STOP WARDROBE MALFUNCTIONS

Don’t Eat Your Sweater:
Continuous Insulation for Code-Compliant & High Performance Walls

Jay Crandell, PE

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

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

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

Foam Plastic Applications for Better Building

Introduction

- Welcome
- What's my story?
  - Joe has been addressing keeping the "sweater" and the wall dry
  - My presentation is about keeping the sweater on and functional – no wardrobe malfunctions!
    - Basically all the other things for code compliance and good practice.
    - Nobody wants a disaster….

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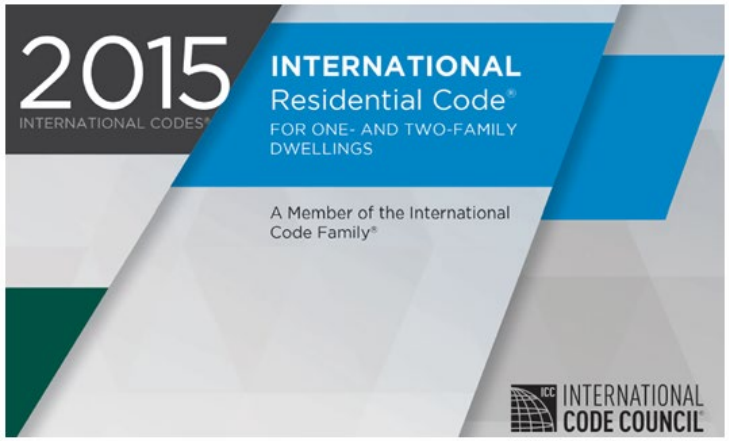
Outline

- Building Code Compliance
  - Continuous Insulation
  - Installation and details
  - Water resistive barrier
  - Siding and Furring Connections
  - Window connections/support
  - Wall Bracing
  - Fire Requirements
- Energy Code Compliance
- Additional Resources



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What is continuous insulation?

- Definition (2015 IRC)

> **[RE] CONTINUOUS INSULATION (ci).** Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope.

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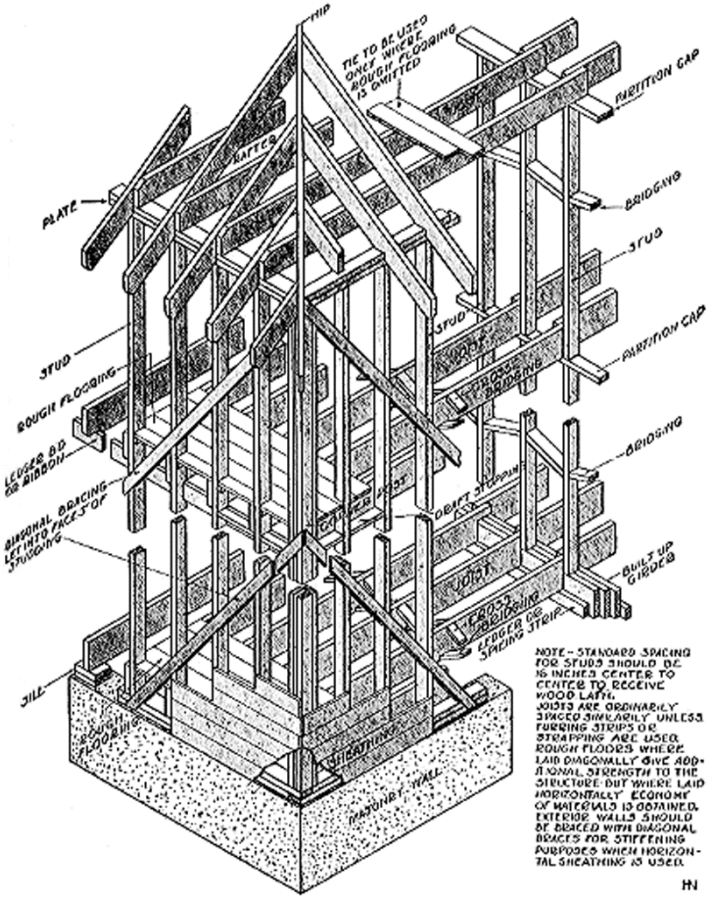
CI History

- In early 1900's, solid wood was considered as insulatio (~1.2 R/in)
- Cellulosic Fiber Insulating B in use since the early 1900's



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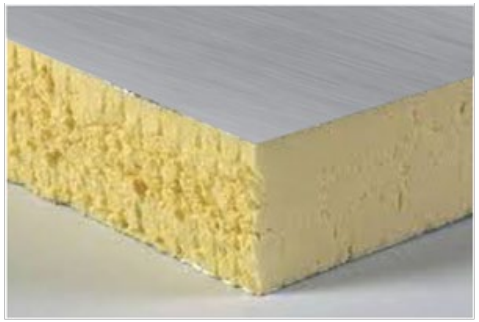
CI History

- Continuous insulation is not a new concept. Foam plastic insulating sheathing has been successfully used in this application for more than 50 years.
  - Foam sheathing has been used as continuous insulation for low-slope roofs since the 1940's
  - Wall applications of continuous insulation saw increased use after the 1970's oil crisis

CI Material Types

- Foam Plastic Insulating Sheathing
  - Foam sheathing, rigid board insulation, etc.
- Other types:
  - SPF (closed cell polyurethane)
    - When used continuously
  - Mineral fiber
  - Fiberboard
  - Insulated siding
  - Insulated wraps



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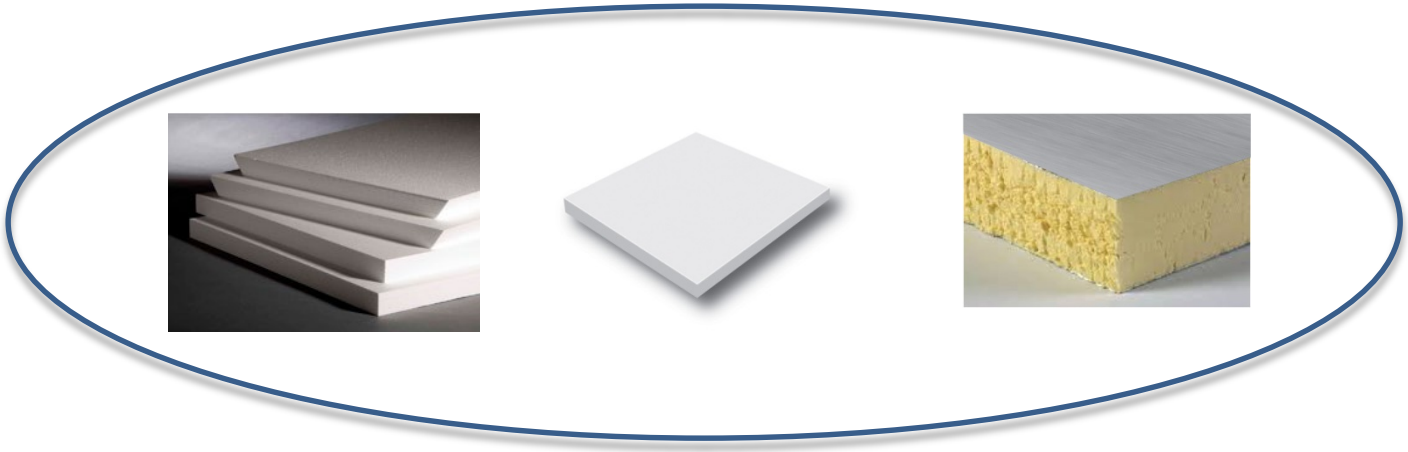
Foam Plastic Insulating Sheathing (FPIS)

- Expanded Polystyrene (EPS), ASTM C578
- Extruded Polystyrene (XPS), ASTM C578
- Polyisocyanurate (Polyiso), ASTM C1289



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Possible Code-Compliant Uses of Foam Sheathing

- Continuous Thermal Insulation (CI)
- Water Resistive Barrier (WRB)
- Air Barrier (AB)
- Water Vapor Control
- Wall Bracing (structural composite panels)

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R-value per Inch

TABLE 1. Examples of Minimum R-Value Per Inch for Common Types of Continuous Insulation (Foam Sheathing)

Continuous Insulation Material Type	R-value per Inch of Thickness
EPS (ASTM C578, Type II)	**4.0**
XPS (ASTM C578, Type X)	**5.0**
Polyiso (ASTM C1289, Type I)	**6.0**

- Consult with FPIS manufacturer for specific values.
- Values shown are representative minimum values.

