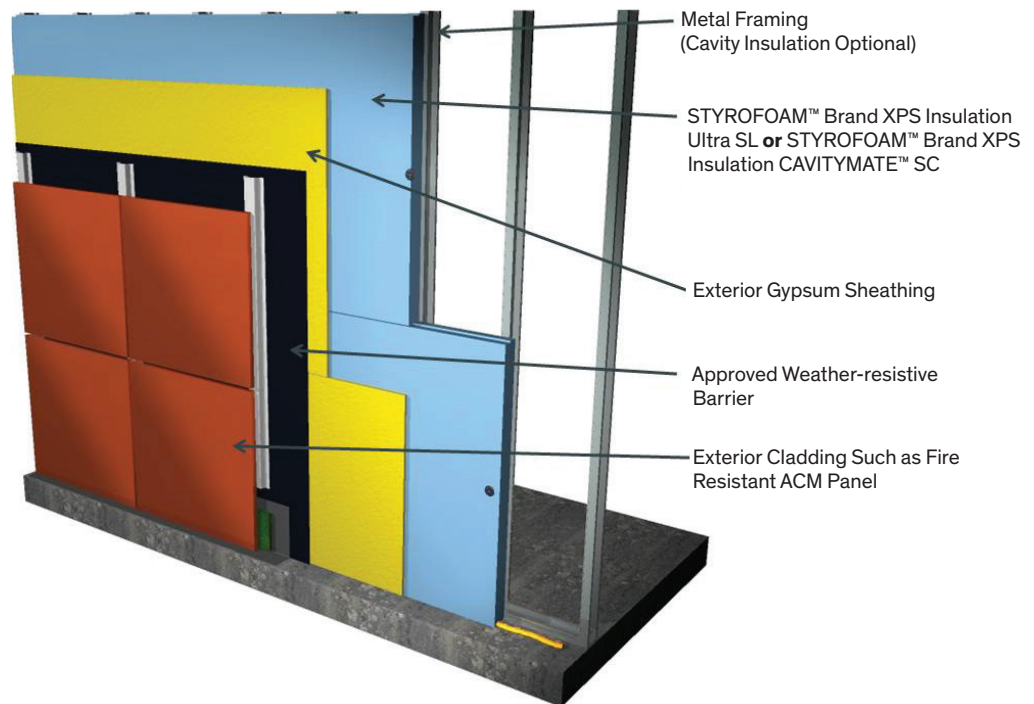




The Use of STYROFOAM™ Brand Insulation in the Commercial Inverted Wall Assembly

This commercial assembly addresses the needs of all building envelope requirements:

- Fire performance (NFPA 285)
- Continuous Insulation/ Thermal efficiency
- Weather-resistive barrier (WRB)
- Durability/security
- Air barrier with appropriate detailing with the WRB



General Description

The Inverted Wall Assembly is a new configuration of a well established exterior commercial wall design. For over 45 years, designers and architects have used STYROFOAM™ Brand XPS Insulation, an exterior insulating sheathing for metal frame curtain wall design, with many exterior claddings including stucco, brick and ACM Panels. The standard curtain wall design starts with a layer of exterior gypsum sheathing attached to the metal framing followed by a weather-resistive barrier, a layer of STYROFOAM™ Brand XPS Insulation, and lastly, the exterior cladding attached over both sheathing layers. This provides architects with the structural, durable, fire-resistant performance they expect from the gypsum and the superior energy savings, moisture management and moisture protection they desire from STYROFOAM™ Brand XPS Insulation.

This long-used assembly, now reconfigured as the STYROFOAM™ Inverted Wall Assembly, meets the NFPA 285 fire test. The layers are rearranged to attach STYROFOAM™ Brand XPS Insulation directly to the metal framing and then gypsum sheathing is attached over the insulation. An approved weather-resistive barrier (see Jensen-Hughes Engineering Judgment letter “Exterior Wall Analysis – Use of Gypsum Sheathing Over XPS Insulation in NFPA 285 Complying Wall Assemblies”) is then applied over the gypsum sheathing.

The assembly extends the number of veneers, including fire sensitive claddings like ACM panels, which can be used to comply with the NFPA 285 acceptance criteria as required by the building code. The design methodology for the attachment of gypsum sheathing, furring systems and exterior cladding systems through foam sheathing is well understood and documented in Section 2603.12 of the 2015 International Building Code (IBC). This is an important facilitator to achieving and complying with continuous insulation requirements of the IBC. The basic wall design, with the exterior cladding over gypsum sheathing and STYROFOAM™ Brand XPS Insulation on metal wall framing, is shown in Figure 1.

