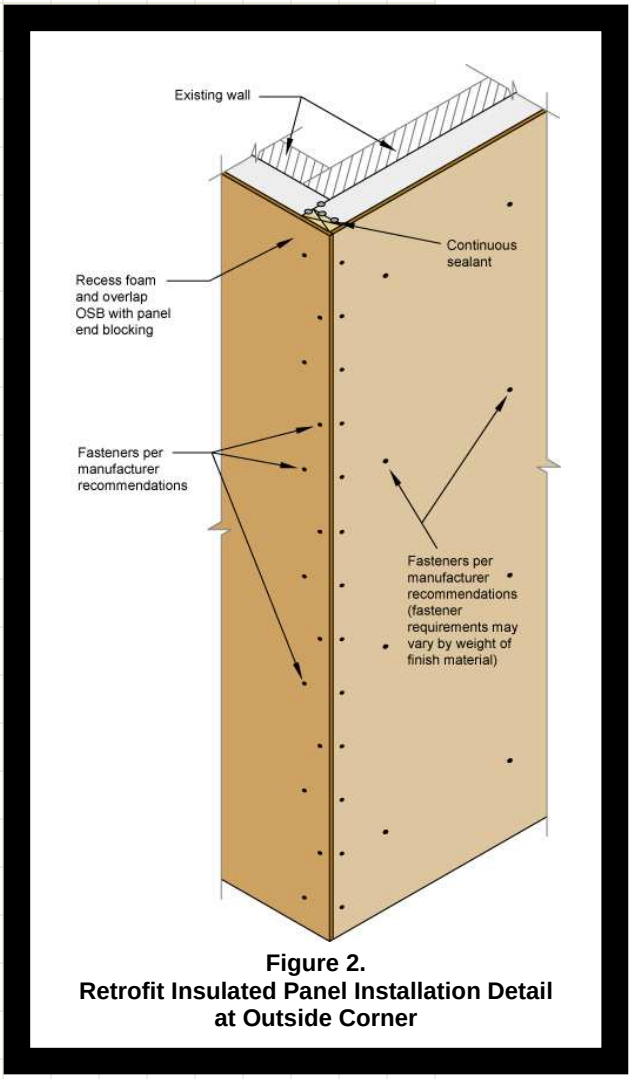

Figure 2.
Retrofit Insulated Panel Installation Detail at Outside Corner

the added thickness of the wall, or provisions should be made for extending overhangs.

Consider whether doors and windows will be replaced with the retrofit. Develop an access plan for later removal and replacement without damaging the retrofit panel installation if the windows and doors will be left in place for the current project. Windows that are left in place after installation of retrofit insulated panels require complex details and dual drainage planes to assure bulk water resistance at the opening. Windows with installation flanges should always be installed on the outer face of the retrofit panels.

Other special features like dormers, roof brackets or corbels, exposed rafter tails, and cantilevers or bays may require special accommodation by a design professional. Begin with a sketch of the exterior of the house, include door and window openings, and outside dimensions.

Key Measurements

Measure the wall and roof area to determine the square footage and layout of retrofit panels that will be required. Retrofit insulated panels are a frequently-employed solution for adding insulation to vaulted ceilings or incorporating attics within a home's conditioned space. For conventional vented attics, retrofit insulated panels are often applied to the walls, only, while bulk insulation and air sealing is added to the attic floor to improve whole house thermal performance.

When measuring the wall area, it is important to note that panels will overlap at the outside corners of the house. This overlap will require panels to extend beyond the existing wall dimensions by the thickness of the retrofit panel and the product should be ordered accordingly (Figure 2). Panels are non-structural, so they can be pieced in the wall structure to accommodate maximum material usage. However, the reliability of the air seal and labor time management, as well as the use of accessory materials like splines, mastic, and spray polyurethane foam (SPF), encourage the use of complete panels whenever possible.

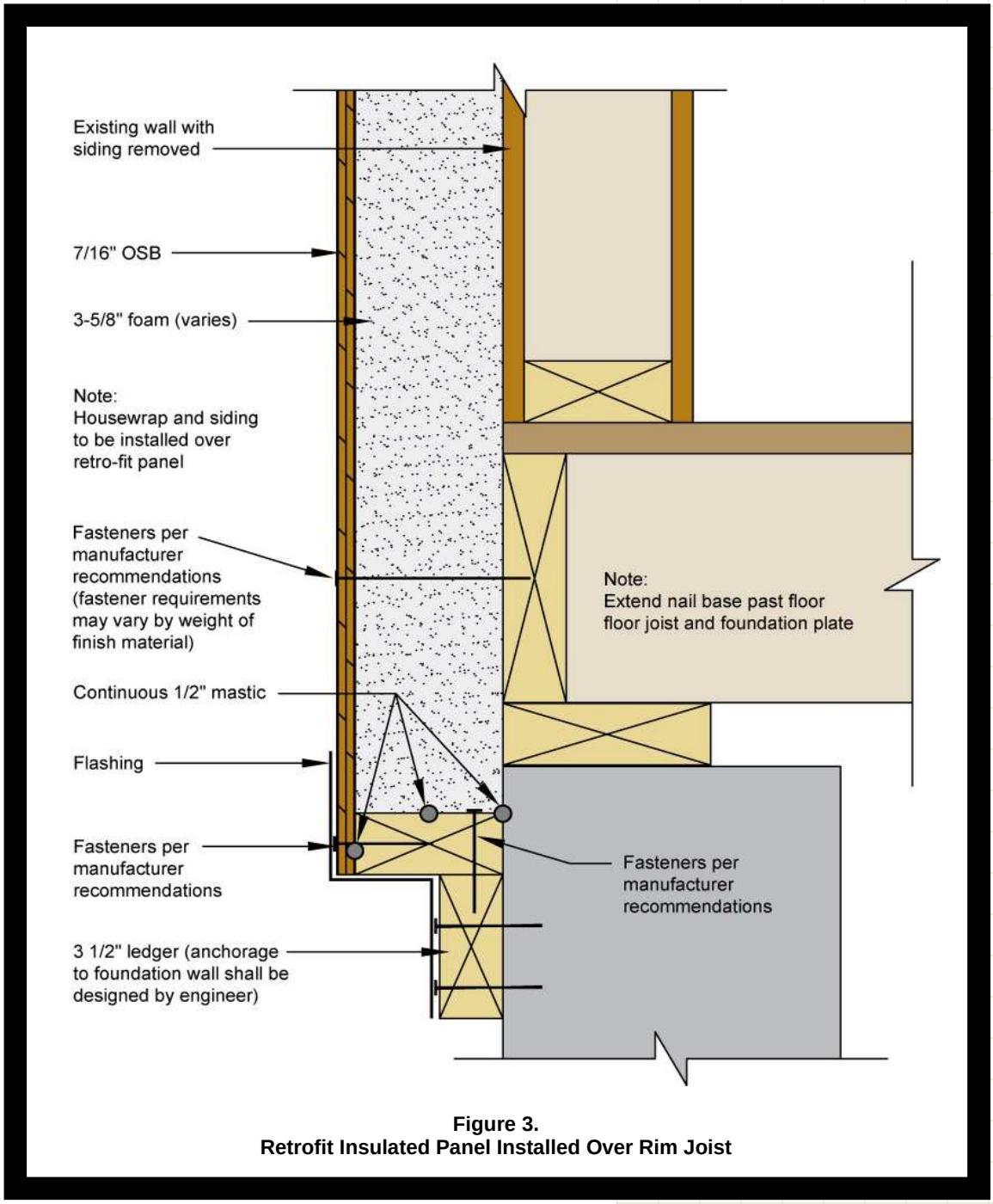

Figure 3.
Retrofit Insulated Panel Installed Over Rim Joist

Rim joists at the edges of the floor system of platform-framed homes are often a principal location for air leakage. To seal air leaks at component intersections like floor rims and walls, retrofit insulated panels can be ordered in a size longer than the room wall height so that the panel will extend over the rim joist and provide a continuous air barrier. Figure 3 shows this detail in section. Ideally, the panel should completely cover the rim joist or sill