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Water Resistance

Table 1 – Standard Test Methods and Criteria for Moisture Absorption Resistance Characterization of Various Insulation Board Materials

Insulation Material Type	**Maximum Moisture Content (% volume basis)**	
	ASTM C272 (24 hr water immersion test)	**ASTM C 209 (2 hr water immersion test)**
XPS (ASTM C578)	0.3%	n/a
EPS (ASTM C578)	2 to 4%	n/a
Polyiso (ASTM C1289)	n/a	1-2%[1]
Fiberboard (ASTM C208)	n/a	7-10%

1. Does not include facers; applies to polyiso core material only.

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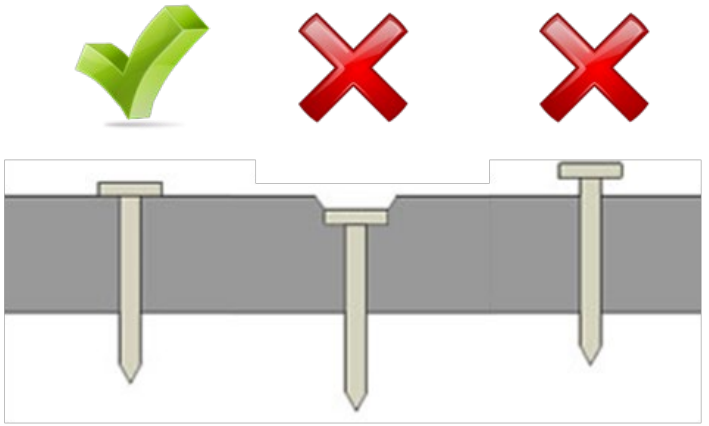
Installation of Foam Boards/Panels

- #1 - Follow manufacturer's installation instructions
- Cut with power/hand saws, utility knife, etc.
- Drive nails flush and snug
- Cap washers are preferred
- Some specialty products may require or allow use of nail or staple guns



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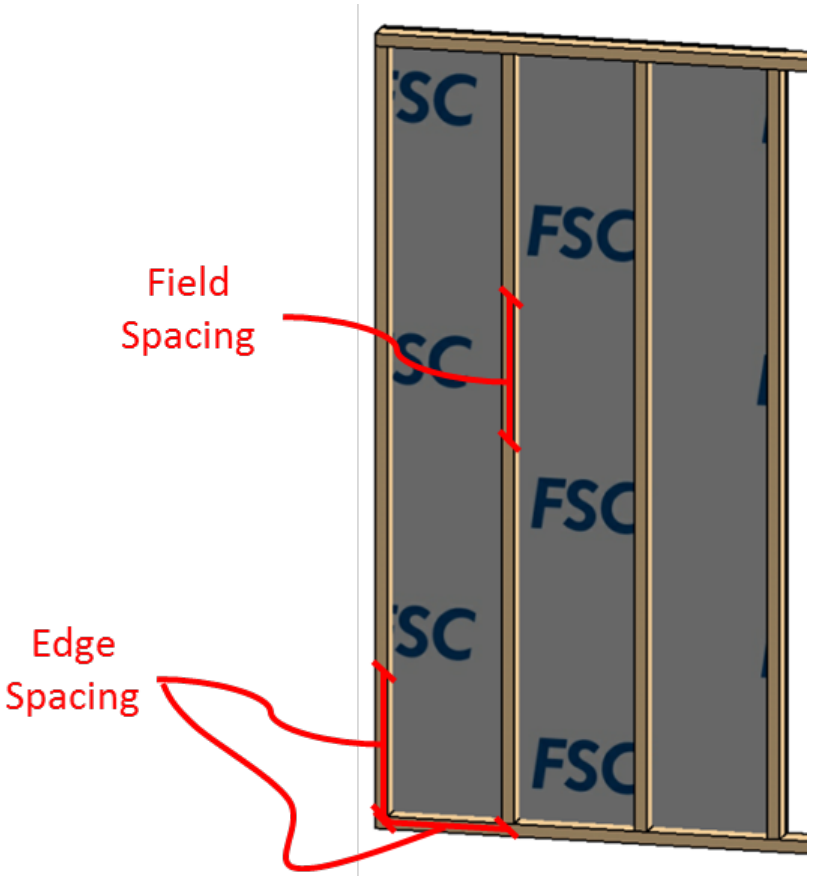
Typical Fastening Pattern

- Fasteners along studs and plates at
  - Edges of panel
  - Field of panel

- Typical: 12” oc (edges and field along studs)
  - Some may specify 16” oc in field



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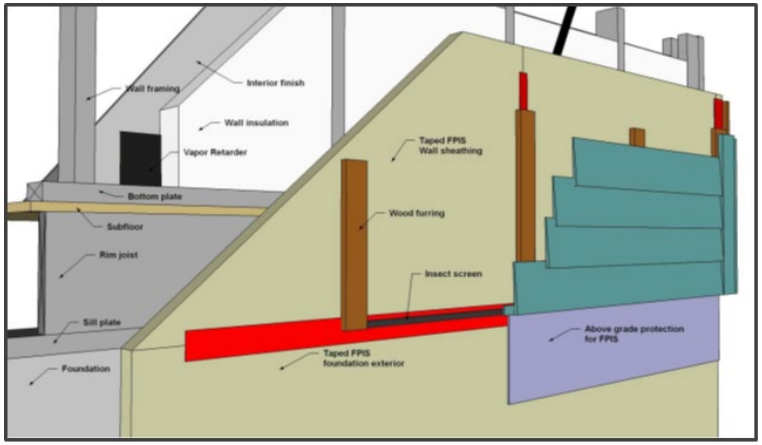
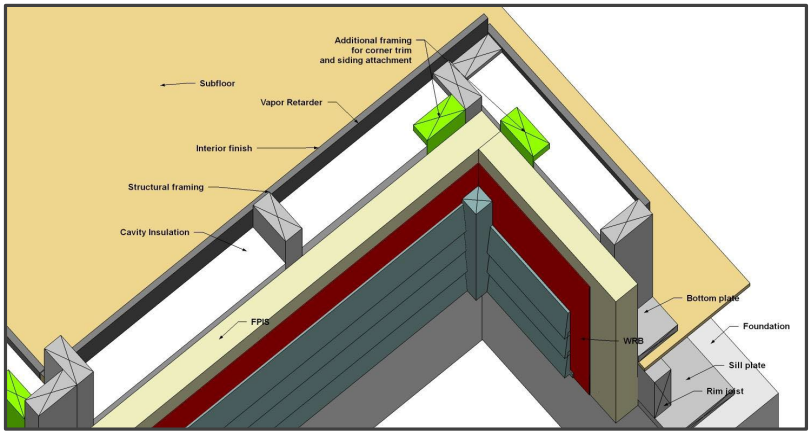
Construction Details – Plan Ahead!

- Framing, Sheathing, WRB, Siding Details
  - Many sources are available for accepted details and code compliance
  - Some resources/ examples follow





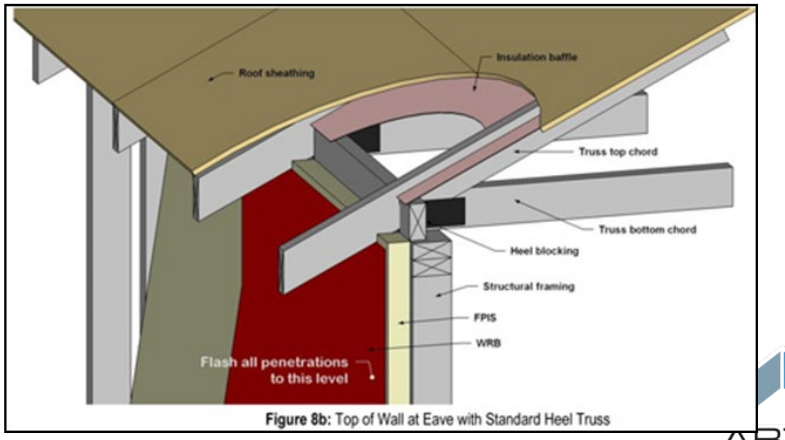


Figure 8b: Top of Wall at Eave with Standard Heel Truss

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TER 1205-05 Construction Details
www.drjcertification.org