Contact your building envelope expert at Dow to access the wall assembly details and component options provided in the Jensen-Hughes Engineering Judgment letter “Exterior Wall Analysis – Use of Gypsum Sheathing Over XPS Insulation in NFPA 285 Complying Wall Assemblies.”

Approved STYROFOAM™ Brand XPS Insulation Products

STYROFOAM™ Brand Ultra SL

R-value at 75F mean temp ASTM C518/ ASTM C578	R-12	2.18"	Superior Energy Savings
	R-14	2.5"	
	R-16.8	3"	
Water Resistance ASTM C272	0.3% max.		Wall durability
Edge Detail	Ship-lap edge on long side		Energy efficiency & resist moisture intrusion

STYROFOAM™ Brand Square Edge Wide

R-value at 75F mean temp ASTM C518/ ASTM C578	R-5.0	1"	Energy Savings
	R-7.5	1.5"	
	R-10	2"	
Water Resistance ASTM C272	0.3% max.		Wall durability
Edge Detail	Ship-lap edge on long side		Energy efficiency & resist moisture intrusion

It is important to consider minimizing the total number of fasteners used to attach the insulation and gypsum sheathing to ensure optimal thermal efficiency.

Wall Assembly Guide

Project sequencing is important to limit the exposure of STYROFOAM™ Brand XPS Insulation to a maximum of 90 days before covering with gypsum sheathing. The gypsum sheathing and weather-resistive barrier layers should not be exposed longer than manufacturer recommendations.

Substrate Preparations

Steel framing shall be designed, installed and braced per manufacturer requirements. Maximum steel stud spacing for this commercial wall assembly is 24" oc.

The installation of STYROFOAM™ Brand XPS Insulation, gypsum sheathing, furring system and wall cladding can begin once the metal wall framing and bracing have been installed. Consideration should be given to construction sequencing to minimizing the number of fasteners used to fasten STYROFOAM™ Brand XPS Insulation and gypsum sheathing to minimize thermal shorts.

The design methodology for the attachment of exterior claddings through foam sheathings is well understood and can comply with the IBC. This document summarizes the minimum fastening requirements when attaching exterior claddings, furring systems and gypsum sheathing over STYROFOAM™ Brand XPS Insulation on steel wall framing. This is an important enabler to achieving and complying with continuous insulation requirements.

Attachment of STYROFOAM™ Brand XPS Insulation

STYROFOAM™ Brand XPS Insulation shall be positioned horizontally or vertically with the metal framing. Use corrosion resistant self-tapping screws with washers such as the Rodenhouse Grip-Deck self-drilling screw with PlastiGrip or Thermal-Grip washers. See manufacturer's recommendations on specific fastener size for the thickness of STYROFOAM™ to be installed.

It is important to consider minimizing the total number of fasteners used to attach the insulation and gypsum sheathing to ensure optimal thermal efficiency. The number of fasteners is based on wall installation sequencing and local weather conditions expected during the wall construction process. STYROFOAM™ Brand XPS Insulation need only be fastened with the minimum number of fasteners to hold it in place until the gypsum sheathing is installed. If the elapsed time between insulation installation and gypsum installation is sufficiently brief and weather conditions are sufficiently mild, as determined by Project Construction Management, STYROFOAM™ Brand XPS Insulation may be installed with as few as 5 fasteners, one in each corner and one in the middle of the board along a stud line. The gypsum sheathing should be installed before weather conditions arise that would require additional securement for the STYROFOAM™ Brand XPS Insulation boards. Where weather conditions cannot be predicted, 4'x8' boards of STYROFOAM™ Brand XPS Insulation should be installed with fasteners 12"oc around the perimeter of the wall and 16"oc in the field of the wall. Fasteners should be set back 3/8" from edges and ends of the insulation boards.