plate/foundation connection. As shown in Figure 3, the 2 x 4 at the bottom of the panel serves as an air seal and bug guard. The mastic adhesive (applied in three specific locations, colored in grey) completes the air seal of the panel. The 2 x 4 ledger supports the panel during installation and provides an attachment surface for the retrofit panel's bottom edge solid blocking. As with all wood products, the blocking should be located at least 8" above grade or installed as treated lumber. (Note that the retrofit panel was routed for the 2 x 4 bottom cap and the mastic is applied continuously to the in place blocking prior to setting the retrofit panel.)

House Preparation

Prior to installing retrofit insulated panels, all existing siding and/or roofing must be removed along with the weather resistive barrier and roofing underlayment. In some cases, panels can be installed over T1-11 or vertical wood siding with a flat profile. However, lap siding and other popular wall claddings make it difficult to establish an effective air seal between the siding and the retrofit insulated panels, creating the potential for air leakage and moisture-related issues within the wall assembly. Siding on older homes may contain lead paint or asbestos which require certified contractors and special handling.

The wall and roof sheathing surface should be cleaned of nails and staples before beginning installation. Verify that walls are plumb and square; and inspect for any water damage. Remediate any structural issues prior to installing retrofit insulated panels. Repair water damaged wood and eliminate source of water entry.

If the project does not include installing new windows, it is recommended that the existing windows be removed and remounted at the exterior of the retrofit panels. However, if the windows cannot be removed and must be left at the inside plane of the existing sheathing, a weather resistant barrier (WRB) can be installed between the existing sheathing and the retrofit panel as per manufacturer's recommendations and taped. A properly installed WRB at the plane of the existing sheathing will act as a secondary drainage plane for water that penetrates to the window surface and its perimeter. When a WRB is installed at the existing window and sheathing plane it is intended to act as a secondary barrier and drain at the window and bottom of the wall.

Accessories

Installing retrofit insulated panels requires the use of several specialty accessories. These may be included with the panel package or it may be the responsibility of the installer to purchase the appropriate accessories prior to installation. The manufacturer of the retrofit insulated panel can provide information on the correct sealants and fasteners to use with their products.

Common accessories include:

- Mastic – caulking used to seal between retrofit insulated panels that does not react with insulating foam (about one 24 oz. tube of adhesive is required to provide the air seal for three panels)
- Low expanding spray polyurethane foam – such as Great Stuff Pro® for Gaps and Cracks is used to seal connections between panels and other surfaces (about one 24 oz. can every six panels, dependent on structure shape and wall details)
- Panel screws – specialty screws used to attach retrofit panels to structural members through the thickness of the panel (count the number per panel from the nailing pattern requirement and add 5%)
- Splines – strips of OSB, pre-manufactured insulated blocks, or dimensional lumber used to join two retrofit panels together

Storage Onsite

Retrofit insulated panels should be protected from the elements on the jobsite. Panels should be stacked on a level surface and elevated off the ground on dunnage or stickers made of dimensional lumber. When stacking panels, the bottom panel needs to have firm contact on all pieces of dunnage and the dunnage needs to be wide enough that it will not deform the bottom panel. Panels should be protected from rain and UV exposure, thus, opaque tarps or roofed shelter is recommended.

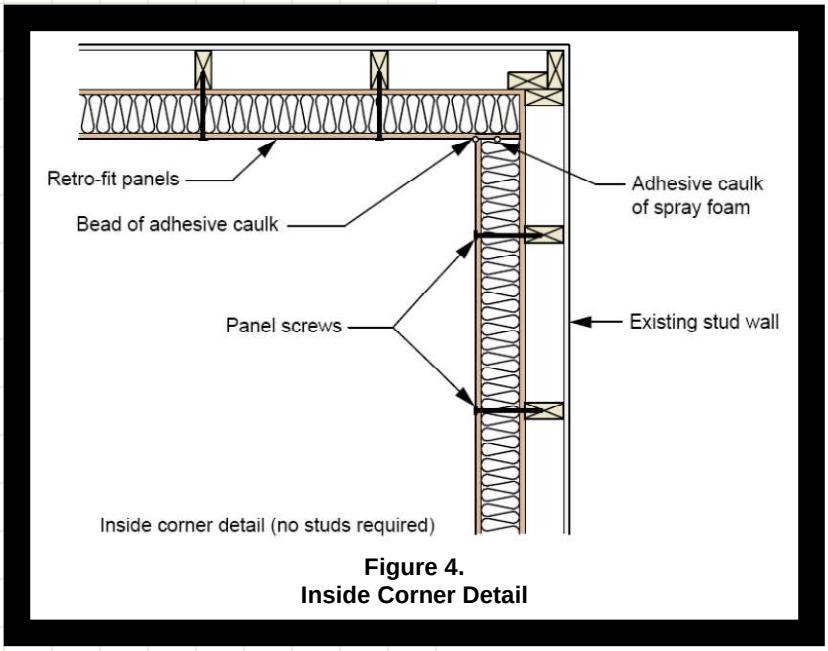

Figure 4.
Inside Corner Detail

Installation

Inside corners present the largest challenge to air sealing, so that is the place to start. Inside corners are installed using a butt joint and two continuous beads of sealant (Figure 4).

If there are no inside corners on the structure start the layout on the longest wall at the outside corner. Work across the wall and from bottom to top of house, continuously. A wall ledger and the retrofit panel bottom blocking are usually installed prior to panel placement to accommodate setting the retrofit panels (Figure 3). Walls are typically installed with a two-person team, dependent upon overall wall height. Roof panels can be set with a crane and a two-person team or from scaffolding, dependent on overall building height and site accessibility. Table 4 covers the estimated weight of retrofit panels.

Table 4. Estimated Retrofit Insulated Panel Weight

Panel Thickness	EPS weight (psf)	Estimated Retrofit Insulated Panel Weight (lbs. per panel)			
	Panel Size	4' x 8'	4' x 10'	4' x 12'	4' x 16'
4"	.33	57	72	86	115
6"	.54	64	80	96	128
7.75"	.61	66	83	99	132
9.75"	.78	72	90	108	143
11.75"	1.00	79	98	118	157

When a window or door opening in the wall is encountered, install the panel that precedes the panel with the cut out, then measure for the cut out. Cut the OSB with a circular saw then use a hot knife to remove the EPS at a work station. Size the opening and the EPS cut to accommodate the desired window detail; i.e., OSB overlapping or butting the window box. Place the adhesive or expanding foam and install the panel.