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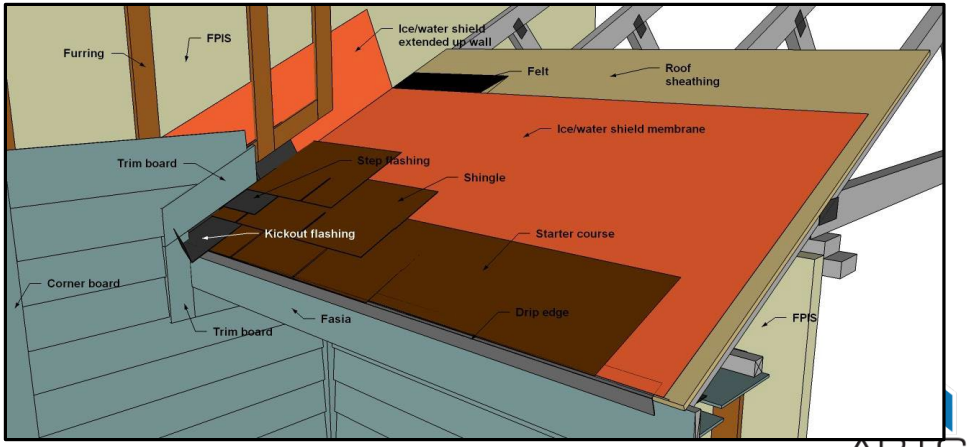
Code Compliance

Construction Details for the Use of Foam Plastic Insulating Sheathing (FPIS) in Light-Frame Construction

Client:
Foam Sheathing Committee (FSC)

Product :
Foam Sheathing

Report



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Building Science Corporation
www.buildingscience.com

http://buildingscience.com/documents/insights/bsi-085-windows-c

BSI-085: Windows Can Be A...

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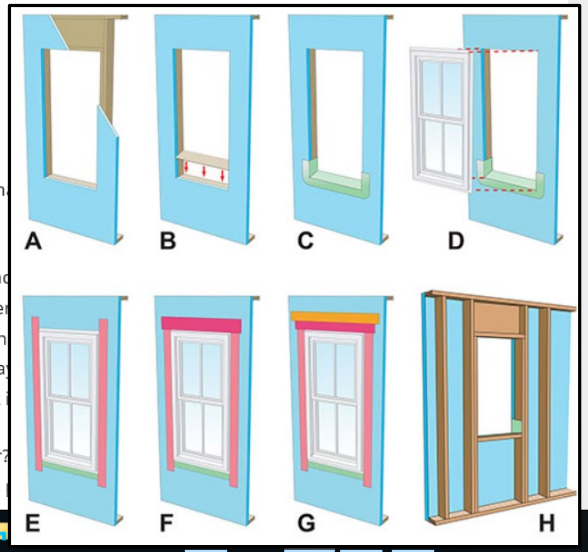
BSI-085: Windows Can Be A Pain*—Continuous Insulation and Punched Openings

Joseph Lstiburek

APRIL 14, 2015



Sometimes we make easy things hard. And sometimes we m
and punched openings both things are true.

The physics is easy. A wall has to control water, air, vapor an
and heat. Both have a water control layer, an air control laye
All you have to do is connect the water control layers to each
vapor control layers to each other and the thermal control la
don't want the windows to be sucked out of the wall when it

Now it gets interesting. Where is the wall water control layer?
continuous insulation layer itself—or it can be behind it. It is

Upcoming Events

- Building Science Fundamentals
- Renovation and Rehabilitation

Related Books

High Performance Enclosures

Related Documents

- BSI-081: Zeroing In
- Wall: Offset Frame Wall Construction
- BSI-040: High Rise Igloos
- BSI-078: Ship Shape—The Luftwaffe, Ballast and Shipping Containers
- BSI-004: Drainage, Holes and Moderation
- BSI-067: Stuck On You
- PA-0301: Water-Managed Wall Systems

Search the web and Windows

4:16 PM
12/11/2015

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DOE Building America Solution Center basc.pnnl.gov

Wind Pressure Requirements

- All exterior sheathing materials (and claddings) must meet wind pressure requirements of the code

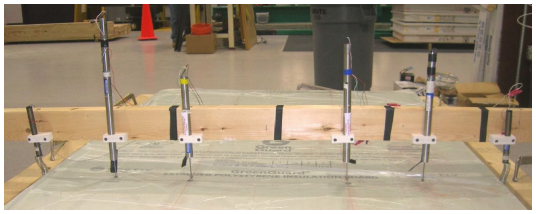
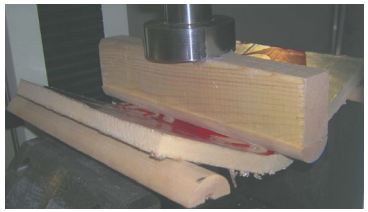
Wood structural panels

Fiber board

Foam sheathing

Wind Resistance of FPIS & Vinyl Siding Over FPIS

- State-of-art testing program
- Worked with FSC/ACC, IBHS, NAHB, VSI, DOE, HIRL, and AWC
- Resulted in ANSI/FS 100 Standard

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Code Compliance (wind pressure)

- ANSI/SBCA/FS 100–2012
  sbcindustry.com/fs100.php
  - Foam sheathing wind resistance rating standard
  - Referenced in 2015 IRC Section R316.8
  - Exception: Foam sheathing does not need to be rated if used over structural sheathing !!!
- Cladding/furring provides permanent attachment for wind resistance
  - Foam sheathing attachment is for temporary construction
  - Can use specialty fastener/washers for permanent wind resistance

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Water Resistive Barrier Application

- Use tested and approved foam sheathing WRB products and accessories (e.g., joint tapes and flashings)!
- Follow manufacturer's installation instructions

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Research Report

Foam Plastic Insulating Sheathing Products & Accessories Used as a Code Compliant Water-Resistive Barrier (WRB) System

DRR No. 1410-05

Issue Date: January 28, 2015
Updated: June 12, 2015

Foam Sheathing Committee (FSC) Members

Atlas Roofing Corporation – atlasroofing.com, atlaswallci.com, atlaseps.com
Dow Building Solutions – building.dow.com
GAF – gaf.com
Hunter Panels – hpanels.com
Johns Manville – jm.com
Kingspan Insulation, LLC – kingspan.com
Owens Corning – owenscorning.com
Rmax Operating, LLC – rmax.com

DIVISON: 06 00 00 – WOOD, PLASTICS, AND COMPOSITES
Section: 06 16 00 – Sheathing
Section: 06 16 13 – Insulating Sheathing

DIVISION: 07 00 00 – THERMAL AND MOISTURE PROTECTION
Section: 07 21 00 – Thermal Insulation

11/27/2015
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.
RYAN JOSEPH [illegible]
DATE REG. NO. 48971

Foam Sheathing Product Code Compliance

Manufacturer	Research Report Number	Product(s)	Type of Application: IBC 1404.2[1]	IBC 2510.6[2]	IRC 703.2[3]	IRC 703.6.3[4]
Atlas	ESR-1375	Energy Shield®, Energy Shield® Plus, Energy Shield® Pro, Energy Shield® Pro2, RBoard®, Stucco Shield®	Y	Y	Y	Y
	UL ER16529-01	ThermalStar LCi	Y	Y	Y	Y
	TER No. 1311-02	LCi-SS	Y	Y	Y	Y
Dow	ESR-1659	THERMAX™ Sheathing, THERMAX™ Light Duty, THERMAX™ Heavy Duty, THERMAX™ Heavy Duty Plus, THERMAX™ Metal Building, THERMAX™ White Finish, THERMAX™ ci Exterior Board	Y	Y	Y	Y
	ESR-2142	STYROFOAM DURAMATE™ Plus, STYROFOAM Residential Sheathing, STYROFOAM Residing Board, STYROFOAM Utilityfit, STYROFOAM SCOREBOARD, STYROFOAM Sheathing Material, STYROFOAM Ship Lap, STYROFOAM Square Edge, STYROFOAM Tongue and Groove, STYROFOAM CAVITYMATE™ Ultra, STYROFOAM Ultra SL, STYROFOAM XPS Insulation, Dow High Performance, Underlayment, BLUECOR™, DOW Protection Board III	Y	Y	Y	Y
	ESR-3089	TUFF-R™, TUFF-R™ C, Super TUFF-R™, Super TUFF-R™ C, ISOCAST™ R	Y	Y	Y	Y
Hunter Panels	TER No. 1402-01	Xci Class A	Y	Y	Y	Y
Johns Manville	ESR-3398	AP™ Foil Faced	Y	Y	Y	Y
Kingspan	TER No. 1011-01	GreenGuard® Insulation Board CM, GreenGuard® Insulation Board SL, GreenGuard® Insulation Board SLX, GreenGuard® PLYGOOD	Y	Y	Y	Y
Owens Corning	ESR-1061	FOAMULAR® 150,250,400,600,1000	Y	Y	Y	Y
Rmax	TER No. 1212-03	ECOMAXci	Y	Y	Y	Y
	TER No. 1207-01	Thermasheath®-SI Thermasheath®-3	Y	Y	Y	Y
	TER No. 1309-03	Thermasheath®-3, Thermasheath®-XP, TSX-8500,TSX-8510, TSX-8520	Y	Y	Y	Y

http://www.drjcertification.org/products/foam-sheathing

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WRB Code Compliance & Performance
ABTG Research Report No. 1504-03
www.appliedbuildingtech.com/rr/1504-03

ASTM E331, 2hrs @ 6.24psf with 5gph/ft^2 spray

No. 15 Felt = 5-7min @ 2.86psf (code benchmark)

Comparison of water resistance tests for WRB materials			
	15# Felt	Housewraps	FPIS
Weathering		✓	✓
AATCC 127		✓	✓
Taped Joints			✓
Full Assembly Water Penetration			✓

Water head test after accelerated aging of tape joint

Foam WRB & Flashing Tape (3-yr exposure)

Tape joints in-service performance (~15 years after install)

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Lesson from EIFS apply to all walls: USE A WRB AND PROPER FLASHING!