Attachment of the Gypsum Sheathing

For NFPA 285 compliant assemblies with fire sensitive veneers, 5/8" Type X gypsum sheathing is required to be installed over the STYROFOAM™ Brand XPS Insulation. The fastening of the gypsum sheathing shall be per manufacturer's recommendations. Again, it is important to consider minimizing the total number of fasteners used to attached the gypsum sheathing and furring/cladding attachment systems for optimum thermal efficiency. In many cases a metal furring or metal cladding attachment system will be installed over the gypsum sheathing with a defined fastening pattern required to meet structural and attachment requirements for the exterior cladding. All fasteners used for gypsum sheathing, furring and cladding attachment systems should be securely fastened back to the metal framing structure as per manufacturer recommendations. When furring or cladding attachment systems are used, Project Construction Management may determine if conditions allow the fastening pattern of the gypsum sheathing to be reduced with the subsequent required fasteners used to secure the furring/cladding attachment system.

The design requirements for the attachment of gypsum sheathing, furring and exterior claddings over foam sheathing on steel wall framing is specifically addressed in Section 2603.12 of the 2015 IBC. The design methodology is also documented in the Dr. J Engineering Technical Evaluation Report TER No. 1303-04 "Attachment of Exterior Wall Coverings Through Foam Plastic Insulating Sheathing (FPIS) to Wood or Steel Wall Framing" (<http://www.drjcertification.org/content/3/attachment-exterior-wall-coverings-through-foam-plastic-insulating-sheathing-fpis-wood-or>).

Application of Weather-Resistive Barrier (WRB)

Install the Weather-Resistive Barrier (WRB) as per manufacturer recommendations over the gypsum sheathing. Where required as an Air Barrier, follow manufacturer recommendations on sealing details.

Attachment of Furring and/or Cladding Attachment Systems

Install metal furring or metal cladding attachment systems over the WRB covered gypsum sheathing as per manufacturer recommendations. All fasteners used for metal furring and metal cladding attachment systems should be securely fastened back to the metal framing structure as per manufacturer recommendations. The design requirements for the attachment of metal furring, metal cladding attachment systems and exterior claddings over foam sheathing on steel wall framing are specifically addressed in Section 2603.12 of the 2015 IBC. The design methodology is also documented in the Dr. J Engineering Technical Evaluation Report TER No. 1303-04 "Attachment of Exterior Wall Coverings Through Foam Plastic Insulating Sheathing (FPIS) to Wood or Steel Wall Framing" (<http://www.drjcertification.org/content/3/attachment-exterior-wall-coverings-through-foam-plastic-insulating-sheathing-fpis-wood-or>).

The 2015 IBC design table for attaching metal furring for exterior cladding over foam plastics is provided below:

IBC Table 2603.12.2 Furring Minimum Fastening Requirements for Application Over Foam Plastic Sheathing to Support Cladding Weight^a

Furring Material	Steel Framing Thickness	Fastener Type and Maximum Size ^b	Fastener Spacing in Furring (inches)	Maximum Thickness of Foam Sheathing ^c (inches)					
				16" oc furring ^d			24" oc furring ^d		
				Cladding Weight			Cladding Weight		
				3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Minimum 33 mil steel furring	33 mil steel stud	#8 screw	12	3	1.5	DR	3	0.5	DR
			16	3	1	DR	2	DR	DR
			24	2	DR	DR	2	DR	DR
		#10 screw	12	4	2	DR	4	1	DR
			16	4	1.5	DR	3	DR	DR
			24	3	DR	DR	2	DR	DR
	43 mil steel stud	#8 screw	12	3	1.5	DR	3	0.5	DR
			14	3	1	DR	2	DR	DR
			24	2	DR	DR	2	DR	DR
		#10 screw	12	4	3	1.5	4	3	DR
			16	4	3	0.5	4	2	DR
			24	4	2	DR	4	0.5	DR

^a Steel furring shall be minimum 33 ksi steel. Steel studs shall be minimum 33 ksi steel for 33 mil thickness and 50 ksi steel for 54 mil steel or thicker.

^b Screws shall comply with AISI S200. Minimum penetration into steel framing is steel thickness plus 3 threads.

^c Foam sheathing shall have a minimum compressive strength of 15 pounds per square inch in accordance with ASTM C578.

^d Furring shall be spaced not more than 24 inches on center, in vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In horizontal orientation, the indicated 8-inch and 12-inch fastener spacing in furring shall be achieved by the use of two fasteners in studs at 16 inches and 24 inches on center, respectively.

DR = Design required.