Wall retrofit panels are installed with the panel length parallel with the wall studs and the panel edges offset from wall studs (Figure 5).

Figure 6 details fastening a retrofit to a CMU wall.

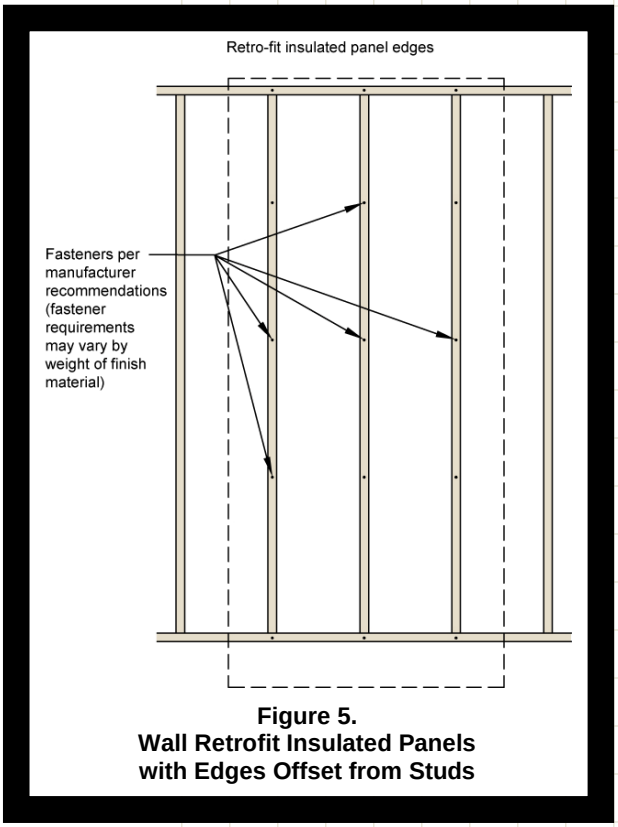

Figure 5.
Wall Retrofit Insulated Panels with Edges Offset from Studs

Fasteners

Retrofit panels are installed with screw connections driven through the retrofit panel into the structural members of the existing house wall or roof. Panel fastening schedules vary with weight of the cladding to be installed. Typical fastening patterns range from 12" to 24" studs spaced at 24" o.c., but actual fastening patterns will be supplied by the retrofit panel manufacturer. Panel screws may be purchased with the retrofit panel package, online, or from big box home centers and hardware retailers.

Wall claddings are attached to the OSB skin of the retrofit panel with nails or screws as per the manufacturer's installation directives. HardiePlank™ fiber cement lap siding has issued a Technical Bulletin covering attachment of their products to 7/16" OSB sheathing. Table 5 covers an abbreviated version of a Technical Bulletin for fastener spacing and type, wind speed zones, and fastening locationfor 5 ¼" wide fiber cement. The *References* section contains a web link to the complete bulletin.

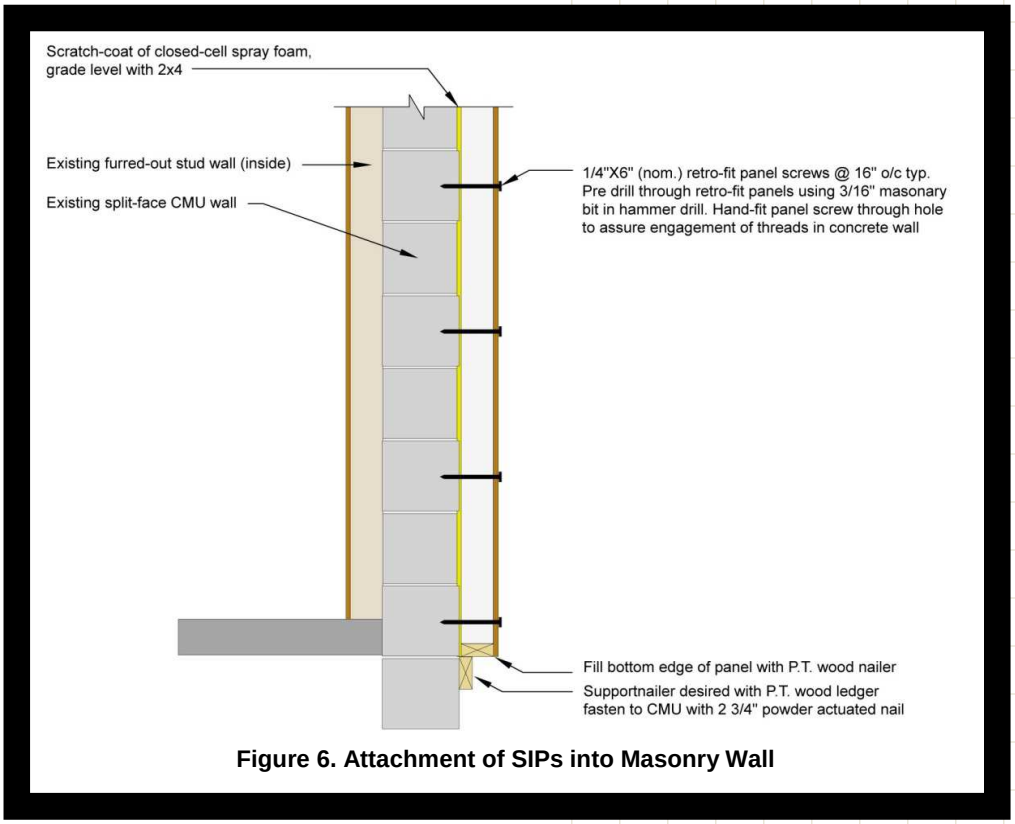

Figure 6. Attachment of SIPs into Masonry Wall

Table 5. Partial Example of a Manufacturer's Fastening Schedule for Horizontal Lap Fiber Cement to OSB Sheathing

Basic Wind Speed (mph)	Building Height (feet)	Max. Fastener Spacing (in inches on center) for 11 gauge x 1 ¾" roofing nail securing 5 ¼" horizontal lap, Blind nailed			Max. Fastener Spacing (in inches on center) for #8 x 1 5/8" wafer head screw securing 5 ¼" horizontal lap, Blind nailed		
		Exposure Category			Exposure Category		
		B	C	D	B	C	D
90	0-15	23	19	16	24	24	24
	20	23	18	15	24	24	24
	30	23	17	14	24	24	24
	40	22	16	13	24	24	24
110	0-15	16	13	11	24	24	24
	20	16	12	10	24	24	24
	30	16	11	9	24	24	23
	40	14	11	9	24	24	23
130	0-15	11	9	8	24	24	21
	20	11	9	7	24	24	20
	30	11	8	7	24	22	18
	40	10	8	6	24	20	17

Excerpt from Technical Bulletin 'Fastening JamesHardie Products over SIPs'

Exposure categories as per IRC 2009

Sidings of similar weight and size will have similar fastening constraints. Table 6 covers the weight of a few of the more popular wall claddings.