- Problems identified:
  - No drainage of cladding
  - No water resistive barrier layer
  - Face sealing (rely on caulk?)
  - Leaky window units and no pan
  - Roof/wall flashing missing or wrong
  - Use of interior poly (“double” and “reversed” vapor retarder) in mixed/warm/humid/rainy climates
- Problems fixed in IRC
  - WRB drainage layer & flashing required behind all claddings, including EIFS (now also drainable)

A very serious wardrobe malfunction

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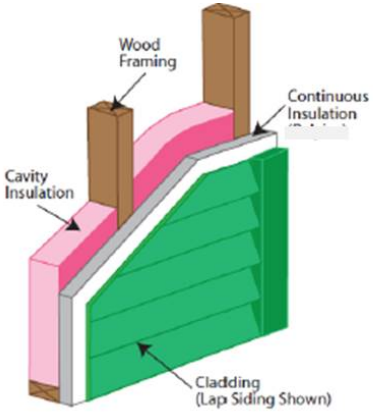
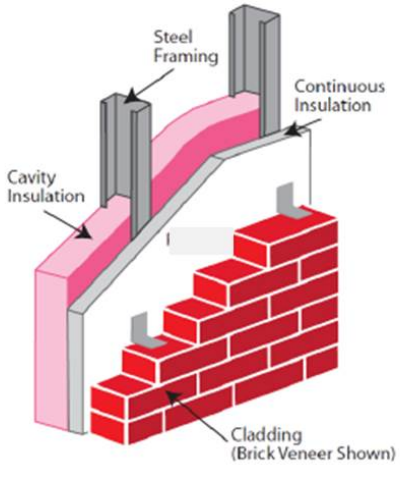
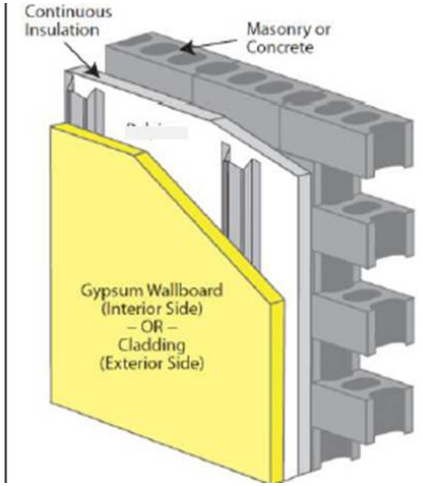
Siding and Furring Connections

- Must fasten through foam sheathing!
- Place wood or steel furring members over CI to avoid heat loss (thermal bridging) and condensation risk
  - Steel furring significantly greater thermal bridge than wood
  - Stainless steel has 1/3rd the thermal transmissivity of carbon steel fasteners and connectors







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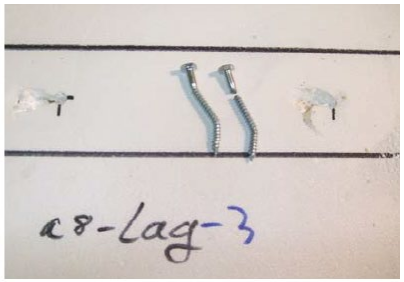
Cladding Attachment through FPIS

- Collaborative research
  - FSC, NYSERDA, SFA, BSC for DOE/BA, Newport Partners, ARES/ABTG, etc.
- Extensive testing effort
  - siding and furring connections
  - FPIS (up to 4” thick)
  - Wood and steel framing
  - Commodity nails, screws, & lags

Typical Test Set-up



Typical Failure

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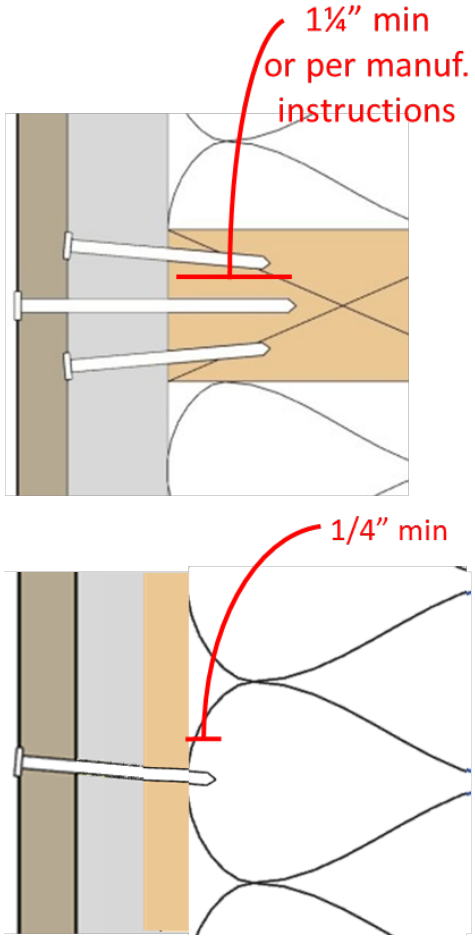
Cladding & Furring Attachment

- 2015 IRC code requirements:
  - R703.15 (wood framing)
  - R703.16 (steel framing)
  - R703.17 (concrete/masonry)
- Siding fastener embedment must be maintained
  - Use longer fasteners as needed
  - Can use WSP nail base for limited (lightweight) siding applications
- Also refer to siding manufacturer's installation requirements
- Minimum 15 psi foam material



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Exterior Wall Covering Attachment over FPIS
www.drjcertification.org/products/foam-sheathing

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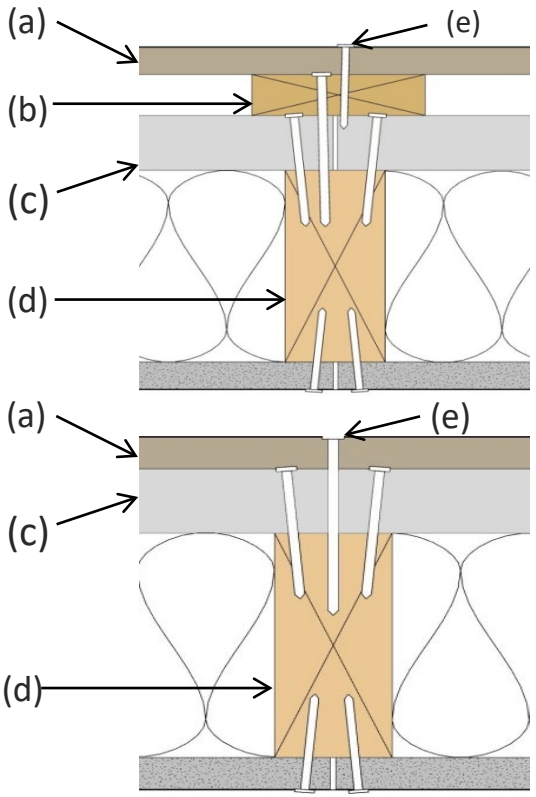
Research Report

