



Technical Evaluation Report

TO ASSIST WITH CODE COMPLIANCE

Prescriptive Wind Pressure Performance of Foam Plastic Insulation Used as Insulating Sheathing in Exterior Wall Covering Assemblies

TER No. 1006-01

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Updated: October 10, 2011

Foam Sheathing Committee (FSC) Members

Atlas Roofing Corporation – www.atlasroofing.com

Dow Chemical Company – www.dow.com

Johns Manville – www.jm.com

Owens Corning – www.owenscorning.com

Rmax Operating, LLC – www.rmaxinc.com

Division: 06 – WOOD AND PLASTICS

Section: 06160 – Sheathing

Division: 07 – THERMAL AND MOISTURE PROTECTION

Section: 07210 – Building Insulation

1. Product Lines Evaluated:

1.1. FPIS Products Evaluated – Manufacturer's "Trade Names":¹

1.1.1. Polyisocyanurate Products (Polyiso) – Type 1², ASTM C1289

1.1.1.1. Atlas Roofing Corporation – "Energy Shield"[®]
2000 River Edge Parkway, Suite 800
Atlanta, GA 30328
800/388-6134

1.1.1.2. Dow Chemical Company – "Super TUFF-R"[™] and "THERMAX"[™]
200 Larkin Center
1605 Joseph Drive
Midland, MI 48674
989/638-8655

1.1.1.3. Rmax Operating, LLC – "R-Matte"[®] Plus-3" and "Thermasheath"[®]-3"
13524 Welch Road
Dallas, TX 75244
972/387-4500

1.1.2. Expanded Polystyrene (EPS) – Type II³, ASTM C578

1.1.2.1. Atlas Roofing Corporation – "Falcon Foam"[®]
2000 River Edge Parkway, Suite 800
Atlanta, GA 30328
800/388-6134

¹ FPIS Types listed in this TER are minimums. Substitution of products with equal or greater performance shall be permitted in accordance with [Section 6.2](#).

² As defined in ASTM C1289, Type 1 products are those that are faced with aluminum foil on both major surfaces of the core foam.

³ See [Appendix A](#) for material properties of Type II and Type X FPIS products.

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1.1.3. Extruded Polystyrene (XPS) – Type X⁴, ASTM C578

1.1.3.1. Dow Chemical Company – “STYROFOAM™”
1605 Joseph Drive
Midland, MI 48674
989/638-8655

1.1.3.2. Owens Corning – “FOAMULAR®”
One Owens Corning Pkwy.
Toledo, OH 43659
419/248-8315

2. Scope of Evaluation:

- 2.1. Items considered within the scope of this TER ([Section 1](#)) were evaluated for compliance with the following building codes
 - 2.1.1. 2003, 2006 and 2009 *International Building Code (IBC)*
 - 2.1.2. 2003, 2006 and 2009 *International Residential Code (IRC)*
- 2.2. The wind pressure resistance performance of FPIS products listed in [Section 1](#) were evaluated for use as part of an exterior wall covering assembly in accordance with the following code sections:
 - 2.2.1. 2009 *IRC* Sections [R104.11](#), [R703.1.2](#), [R703.4](#) and [Table R703.4](#)
 - 2.2.2. 2009 *IBC* Section [104.11](#), [1404.8](#)
 - 2.2.3. 2006 *IRC* Section [R104.11](#), [R703.4](#) and [Table R703.4](#)
 - 2.2.4. 2006 *IBC* Section [104.11](#) and [1404.8](#)
 - 2.2.5. 2003 *IRC* Section [R104.11](#), [R703.4](#) and [Table R703.4](#)
 - 2.2.6. 2003 *IBC*, Section [104.11](#) and [1404.8](#)
- 2.3. This TER evaluates only the wind pressure resistance performance of the foam plastic insulating sheathing (FPIS) products listed herein ([Section 1](#)) for use as exterior wall sheathing in exterior wall covering assemblies in compliance with the building codes listed in [Section 2](#).
- 2.4. This TER is limited to exterior applications where the FPIS product is used as an exterior wall sheathing that is required to resist transverse wind loading only.
 - 2.4.1. The wind pressure requirements of this TER do not apply to FPIS products when used as over-sheathing⁵ on light-frame, masonry, or concrete exterior walls.
 - 2.4.2. The wind pressure requirements of this TER do not apply to FPIS products, including composites or laminates, that are intended to provide structural functions in addition to transverse wind load resistance of a wall assembly, such as in-plane racking shear resistance (wall bracing), in-plane uplift resistance, and buckling restraint of studs or columns.
 - 2.4.3. This TER does not address wind pressure resistance requirements for FPIS products used as part of an Exterior Insulation Finish System (EIFS). Refer to the EIFS manufacturer’s installation instructions for building code compliance.
- 2.5. FPIS products addressed in this TER shall comply with the material standards listed in [Section 3](#) and shall be applied to exterior wall construction in accordance with the general requirements of [Section 4](#) as well as the prescriptive wind pressure resistance requirements of [Section 5](#).
- 2.6. FPIS products used in accordance with this TER and required to resist wind pressure in exterior wall covering assemblies shall also comply with the quality control requirements of [Section 6](#), the product marking requirements of [Section 7](#), and the conditions of use listed in [Section 8](#).

⁴ See [Appendix A](#) for material properties of Type II and Type X FPIS products.

⁵ Over-sheathing definition. As used in this TER, Over-sheathing refers to the use of FPIS product in a wall assembly where the FPIS is installed over a code-compliant solid concrete/masonry wall or a sheathing material capable of resisting the code required design wind pressure on a light-frame wall. In addition, cladding is separately installed over foam sheathing in accordance with Section 5.2. An over-sheathing application of foam sheathing does not require that the foam sheathing resist wind pressure in accordance with this TER.