Table 6. Average Weight of Wall Cladding Materials

Type of Cladding	Weight Per Square Foot (lbs.)
Cedar, 5/8" bevel stk.	3.0[B]
Fiber Cement, 5/8" smooth lap	2.3[C]
Vinyl, double 4.5, .040"	0.4[A]

[A] http://ws680.nist.gov/bees/ProductListFiles/Generic%20Vinyl%20Siding.pdf

[B] www.csgnetwork.com/lumberweight.html

[c] www.jameshardie.com/homeowner/products_siding_hardieplankLapSiding.py?search_zipcode=retail

Solid lumber blocking is often required to attach heavier items like hand rails or awnings. Lumber blocking should be sized the width of the foam and slightly larger than the object that needs to be fastened to it. After removing foam to and installing the appropriate lumber, seal all interfaces with expanding foam to prevent air leakage (Figure 7).

Roof claddings are attached to the OSB skin of the retrofit panel as per the manufacturers' fastening installation instructions. In a conventional roof assembly many of the fastener connections are made as shingle through OSB rather than fastener embedment in a structural member, thus there is nothing new about fastening composition shingles to a retrofit roof panel. Make certain to review manufacturer's guidelines with regard to roof pitch and nailing patterns. Consult product manufacturers about fastening specialty roofing finishes.

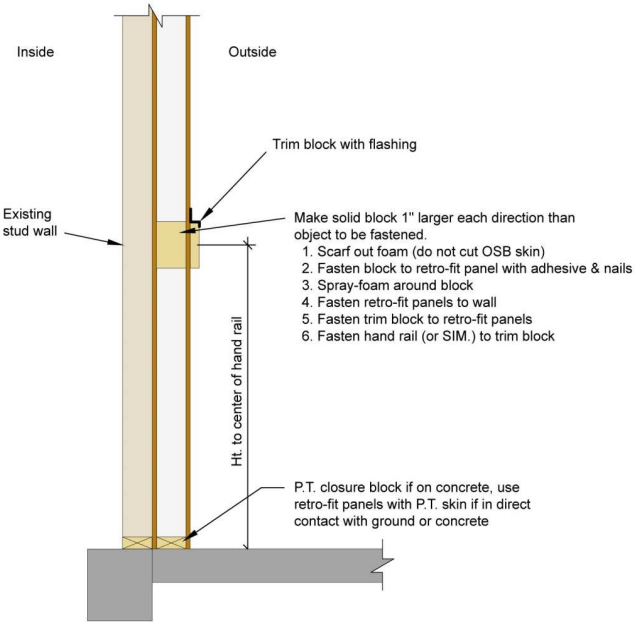

Figure 7. Lumber Blocking for Handrail

Adhesives and Sealants

Panel sealants are supplied by the manufacturer with the retrofit panels and are EPS compatible. These products can be used for foam to foam, wood to foam, or wood to wood connections. Common solvent-based construction adhesives are not compatible with EPS foam and should not be used where they are likely to come in contact with the EPS. Mastic sealant dispensed from a caulk gun may also be used as an EPS and OSB sealant.

Another commonly used sealant is low-expansion, closed cell, spray polyurethane foam sealant. Unlike mastic, spray polyurethane foam can be used to seal larger gaps or voids. It is recommended that all sealants and adhesives used with retrofit panels should be low VOC products check with the retrofit panel manufacturer to see which type of sealant they recommend for their product.

Windows & Doors Installation Using New Units

Installing retrofit insulated panels adds to the wall thickness, thus, new windows will be mounted flush with the OSB surface of the retrofit panel. A new construction, flanged, window, or pre-hung door, with exterior molding attached to the jamb will be installed flush with the OSB surface of the retrofit panel. Jamb extensions are fashioned with dimensional wood that matches the thickness of the foam in the retrofit panel. Jamb extensions are attached with long screws through the depth of the new dimensional lumber member into the existing studs at the window opening and caulked at the

Figure 8. Retrofit Panel Routed for Window Box
Courtesy Zero-EnergyPlans.com

Figure 9. Window Box with Retrofit Panel
Courtesy Zero-EnergyPlans.com

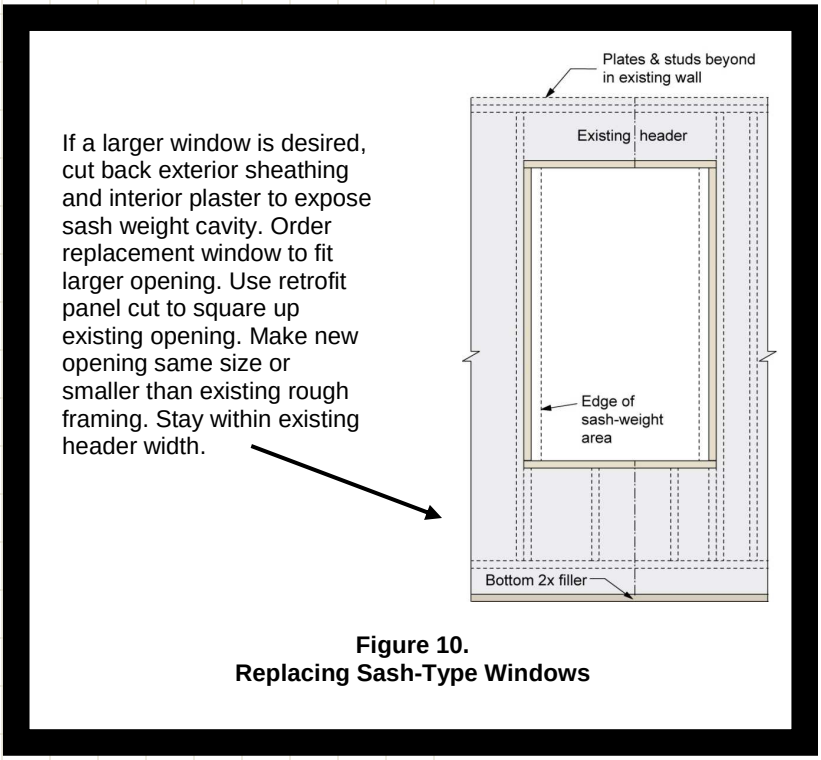

Figure 10.
Replacing Sash-Type Windows

building and the existing sheathing. Adhesive caulk is installed on the outside edge of the jamb extensions to adhere to the back of the OSB of the retrofit panel if the EPS foam at the window opening in the retrofit panel was routed out 1 ½" from the panel edge prior to panel installation (Figure 8). It is often easier to install the dimensional lumber after the panel has been installed.

Otherwise, the window opening can be cut into the retrofit panel so that the foam and the OSB of the retrofit panel butts to the window box extension. Spray polyurethane foam completes panel to panel and foam to window box connections (Figure 9).

Homes with older, sash-type windows may need to have the rough opening enlarged by cutting back sheathing to expose and remove sash weights (Figure 10). In this case, a larger window is ordered and mounted on the outside as described above.

Windows and doors are installed after the WRB has been installed and taped and flashed consistent with the window manufacturer's instructions and ASTM 2112 (*References* section). Mounting an exterior window or door will require jamb extensions on the interior of the house (Figure 11). Interior jamb extensions can be fashioned from painted drywall or trim material and fastened to the material that is used to create the window box.

Installation with Existing Windows

When the decision to keep the existing windows is made, the existing windows should be removed and remounted at exterior of the retrofit insulated panel using the process described above for new windows (Figure 11).