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

DRR No. 1303-04

Furring Material	Framing Member	Fastener Type & Minimum Size	Minimum Penetration into Wall Framing (in.)	Fastener Spacing in Furring (in.)	Maximum Thickness of Foam Plastic Insulating Sheathing (in.)						Allowable Wind Pressure Resistance of Furring Attachment (psf)	
					16" o.c. Furring			24" o.c. Furring				
					Siding Weight:			Siding Weight:				
					3 psf	11 psf	25 psf	3 psf	11 psf	25 psf	16" o.c. Furring	24" o.c. Furring
Minimum 1x3 Wood Furring	Minimum 2x Wood Stud	Nail (0.120" shank; 0.271" head)	1¼"	8	2	1.5	0.5	2	1	DR	42.6	28.4
				12	2	1.5	DR	2	0.5	DR	28.4	18.9
				16	2	0.75	DR	2	DR	DR	21.3	14.2
		Nail (0.131" shank; 0.281" head)	1¼"	8	4	2	1	4	1.5	DR	46.5	31.0
				12	4	1.5	DR	3	1	DR	31.0	20.7
				16	4	1	DR	3	0.5	DR	23.3	15.5
		0.162" diameter nail	1¼"	8	4	4	1.5	4	2	0.75	57.5	38.3
				12	4	2	0.75	4	1.5	DR	38.3	25.6
				16	4	1.5	DR	4	1	DR	28.8	19.2
		#10 wood screw	1"	12	4	2	0.75	4	1.5	DR	107.3	71.6
				16	4	1.5	DR	4	1	DR	79.0	52.7
				24	4	1	DR	3	DR	DR	35.1	23.4
		¼" lag screw	1½"	12	4	3	1	4	2	0.5	140.4	93.6
				16	4	1.5	DR	4	1.5	DR	79.0	52.7
				24	4	1.5	DR	4	0.75	DR	35.1	23.4
		#8 screw (0.285" head)	Steel thickness +3	12	3	1.5	DR	3	0.5	DR	52.9	35.3
				16	3	1	DR	2	DR	DR	39.7	26.5



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Vinyl Siding Over Foam Sheathing (wind pressure ratings)

- OK, we've addressed the "sagging covering" wardrobe malfunction. Now, what if the wind blows?
- IRC 2009/2012/2015:

R703.11.2 Foam plastic sheathing. Vinyl siding and insulated vinyl siding used with foam plastic sheathing shall be installed in accordance with Section R703.11.2.1, R703.11.2.2 or R703.11.2.3.

Exception: Where the foam plastic sheathing is applied directly over wood structural panels, fiberboard, gypsum sheathing or other *approved* backing capable of independently resisting the design wind pressure, the vinyl siding shall be installed in accordance with Section R703.11.1.

Exceptions are important! – use standard siding wind rating and installation if FPIS is installed over other panels capable of resisting the wind load (oversheathing)

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What if the exception doesn't apply?

- If in 115 mph wind zone (non-hurricane) and exposure B (typical wooded/suburban)…
  - Use min. ½" XPS or polyiso, or min. 1" EPS
  - Use 1-1/4" fastener penetration in to framing
- No problem, follow vinyl siding manufacturer's installation instructions
- No need to adjust siding wind pressure rating

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What if that doesn't apply?

- It gets a bit more complicated
- Vinyl siding standard wind pressure ratings will need to be modified to determine appropriate siding for the application
  - Multiply siding wind pressure rating by 0.39 if wall has interior gypsum board finish
  - Multiply siding wind pressure rating by 0.27 if wall is not finished on the interior (e.g., gable end wall)
- This only applies to vinyl siding because its wind rating relies on pressure equalization

Vinyl Siding Wind Rating Adjustment

- Example:
  - 130 mph, exposure B (moderate hurricane area)
  - Code wind pressure required = 24 psf (neg. pressure)
  - Siding wind pressure std. rating = 65 psf
    - This is a moderately high rated product (premium)
  - Adjustment = 0.39 x 65 psf = 25 psf
  - 25 psf > 24 psf OK
- Results in a more rigid and higher performing (higher safety factor) vinyl siding installation
- More resilient protection of WRB during major wind event
  - Unintended “exposure” wardrobe malfunction avoided

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Window Install and Flanges over FPIS

- Attachment of flanges directly through foam up to 2” thick have been tested.
  - Support of gravity loads
  - Wind resistance

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Research Report

Attachment of Windows with Integral Flanges Through Foam Plastic Insulating Sheathing to Wood Framing

DRR No. 1304-01

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Foam Sheathing Committee (FSC) Members

Atlas Roofing Corporation – atlasroofing.com, atlaswallci.com, atlaseps.com
Dow Building Solutions – building.dow.com
GAF – gaf.com
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Section: 06 16 00 – Sheathing

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Section: 07 21 00 – Building Insulation

11/27/2015
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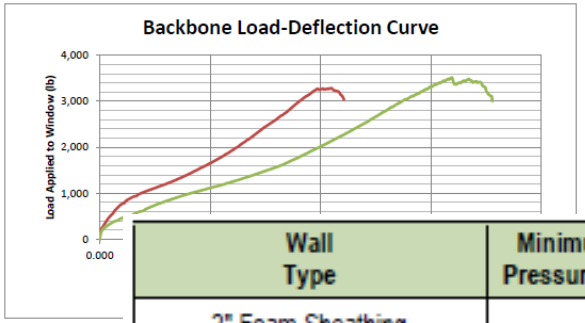
http://www.drjcertification.org/products/foam-sheathing

Photo 2: Structural Loading – Fastener/Flange Capacity

Photo 3: Wind Pressure Loading Test Setup



Wall Type	Minimum Structural Pressure Rating (STP)	Failure Load (psf)
2" Foam Sheathing	37.5	118

Table 2: Summary of Wind Pressure Test Results

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Installation Guidance (flange fasteners)

- Follow window manufacturer instructions (shims, anchors, etc.) and verify adequate flange fastening
  - Typical flange fastening generally OK for up to 2” thick foam sheathing and typical 3’ windows

Minimum Fastener (or equal)	Thickness of Foam Sheathing (in.)	Maximum Fastener Spacing in Flanges per Width of Window Unit	
		≤ 3'	> 3'
0.120"-Diameter Roofing Nail	½"	16" o.c.	9" o.c.
	1"	10" o.c.	5" o.c.
	1½"	7" o.c.	3.5" o.c.
	2"	6" o.c.	3" o.c.

1. Values assume integral flanges with fasteners that support 100% of window unit weight even when sill shims are installed per the manufacturer's installation instructions.
2. Table is based on a window unit weight of 7 pounds per square foot. For different weights, multiply fastener spacing by 7/w, where w is the actual weight in pounds per square foot.
3. The fastener spacings provided in this table are the maximum allowed, based on support of the window unit's weight.
4. For wind load resistance, a lesser fastener spacing may be specified in the window manufacturer's installation instructions.
5. The window manufacturer's installation instructions, where more stringent, shall be followed, in the event of any conflict.
6. Spacing calculations in table assume that vertical flanges support 100% of the gravity load.

Table 3: Minimum Fastener Size & Maximum Spacing Along Window Flanges for Attachment to Wood Framing Through FPIS