Exterior Cladding Attachment

Attach the exterior cladding back to the metal furring, metal cladding attachment system or metal framing per manufacturer recommendations. The design methodology for the attachment of metal furring, metal cladding attachment systems and exterior claddings over foam sheathing on steel wall framing is specifically addressed in Section 2603.12 of the 2015 IBC. The design methodology is also documented in the Dr. J Engineering Technical Evaluation Report TER No. 1303-04 "Attachment of Exterior Wall Coverings Through Foam Plastic Insulating Sheathing (FPIS) to Wood or Steel Wall Framing" (<http://www.drjcertification.org/content/3/attachment-exterior-wall-coverings-through-foam-plastic-insulating-sheathing-fpis-wood-or>).

The 2015 IBC design table for attaching exterior cladding over foam plastics is provided below:

Design Example # 1 of Exterior Cladding Attachment Over Foam Sheathing Using IBC Section 2603.12 (Determine Metal Furring Fastener Type and Size)

Step 1. Define the wall assembly component and cladding weights:

Wall Components	Example Assumptions
Steel Framing:	2X4 18ga (0.043 inch thick) steel wall framing 24" o.c.
STYROFOAM™ Brand CAVITYMATE™ Ultra Insulation (R-16.8) Thickness:	3"
Gypsum Sheathing:	5/8" DensGlass Sheathing (2.2psf)
Weather Resistive Barrier (WRB):	Barritech VP at 40 mil dry film thickness (0.4psf)
Furring System:	Knight CI System Rain Screen Attachment (1.5psf) (18ga 0.0475 inch thick)
Cladding Material:	FR ACM panels (1.6 psf)

Step 2. Define the total cladding weight on the exterior side of the foam insulation:

1. Gypsum Sheathing	2.2 psf
2. Barritech VP	0.4 psf
3. KWS furring	1.5 psf
4. ACM panel cladding	1.6 psf
Total Weight	5.7 psf

Step 3. Determine fastener minimum size and spacing for furring using:

- 0.0475" 18ga (0.048 mil) Knight Wall System CI metal furring
- 18ga 0.043 mil steel framing 24" oc
- 4-1/2" #10 screw Rodenhouse Grip-Deck (Fastener length: 3" STYROFOAM™ + 5/8" gypsum sheathing + WRB + furring thickness + steel stud penetration)
- Metal furring on 24" oc
- 5.7 psf cladding weight (round up to 11 psf)
- 3" thick STYROFOAM™ Brand Ultra SL Insulation (R-16.8)



Use the 2015 IBC Table 2603.12.2 “Furring Minimum Fastening Requirements for Application Over Foam Plastic Sheathing to Support Cladding Weight” to determine spacing of metal furring:

IBC Table 2603.12.2 Furring Minimum Fastening Requirements for Application Over Foam Plastic Sheathing to Support Cladding Weight

Furring Material	Steel Framing Thickness	Fastener Type and Maximum Size	Fastener Spacing in Furring (inches)	Maximum Thickness of Foam Sheathing (inches)					
				16" oc furring			24" oc furring		
				Cladding Weight			Cladding Weight		
				3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Minimum 33 mil steel furring	33 mil steel stud	#8 screw	12	3	1.5	DR	3	0.5	DR
			16	3	1	DR	2	DR	DR
			24	2	DR	DR	2	DR	DR
		#10 screw	12	4	2	DR	4	DR	DR
			16	4	1.5	DR	3	DR	DR
			24	3	DR	DR	2	DR	DR
	43 mil steel stud	#8 screw	12	3	1.5	DR	3	0.5	DR
			16	3	1	DR	2	DR	DR
			24	2	DR	DR	2	DR	DR
		#10 screw	12	4	3	1.5	4	3	DR
			16	4	3	0.5	4	2	DR
			24	4	2	DR	4	0.5	DR

* Screw shall comply with AISI S200. Minimum penetration into steel framing is steel thickness plus 3 threads.
DR = Design required.