If the home contains older sash-type wood-frame windows that cannot easily be removed and reinstalled, they can be left in place and jamb extensions can be installed on the exterior to accommodate the thickness of the retrofit insulated panels. Provisions for future window replacement without compromising the air seal of the retrofit panel installation must also be made. Strip the existing window trim to determine the type of window mount. Verify that head and side flashing and sill pan are repelling water and that area around window shows no sign of water intrusion. (If there is water intrusion and the window must be removed to repair, consider remounting it at the outside face of the retrofit panels.) Once the window is well flashed and sealed, install the new window/jamb extensions wide of the window flanges or jamb edge so that the window unit can be reached and removed at a later time without damage to the window box. The construction of the window box can be of any number of materials which are dependent on future window installation location and aesthetics. If the intention is to remount a future replacement window inside the wall, as before, the jamb extensions can be formed in aluminum coil stock or other light gauge metal as flashing and the finish trim. This type of trim can be installed after the retrofit panel and should include a continuous downward-sloped sill.

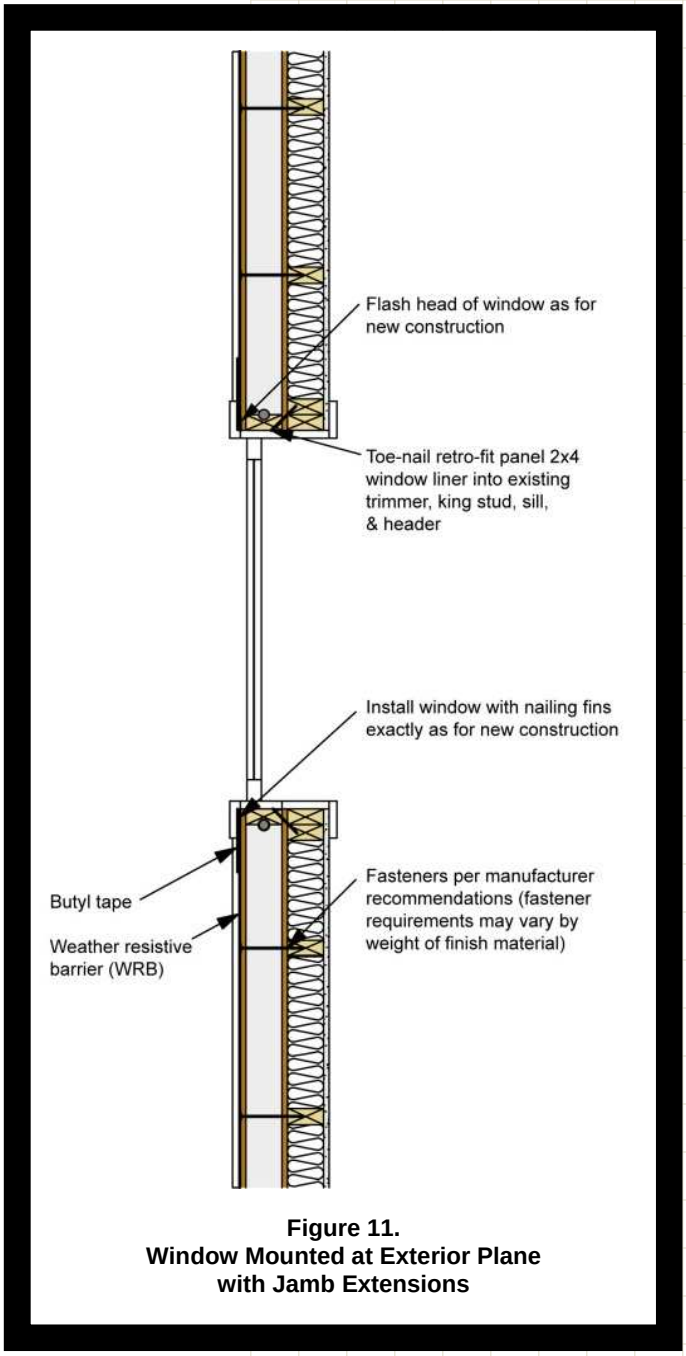

Figure 11.
Window Mounted at Exterior Plane with Jamb Extensions

Figure 12. Alternate Window Box Mount
Courtesy: Cold Climate Housing Research Center

In Figure 12, the window box has been created with a 1" x 8" trim board of cellular PVC. The box is supported by a steel L bracket on all four sides. To make the window accessible for a future replacement, size the box wide of the window flange and seal the window box to the retrofit panel with spray polyurethane foam (SPF). Trim inside window box at window frame with custom coil stock as required.

Mechanical Penetrations through the Exterior Wall

Any plumbing or electrical penetrations through the building enclosure will also require extensions to account for the additional wall thickness. Hose bibs can be inexpensively and quickly replaced with freeze proof models that are available with various extension lengths that will clear the new wall thickness. Wall mounted light fixtures will need to be removed and remounted after the retrofit panels are installed. The OSB face eliminates the need for light blocks where the fixture attaches to the wall.

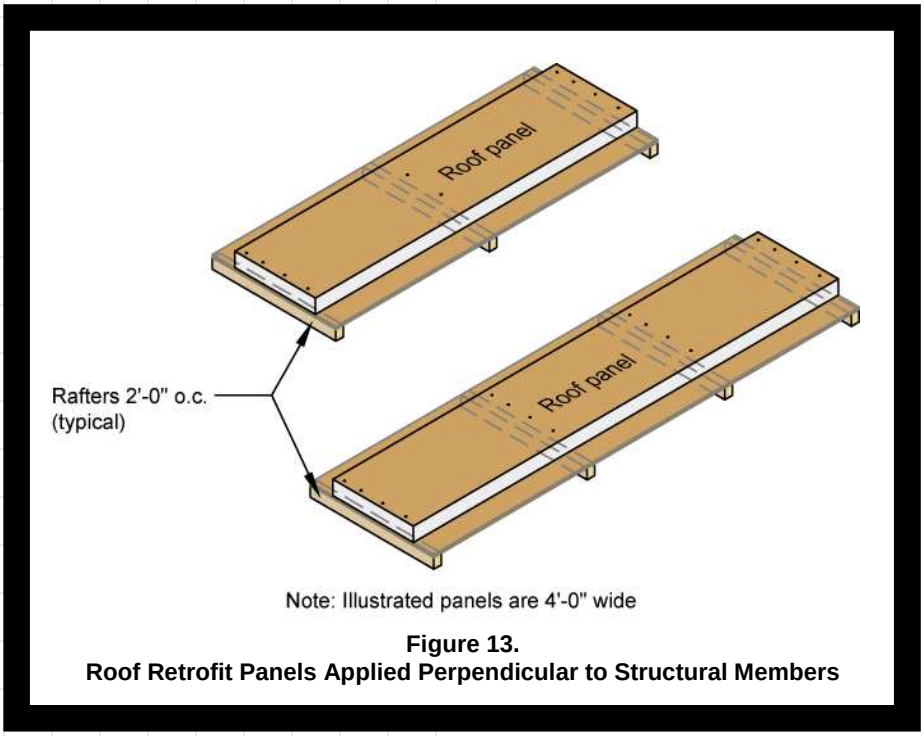

Figure 13.
Roof Retrofit Panels Applied Perpendicular to Structural Members

Roof Retrofit Insulated Roof Panels

Retrofit insulated roof panels are installed with the panel length perpendicular to the rafters and attached through the width of the panel to a structural member using panel screws (Figure 13). Fastening patterns will be provided by the retrofit insulated panel manufacturer.