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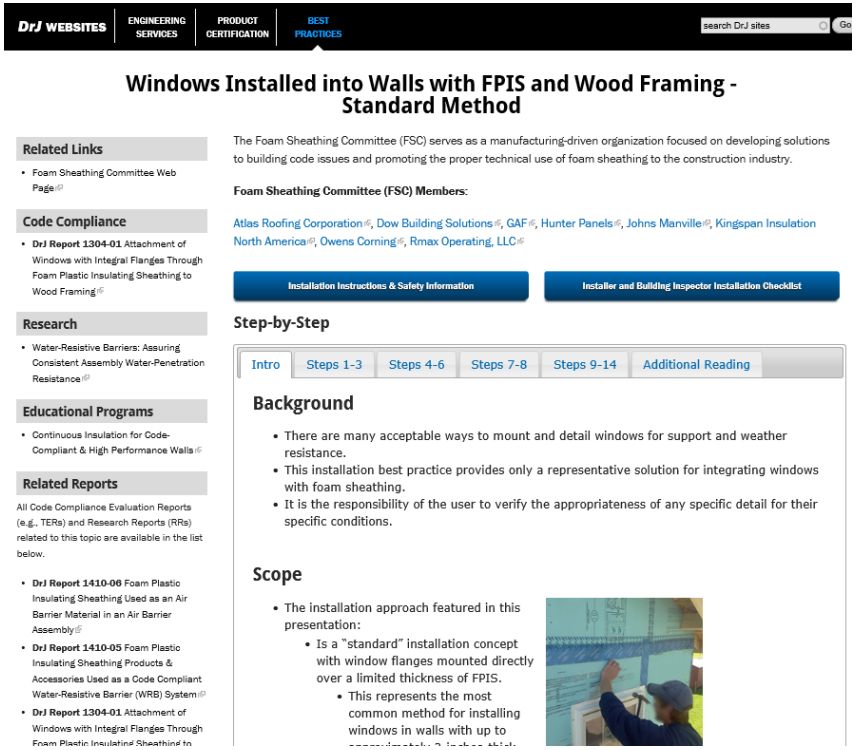
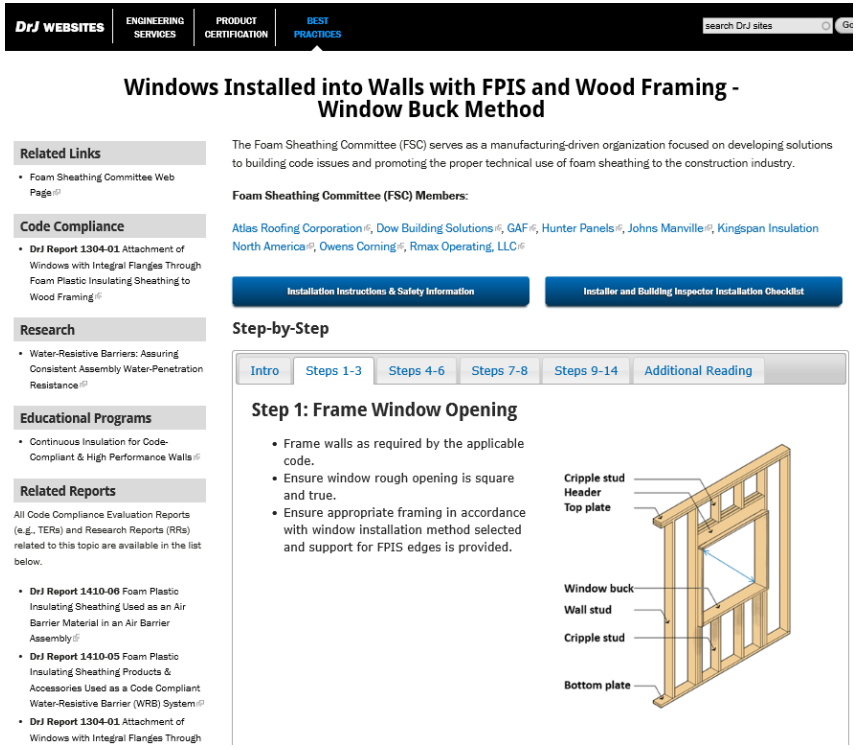
Installation Guidance (typical practice)

- Common field practice (rule-of-thumb):
  - Directly attach flange over foam to framing if foam sheathing thickness is 2” thick or less
  - Use a window “buck” to support window if foam sheathing is greater than 2” thick
  - Some prefer 1-1/2” thick as the trigger – use what you’re comfortable working with for your project!

Window Installation Guides (Standard & Window Buck Installation Methods)





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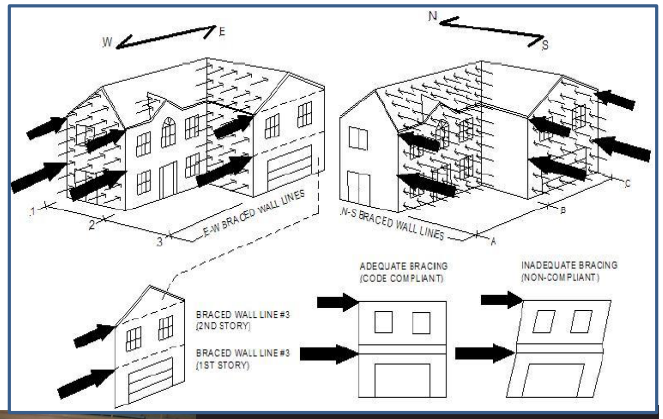
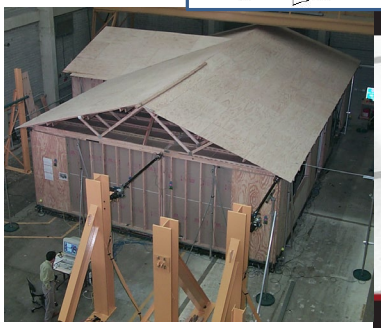
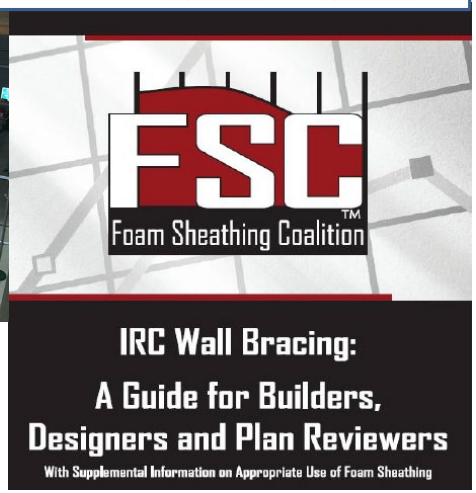
Wall Bracing (IRC Section R602.10)

- Many building design factors impact wall bracing and sheathing/insulation decisions.
- APA/ICC, FSC, and others offer Wall Bracing Guides to help with this section of code
- All bracing methods have limitations, advantages, and disadvantages







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Wall bracing – integration with FPIS

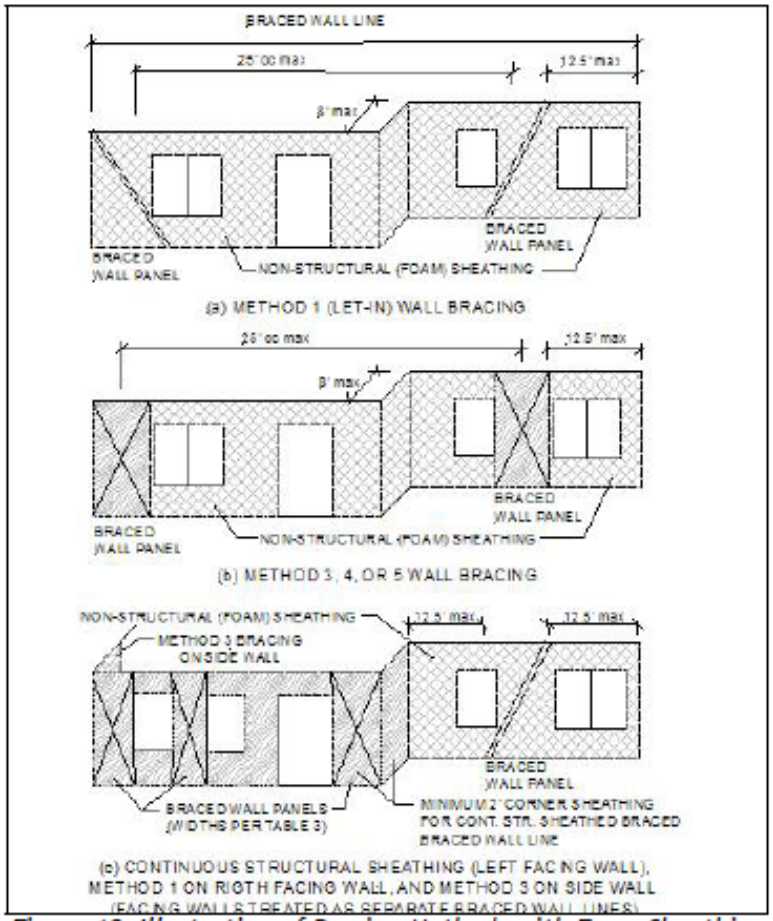

Figure 10: Illustration of Bracing Methods with Foam Sheathing

- Code-compliant bracing methods include:
  - Use of foam over continuous structural sheathing (e.g., OSB, plywood, structural fiberboard, etc.) – larger homes/lots of windows
  - Use of foam between and/or over intermittent braced wall panels (e.g. WSP, let-in brace, etc.) – smaller/affordable homes

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Different views of the world of walls?

Sources:

(1) http://www.greenbuildingadvisor.com/blogs/dept/musings/osb-airtight

(2) http://buildingscience.com/documents/digests/bsd-139-deep-energy-retrofit...

(3) Baby It's Cold Outside – Nazareth College, Rochester, NY (Wikimedia commons)

- Minimum bracing requirements rule the wall area!
- But, everybody seems to want the product continuous…
  - Continuous structural sheathing
  - Continuous insulation
  - What next?...Continuous windows?
- Balance is achieved in smart, code-compliant designs.