Design Example #2 of Exterior Cladding Attachment Over Foam Sheathing Using IBC Section 2603.12
(Determine Maximum STYROFOAM™ Brand CAVITYMATE™ Ultra Thickness)

Step 1. Define the wall assembly component and cladding weights:

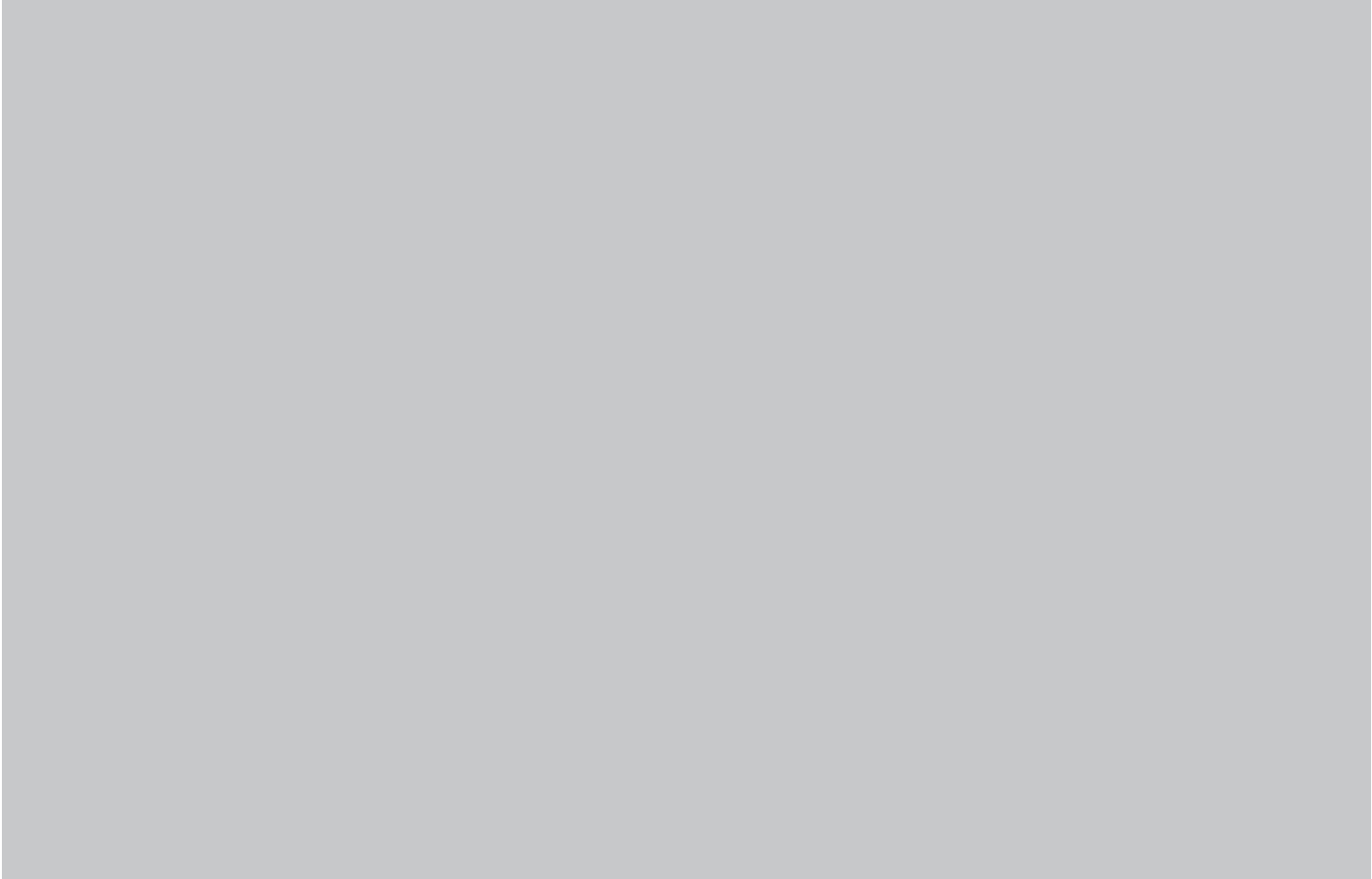
Wall Components	Example Assumptions
Steel Framing:	2X4 20ga (0.033 inch thick) steel wall framing 16" oc
STYROFOAM™ Brand Ultra SL insulation (R- 16.8) Thickness:	Maximum to be determined
Gypsum Sheathing:	5/8" DensGlass Sheathing (2.2 psf)
Weather Resistive Barrier (WRB):	Barritech VP at 40 mil dry film thickness (0.4 psf)
Furring System:	Knight CI System Rain Screen Attachment (1.5 psf) (18ga 0.0475" thick)
Cladding Material:	FR ACM panels (1.6 psf)

Step 2. Determine the total cladding weight on the exterior side of the foam insulation:

1. Gypsum Sheathing	2.2 psf
2. Barritech VP	0.4 psf
3. KWS furring	1.5 psf
4. ACM panel cladding	1.6 psf
Total Weight	5.7 psf

Step 3. Determine maximum STYROFOAM™ Brand XPS Insulation thickness and furring fastener Type and Spacing using:

- 0.0475" 18ga (0.048 mil) Knight Wall System CI metal furring
- 20ga 0.033 mil steel framing 16" oc
- Metal furring on 16" oc
- 5.7 psf cladding weight (round up to 11 psf)



Use the IBC Table 2603.12.2 “Furring Minimum Fastening Requirements for Application Over Foam Plastic Sheathing to Support Cladding Weight” to determine spacing of metal furring:

IBC Table 2603.12.2 Furring Minimum Fastening Requirements for Application Over Foam Plastic Sheathing to Support Cladding Weight

Furring Material	Steel Framing Thickness	Fastener Type and Maximum Size	Fastener Spacing in Furring (inches)	Maximum Thickness of Foam Sheathing (inches)					
				16" oc furring			24" oc furring		
				Cladding Weight			Cladding Weight		
				3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Minimum 33 mil steel furring	33 mil steel stud	#8 screw	12	3	1.5	DR	3	0.5	DR
			16	3	1	DR	2	DR	DR
			24	2	DR	DR	2	DR	DR
		#10 screw	12	4	2	DR	4	1	DR
			16	4	1.5	DR	3	DR	DR
			24	3	DR	DR	2	DR	DR
	43 mil steel stud	#8 screw	12	3	1.5	DR	3	0.5	DR
			16	3	1	DR	2	DR	DR
			24	2	DR	DR	2	DR	DR
		#10 screw	12	4	3	1.5	4	3	DR
			16	4	3	0.5	4	2	DR
			24	4	2	DR	4	0.5	DR

* Screw shall comply with AISI S200. Minimum penetration into steel framing is steel thickness plus 3 threads.
DR = Design required.

Product Warranty

In the United States, a 50-year thermal limited warranty is available on STYROFOAM™ Brand XPS Insulation products 1.5 inches and greater. For thickness less than 1.5 inches, other warranties may apply. Warranties are available as described at www.dowbuildingsolutions.com

Knight Wall CI System metal furring must be attached back to steel framing 12" oc with 4-1/2" Rodenhouse #10 screws.

Maximum thickness of STYROFOAM™ Brand XPS Insulation (2 inches) can be achieved using 4.5" Rodenhouse Grip-Deck #10 screws spaced 12"oc along the metal furring.

The Dow Chemical Company

Building Solutions
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Technical Information: 1-866-583-BLUE (2583)
Sales Information: 1-800-232-2436

dowbuildingsolutions.com

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STYROFOAM™ Brand Extruded Polystyrene Foam Insulation

CAUTION: This product is combustible. Protect from high heat sources. A protective barrier or thermal barrier may be required as specified in the appropriate building code. For more information, consult (M)SDS, call Dow at 1-866-583-BLUE (2583) or contact your local building inspector. In an emergency, call 1-989-636-4400 in the U.S. or 1-519-339-3711 in Canada.

Water-Resistive Barrier

NOTICE: Changes to the International Residential Code require the installation of a water-resistive barrier (WRB) within most exterior wall assemblies in residential construction. The following Dow insulated sheathing products qualify as a WRB when installed according to the installation instructions developed for "installation of foam sheathing as a weather-resistive barrier": STYROFOAM™ DURAMATE™ Plus, STYROFOAM™ Residential Sheathing, STYROFOAM™ Tongue and Groove, STYROFOAM™ Square Edge, STYROFOAM™ Residing Board, THERMAX™ Sheathing, TUFF-R™ and Super TUFF-R™ and therefore do not require the use of a building paper or a housewrap as a WRB. When a WRB is not needed, these Dow foam sheathings may be installed according to standard installation instructions for foam sheathing from Dow. Be sure products and installation instructions meet code requirements for your particular location. Note: WEATHERMATE™ and WEATHERMATE™ Plus Housewraps have already qualified as water-resistive alternatives to the prescribed felt (see Evaluation Reports NER-593 and NER-640 for approved alternative).

Building and/or construction practices unrelated to building materials could greatly affect moisture and the potential for mold formation. No material supplier including Dow can give assurance that mold will not develop in any specific system.

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