Tools Used With Retrofit Insulated Panels

The OSB facing of retrofit insulated panels is easily cut using a circular saw. After marking and cutting the OSB facing, the cut can be completed by slicing through the EPS foam with an electric hot knife or a hot wire. A 16 5/16" circular saw with the blade depth set to the desired size of the foam that is to be removed and a double sided pull saw can also be used to rout foam from the panel.

Depending on the type of panel-to-panel connection used, builders may need to recess the foam along panel edges to accept splines. Generally, retrofit panel vertical edges are butted together and sealed with a continuous bead of SPF or mastic and splines. The foam at door and window box openings can be removed to accommodate the dimensional lumber frame, as per Figure 9. An electric hot knife, hot wire, or a foam scoop will remove EPS from the OSB of retrofit panels because EPS has a relatively low melting temperature. Panels of polyurethane or extruded polystyrene (XPS) foam require an angle grinder attachment to mechanically remove the foam.

Figure 14. Electric Hot Knife

Figure 15.Spray Foam Application Gun

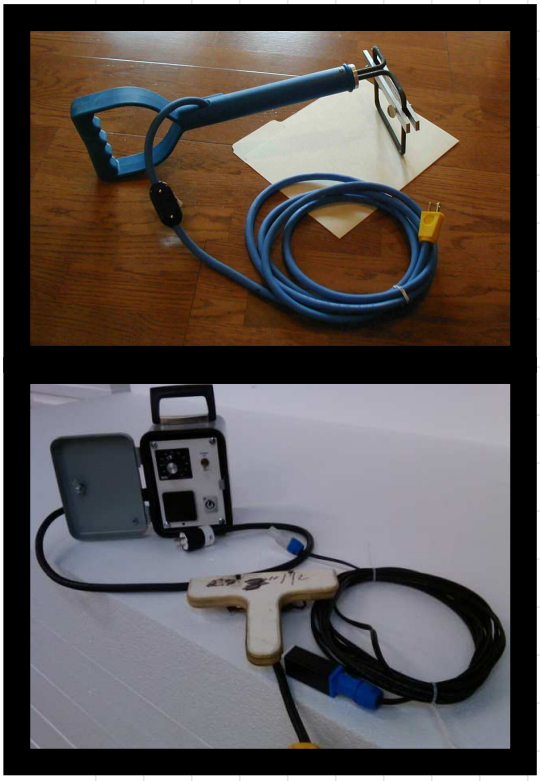

Figure 16. Electric Foam Scoop and Electric Hot Wire Tools

Figure 17. Panel Adhesive Applicator

Figure 18. Sixteen-Inch Circular Saw

Figure 19. Double Edged Pull Saw
Courtesy: Zoro Tools

Air Sealing

Retrofit insulated panels owe their effectiveness to the combination of insulation and air sealing. Sealing is a critical part of the retrofit panel installation process. Any gaps in the air barrier can become hotspots for moisture migration. Sealing is done using low expansion polyurethane foam sealant or sealing mastic, also called panel adhesive.

These adhesives are sold in 20 ounce sausage rolls that are applied with the “gun” shown in Figure 17.

Sealant needs to be applied at all joints between panels and every interface between the retrofit insulated panels and dimensional lumber blocking. Blocking is sealed where it comes in contact with the existing sheathing or other parts of the building as well. The figures in this guide indicate 3/8" sealant bead locations in gray.

Splines and Panel-to-Panel Joint Details

The preferred detail for in-plane panel connections is a butt joint (Figure 20). This method makes it easy to maintain a continuous air barrier by applying two 3/8" beads of mastic sealant between panels.

As previously mentioned, panel joints should be offset from wall studs for a flush connection (Figure 5).

Some retrofit insulated panel manufacturers may specify splines for in-plane panel connections in certain situations. Splines keep adjacent panel planes plumb and level along the long edges or in uneven wall situations. If splines are specified, the product supplier will provide connection details.

Surface splines (Figure 21) are installed into pre-routed channels just below the OSB surface at panel edges. Block splines (Figure 22) are typically supplied by the retrofit panel manufacturer and are installed by removing the foam on each side of the panel joint. With any of the connection details, it is crucial to seal between panels with mastic sealant or expanding foam.

Dimensional lumber blocking is installed around window and door openings, on outside corners, and at the top and bottom of each panel if necessary. Blocking is not needed along the top edge if panels are installed against a solid surface. Blocking is normally installed after panels are in place except where it is not feasible to do so, such as the bottom edge blocking above the starting ledger (Figure 3).

Finishing – Walls

After retrofit insulated panels are installed over the walls of an existing home, the building must be covered with a weather resistive barrier (WRB). Windows, doors, and any retrofit panel penetrations must be properly flashed to protect against bulk water intrusion. Almost any type of siding or exterior finish material normally used over wood frame construction can be applied over retrofit insulated panels. Refer to the siding manufacturer's installation instructions for fastener spacing. The 7/16" OSB facing on retrofit insulated panels offers less pullout resistance than dimensional lumber and typically requires an increased, or closer, fastening schedule.

In cold and wet climates (average annual rainfall greater than 40"), it is recommended that siding be installed with a vented air space between the siding and the weather resistive barrier, also known as a rain screen. This detail allows any moisture that enters the wall assembly to dry, increasing the durability of the structure. Consult a qualified building science professional and local building codes to determine if a vented cladding system is the best choice for your climate.