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Fire Requirements - IRC

- Fire safety requirements for foam sheathing
  - IRC Section R316
    - R316.3 – Surface burning characteristics
      - ASTM E84 or UL 723 - Standard Test Method for Surface Burning Characteristics of Building Materials
      - FS ≤ 75 (oak = 100) and SDI ≤ 450
    - R316.4 – Thermal barrier
      - ½" gypsum or other approved material on interior (typical)
      - Some exceptions per approval
    - R316.6 – Special approval
      - NFPA 286, FM 4880, UL 1040, UL 1715, or other fire tests related to end use configurations

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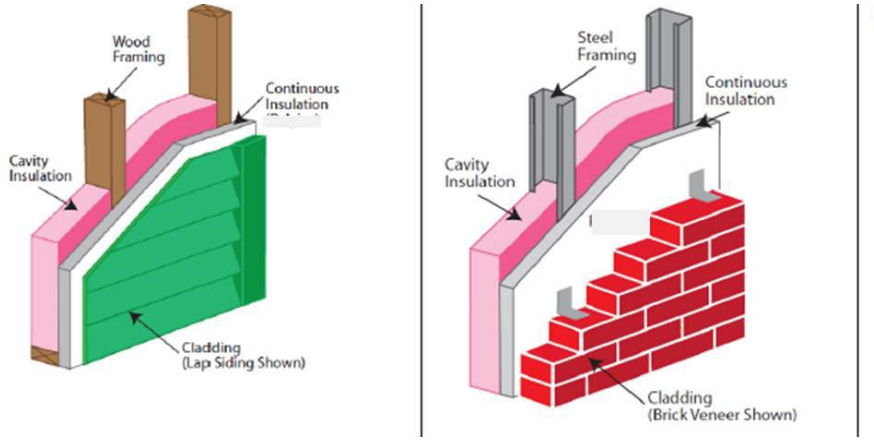
Fire Resources for FPIS

- DRR No. 1202-04 Type I-IV Construction
- DRR No. 1202-03 Type V Construction
- DRR No. 1202-01 NFPA 285 Tested Assemblies
  - www.appliedbuildingtech.com/fsc



Add gypsum sheathing for exterior fire rating where needed (e.g., narrow building separation)

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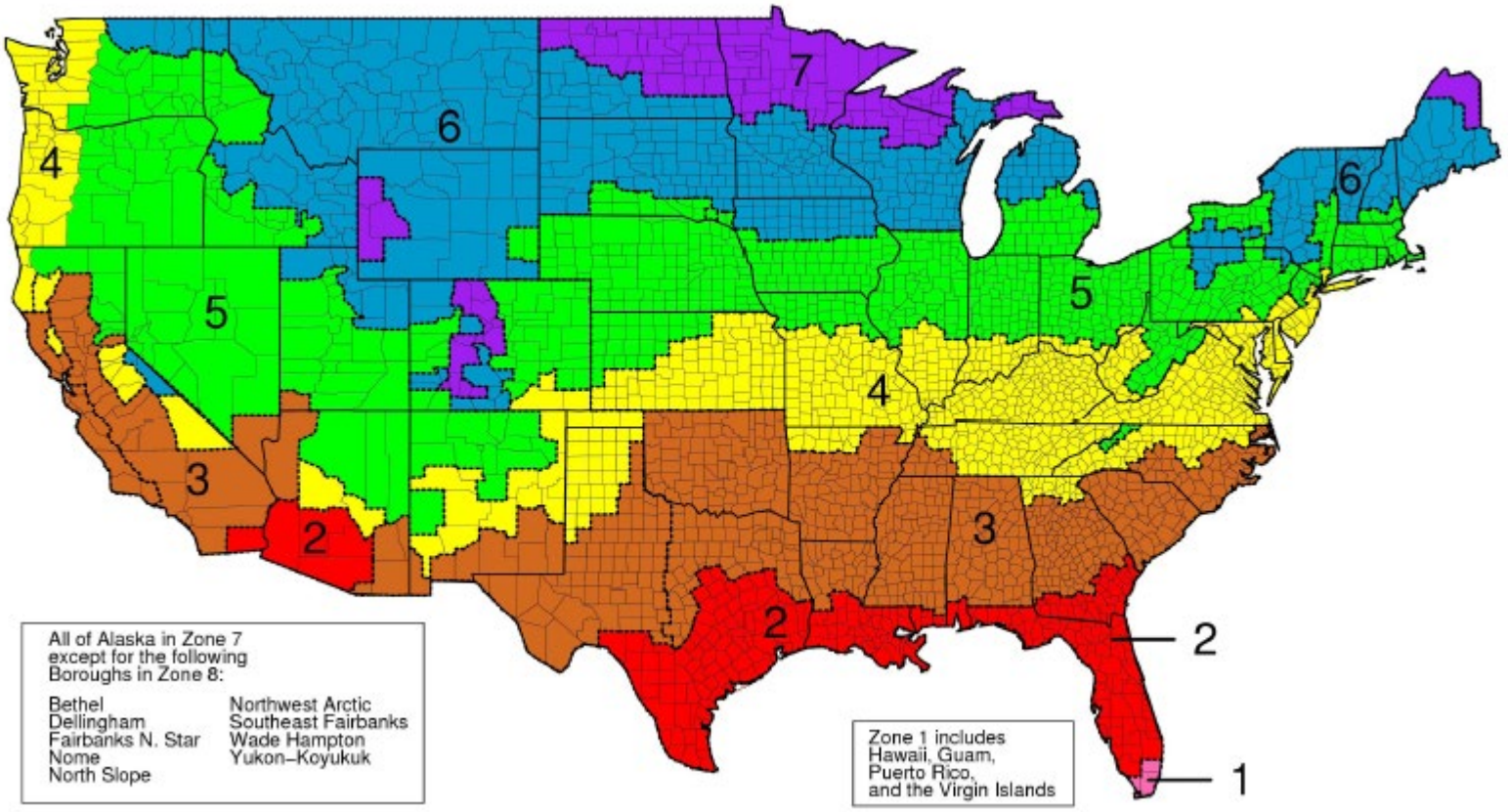
Energy Code Compliance



[US Climate Zone Map]

R-value Compliance Path (prescriptive)

2012 IECC Residential Wall R-value

Installation	Wood Frame R-value		
Climate Zone	2009 IECC	2012 IECC	2015 IECC
1	13	13	(same as 2012 IECC)
2	13	13	
3	13	20 or 13+5**	
4 exc. Marine	13	20 or 13+5	
4 Marine & 5	20 or 13+5	20 or 13+5	
6	20 or 13+5	20+5 or 13+10	
7 & 8	21	20+5 or 13+10	

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Other Compliance Paths

- U-factors (simple to derive alternate R-values)
  - R11+11ci = R13+10ci = R15+8.5ci = R20+5ci = R30
  - 2x4…2x4…2x4…2x6…2x8 (wall thickness increases as cavity insulation amount increases)
- Total envelope UA = UwAw + UrAr + etc.
  - Trade away insulation in one place, put more in another
- Performance Path (more flexibility)
- Energy Rating Index (HERS)
- All are tools to help to fine-tune designs
  - Limits? – moisture control, comfort, ghosting, etc.

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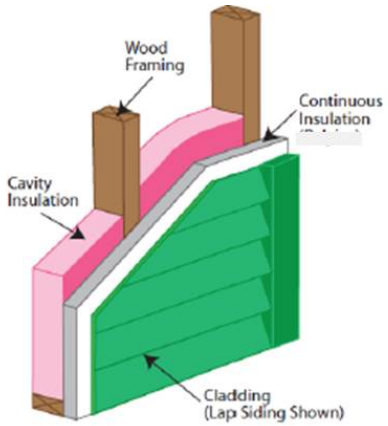
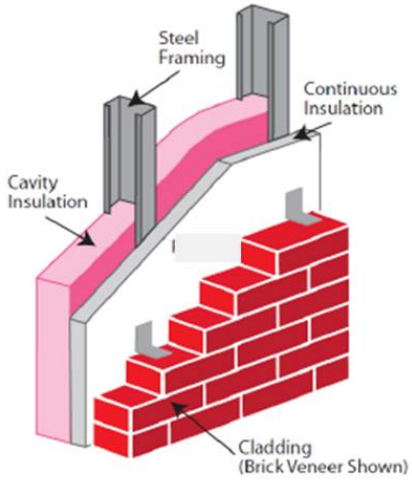
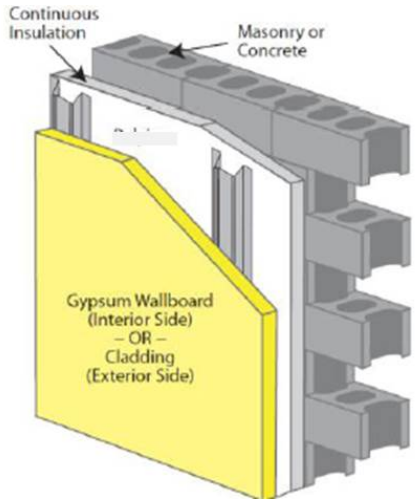
Three Wall Insulation Approaches