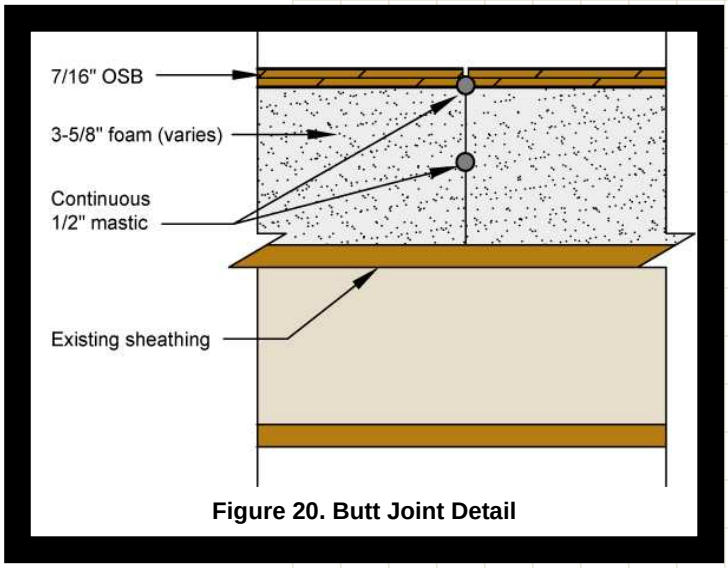

Figure 20. Butt Joint Detail

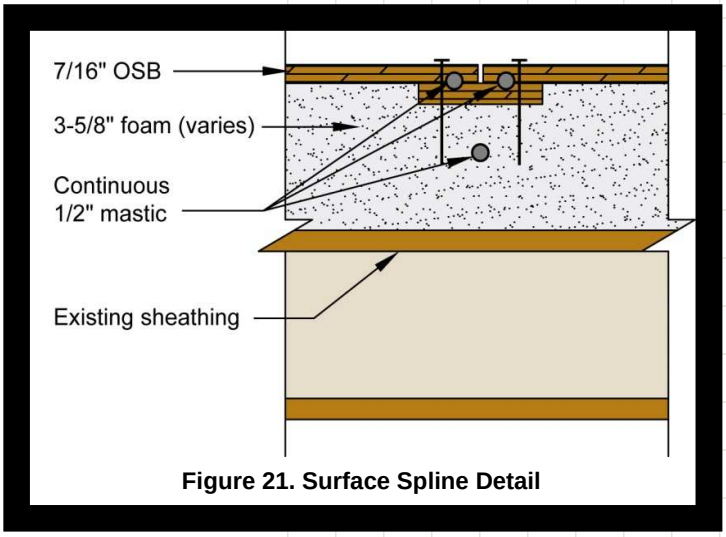

Figure 21. Surface Spline Detail

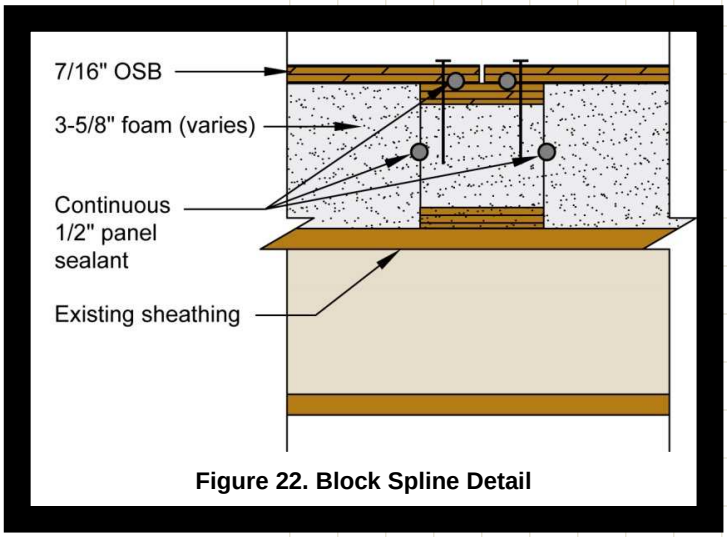

Figure 22. Block Spline Detail

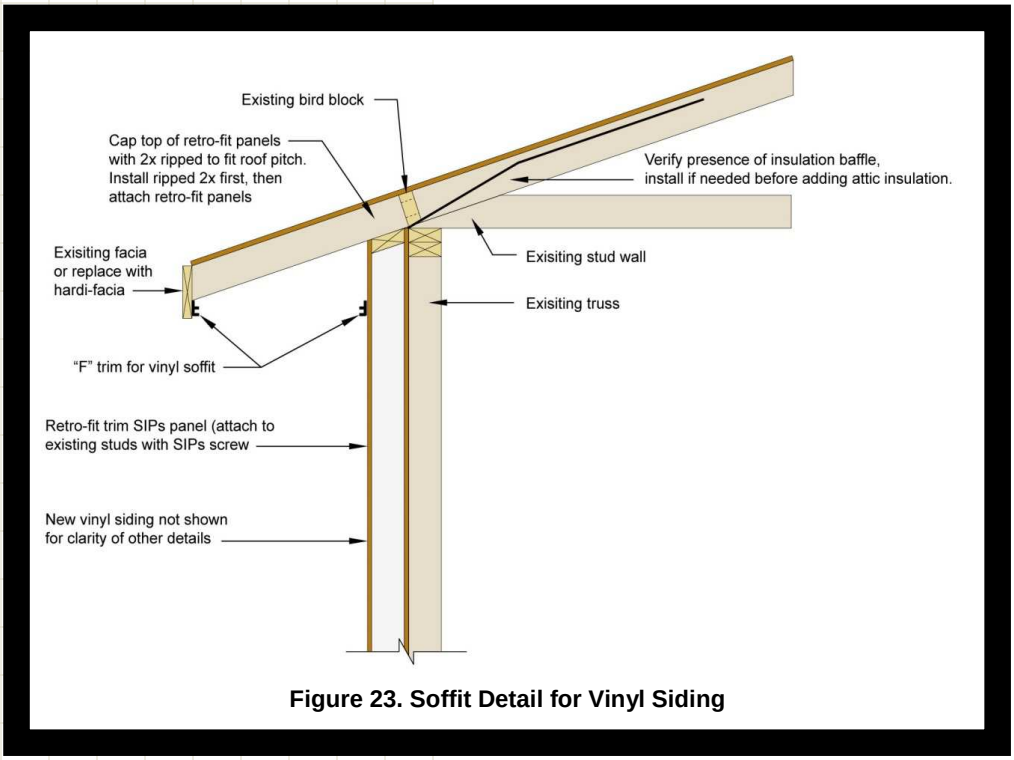

Figure 23. Soffit Detail for Vinyl Siding

Finishing – Roofs

In roof applications, retrofit insulated panels need to be covered with standard roofing underlayment and roofing shingles. It is acceptable to install roofing felt underneath retrofit insulated panels to keep the home dry during the construction process until the panels can be installed and new roofing material applied.

Like wall claddings, roofing material should be vented in extremely cold or wet climates. This is accomplished by installing a second layer of roof sheathing over furring strips, followed by another layer of roofing underlayment, or by using a retrofit insulated panel with pre-formed ventilation channels.

Roof/Wall Details

If the project is using retrofit insulated panels for the walls only and not enclosing the attic space with retrofit insulated panels, the wall retrofit insulated panels should be installed flush with the existing eaves and sealed to create an air barrier around the exterior. Inspect the attic and verify that an insulation baffle is present and that it extends down to the heel of the truss, maintaining the air barrier. Once this is complete, then new fascia and a new soffit can be installed (Figure 23).

One way to approach the intersection of wall and roof retrofit panels, whereby the wall panel encapsulates the attic area right up to the bottom of the roof deck, is shown in Figure 24. The original truss overhang was removed prior to installation of the wall panel. When an attic is very leaky where the truss meets the outside wall, covering that poor connection with the wall panel and sealing it to the bottom of the roof retrofit panel incorporates the old attic

space into the conditioned space of the remodeled house. Roof overhangs can be rebuilt in several ways.

Precut Pockets

Figure 24 shows how dimensional lumber rafter tails can be embedded in precut pockets in the foam that are fabricated by the retrofit insulated panel manufacturer. This option requires advanced coordination with the retrofit panel manufacturer but saves labor onsite and creates fewer opportunities for air leakage. The rafter tails are secured through the OSB facing and sealed in place with expanding foam. Blocking running along the panel edge provides the primary support, although larger overhangs may require a kicker brace as well.