1. Cavity insulation only
2. Cavity insulation + continuous insulation (ci)
3. Continuous insulation (ci) only







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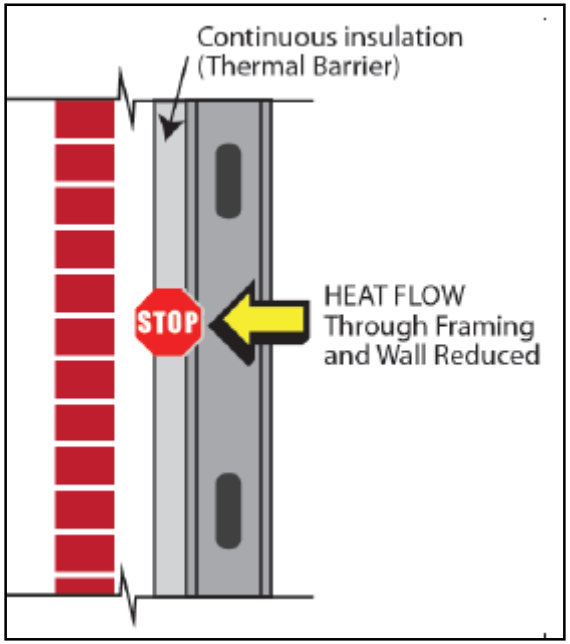
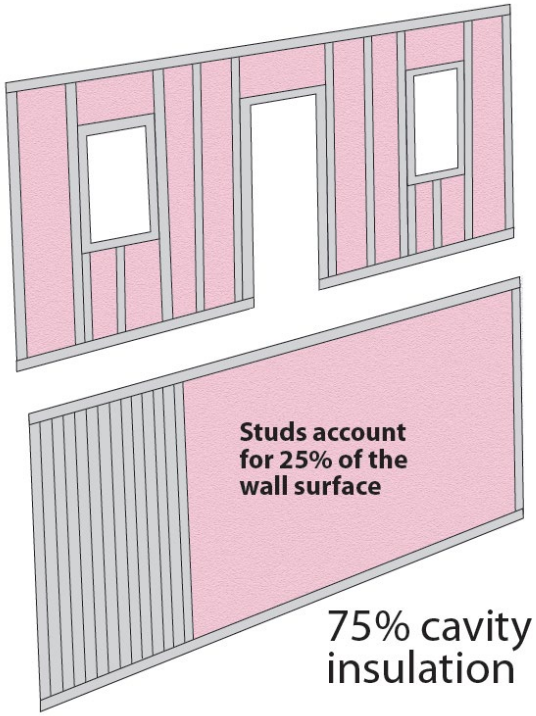
CI Helps Stop Thermal Bridging





25% studs ("thermal bridges")

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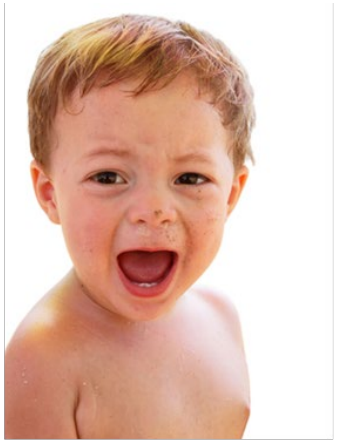
How the sweater works

R-13 cavity insulation

CONCLUSION:

Uh Oh, baby ate sweater…



Source: FreeImages.com/Hector Landaeta

½" rigid foam CI added

CONCLUSION:

Warm baby, happy baby…

Source: Dryvit/DOW

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

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

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U-factor Comparison (sweater vs. no sweater)

	U-factor Comparison		
Wall Component	**R20**	**R25**	**R20+5ci**
Outside winter air	0.17	0.17	0.17
Siding	0.62	0.62	0.62
Continuous insulation	0	0	5
OSB - 7/16	0.62	0.62	0.62
SPF stud	6.875	6.875	6.875
SPF header	6.875	6.875	6.875
Cavity insulation	20	25	20
1/2 drywall	0.45	0.45	0.45
Inside air film	0.68	0.68	0.68
R-value stud path	9.42	9.42	14.42
R-value header path	9.42	9.42	14.42
R-value cavity path	22.54	27.54	27.54
Framing factor - studs	21%	21%	21%
Framing factor -header	4%	4%	4%
Framing factor - cavity	75%	75%	75%
U-factor	**0.060**	**0.054**	**0.045**
Effective R of wall	**17**	**19**	**22**

R25 ≠ R20 + 5ci

- The R20+5ci wall is 15% more efficient than the R-25 wall.
- This demonstrates a benefit to wearing and not eating your sweater.

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Coordinate with Building Code Vapor Retarder Requirements

- This check is important…

R402.1.1 Vapor retarder. Wall assemblies in the *building thermal envelope* shall comply with the vapor retarder requirements of Section R702.7 of the *International Residential Code* or Section 1405.3 of the *International Building Code*, as applicable.

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Air Leakage Control (Air Barriers)

- Continuous air-barrier (AB) is required by the IECC & IRC Chapter 11-Energy
- The code does not specify air barrier location
  - Can be located on the interior, inside, or to the exterior side of walls
- EPA Energy Star* requires AB on both sides of walls in cold climates (best practice and highly recommended)
- Important to energy conservation and moisture control
- Refer to:
  - Air Leakage Guide, US DOE, Building Technologies Program

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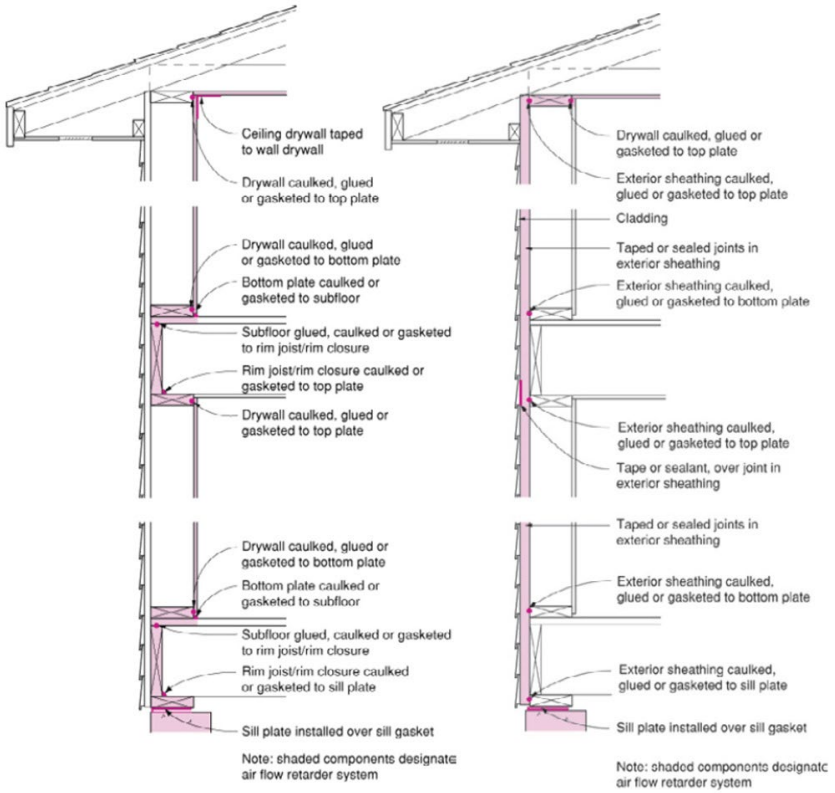
Air Barrier Materials & Methods

- Many materials and methods of AB installation are available
  - Foam Sheathing w/taped joints
    - DRR 1410-06, FPIS Used as an Air Barrier Material in an Air Barrier Assembly.
  - Other materials/methods include:
    - Sealed drywall installation
    - Wraps with sealed/taped joints
    - Adhered membranes
    - Spray-applied coatings
    - Exterior sheathing with sealed joints
    - Closed-cell spray foam



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Going beyond minimum code with CI

Building Science Corporation
NIST Net Zero Energy Research Home

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A Final Helpful Resource

- Durability by Design
- – A Professional's Guide to Durable Home Design
- (2nd Edition)
- U.S. HUD, Office of Policy Development & Research (www.huduser.gov)

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THANK YOU!

- Questions?
  - Back to Joe…

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