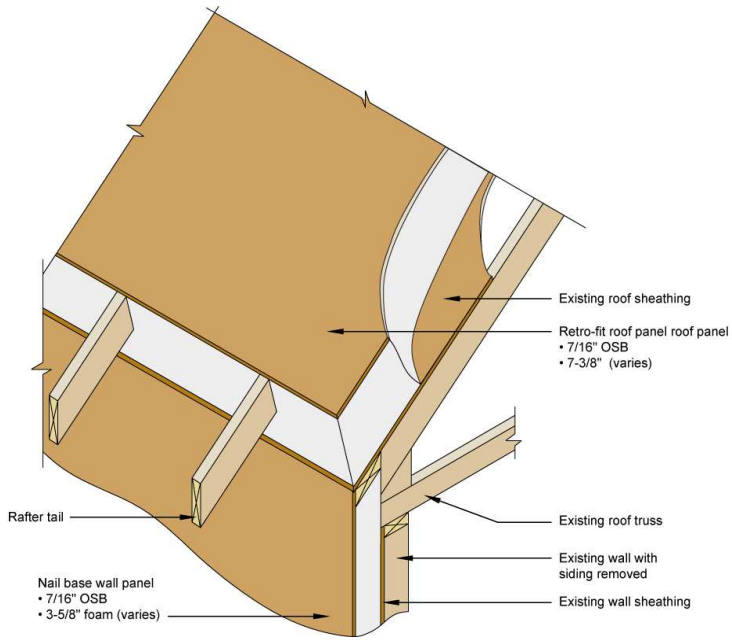

Figure 24. Wall and Roof Panel Overview

Extending Overhangs at Panel Joints

Another method for extending overhangs is to place dimensional lumber rafter tails at panel intersections. The foam is recessed in the field to accept the dimensional lumber matching the full thickness of the panel. They are secured through the OSB surface of the retrofit insulated panels. Because the lumber is installed along panel joints, it is a potential opportunity for air leakage, so all connections should be carefully sealed.

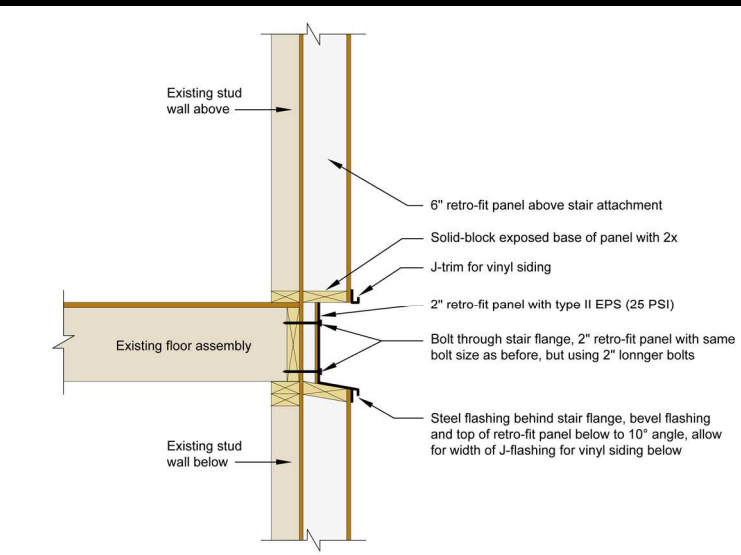

Figure 25. Flashing Detail at Stair Attachment

SIP Overhang

A third option is to create an overhang using a structural insulated panel (SIP). SIPs and retrofit insulated panels are readily available from the same suppliers. If SIPs of non-standard thickness are available, they will interface seamlessly with standard retrofit insulated roof panels.

Additional Wall Details

Estimation Sheet

Walls

Walls (from below sill plate line to above top plates, as roof trusses/rafters allow)	_____	SQ. FT.
Add: Gable ends	_____	SQ. FT.
Add: Dormer sides	_____	SQ. FT.
Add: Upper gambrel walls or parapets	_____	SQ. FT.
Subtotal (walls)	_____	SQ. FT.
Subtract: Large areas not covered (garage doors, sliding doors, windows)	_____	SQ. FT.
Total wall panel area take-off (subtract uncovered area from subtotal)	_____	
Divide wall square footage by panel size		
Total number of 4 x 8 panels to order	_____	
Total number of 4 x 10 panels to order	_____	
Total number of 4 x 12 panels to order	_____	

Roofs

Total roof panel area take-off	_____	SQ. FT.

Lumber - Walls

Treated lumber for ledgers	_____	LF
Bottom blocking	_____	LF
Blocking at outside corners	_____	LF
Window blocking	_____	LF
Total - wall lumber	_____	LF

Lumber - Roofs

Perimeter blocking for fascia attachment	_____	LF
Rafter tail extensions	_____	LF
Soffit framing (if required)	_____	LF
Total - roof lumber	_____	LF

Splines

Number of splines required _____

Screws

Wall panel screws -
approx. 1 per 2 sq. ft. of wall panel area _____

Roof panel screws -
approx. 1 per 2 sq. ft. of wall panel area _____

Sealants

Tubes of mastic sealant _____

Cans of expanding foam _____

Additional Deep Energy Retrofit Considerations

The existing heating or cooling system may be too large for the home after the thermal performance has been improved, causing the HVAC equipment to operate less efficiently and effectively. Oversized HVAC equipment results in uncomfortable conditions and fails to properly dehumidify or deliver fresh air, creating the potential for mold growth and other indoor air quality concerns. To achieve the best energy efficiency results and maintain good indoor air quality, older equipment should be replaced. All natural combustion equipment should be tested for proper draft by a RESNET or BPI certified analyst after the retrofit.

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Appendix I

IRC Requirements for Exterior Foam Insulation

Section 601.3.1 of the 2009 International Residential Code (IRC) provides worst case guidance as to the minimum thickness of exterior foam required to prevent moisture accumulation in wall cavities in cold climates where class III vapor retarders were used on the interior walls (no vapor barrier, painted drywall). Table 1 contains these minimum R-values for exterior wall foam application by climate zone, as referenced by the IRC.

Table 7. Minimum R-Value of Exterior Wall Foam Application in Cold Climate Zones

Climate Zone	Minimum R-value of Exterior Foam Insulation	
	2x4 walls	2x6 walls
Marine 4	R-2.5	R-3.75
5	R-5	R-7.5
6	R-7	R-11.25
7 and 8	R-10	R-15

The IRC provides similar guidance for the use of exterior foam on roofs when the interior insulation is air permeable and the attic is unvented with Table R806.4 *Insulation for Condensation Control* , reported here as Table 2. *These minimums may be added to the minimum R-values established by the Chapter 11 (IRC) energy requirements.

Table 8. Minimum Exterior Rigid Foam R-Value in Unvented Attic*

Climate Zone	Minimum Rigid Board R-Value
2B and 3B, tile roof only	None required
1, 2A, 2B, 3A, 3B, 3C	R-5
4C	R-10
4A, 4B	R-15
5	R-20
6	R-25
7	R-30
8	R-35

* with air permeable insulation below sheathing.

Appendix II

Sample fastening schedule for retrofit insulated panels

The following fastening schedule was taken from an actual deep energy retrofit project and used to attach retrofit insulated panels in the listed thickness to wood-framed 2 x 4 walls. The panels support horizontal vinyl siding. Actual fastener spacing will depend on the panel thickness, cladding type, screw type, stud spacing, and other factors. Table 9 is shown for demonstration purposes only. Each job will receive specific fastening instructions based on custom factors.

Table 9. Typical Fastening Schedule

Panel Thickness	Screw Length	Screw Spacing
2"	4"	24" o.c.
4"	6"	24" o.c.
6"	8"	16" o.c.

1. Panel Joints should occur between supports
2. Screw spacing is into each stud/rafter/truss
3. Fasten to studs spaced at 16" on center