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3. Material Standards, Product Description, and Availability:

- 3.1. FPIS products listed in [Section 1](#) and used in accordance with this TER shall comply with the following material standards:
 - 3.1.1. Expanded polystyrene (EPS) manufactured in compliance with [ASTM C578](#)
 - 3.1.2. Extruded polystyrene (XPS) manufactured in compliance with [ASTM C578](#)
 - 3.1.3. Polyisocyanurate (Polyiso) manufactured in compliance with [ASTM C1289](#)
- 3.2. FPIS products are produced under proprietary manufacturing processes and are formed into rigid insulation panels.
- 3.3. EPS and XPS Foam Plastic Sheathing complying with [ASTM C578](#) are used with:
 - 3.3.1. No facings
 - 3.3.2. Facings on one side
 - 3.3.3. Facings on both sides
- 3.4. Polyiso Foam Plastic Sheathing complying with [ASTM C1289](#) must have facings on both sides.
- 3.5. FPIS products are typically available in the following sizes:
 - 3.5.1. Thicknesses range from ½" to 6".
 - 3.5.2. The standard product width is 48".
 - 3.5.3. Standard lengths include 96", 108" and 120".
- 3.6. Consult manufacturer for availability of product with non-standard width or length.

4. General Requirements:

- 4.1. Minimum Installation Requirements for Foam Plastic Sheathing Products Listed in [Section 1](#) When Applied to Light-Frame Wall Framing Members
 - 4.1.1. Light-frame wood framing members supporting FPIS products shall have a nominal thickness of not less than 2" (1.5" actual).
 - 4.1.2. Light-frame steel framing members shall have a flange width of not less than 1-½" (including bend radius at web and lip).
 - 4.1.3. Framing members shall be spaced a maximum of 24" o.c.
 - 4.1.3.1. FPIS products shall be attached to the wall framing in accordance with the manufacturer's installation instructions
 - 4.1.3.2. All sheathing edges shall be supported by wall framing or blocking. Blocking at horizontal sheathing joints located between the top and bottom plates of a wall shall not be required when it is determined to be unnecessary through evaluation in accordance with [Section 6](#).

4.2. Cladding Installation

- 4.2.1. Wind pressure rating adjustments for vinyl siding installed directly over FPIS shall comply with [Section R703.11.2](#) of the *IRC* for buildings constructed under the *IRC* or *IBC*.
- 4.2.2. Cladding installation and fastening through foam sheathing shall comply with the applicable building code and the cladding manufacturer's installation instructions. The minimum fastener size shall be capable of supporting the cladding weight when cantilevering through a layer of FPIS. Refer to [Section 10.4](#) for guidance on minimum fastener size to support cladding weight based on thickness of FPIS and the method of cladding installation.
- 4.3. Wall assemblies that include FPIS and that are intended to serve as part of the lateral force resisting system of a structure shall be braced to resist the in-plane shear force in accordance with [Section R602.10](#) of the *IRC*, [Section 2308.9.3](#) of the *IBC*, or a design in accordance with [Section 301](#) of the *IRC* or Section 2305 of the *IBC*, as applicable.
- 4.4. Wall assemblies with FPIS attached to gravity load supporting members (i.e., studs) that require buckling restraint in a direction parallel to the plane of the wall shall have such restraint provided by other suitable materials. Wall assemblies shall be designed with an effective buckling length equal to the length of the member between points of lateral support provided by attachment to other building assemblies.

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5. Wind Pressure Requirements for FPIS:

5.1. General

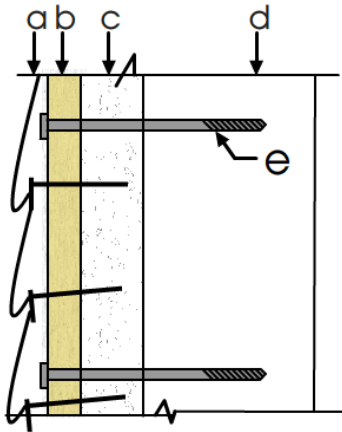
5.1.1. When fastened directly to light-frame wall members (i.e., studs), FPIS products listed in [Section 1](#) shall comply with the prescriptive requirements of [Section 5.2](#).

5.1.1.1. Alternatively, manufacturers listed in [Section 1](#) shall be permitted to qualify specific FPIS products in accordance with *IBC* [Section 104.11](#), *IRC* [Section R104.11](#), [ASTM C578](#) and [ASTM C1289](#), as applicable.

5.2. Prescriptive Requirements

5.2.1. The minimum thickness of foam plastic sheathing products listed in [Section 1](#) shall comply with [Table 1](#), for one of the following two conditions:

5.2.1.1. Where a code-compliant cladding system is installed over but not directly on the surface of the FPIS such that there is a space between the FPIS and the cladding (e.g., furring is used over the FPIS product as shown in [Figure 1](#)), the components and cladding design negative wind pressure determined in accordance with [Section R301.2](#) of the *IRC* or [Section 1609.6](#) of the *IBC* shall not exceed the allowable wind pressure value of the FPIS product in accordance with [Table 1](#).



Exterior Wall Covering Assembly:

- a – Cladding material and fasteners
- b – Wood furring (which battens FPIS to wall framing and creates an airspace between the FPIS and the cladding); furring sized to provide adequate substrate for cladding attachment.
- c – Foam Plastic Insulated Sheathing
- d – Wall framing per code (i.e., wood or steel studs)
- e – Furring fastener by design and with minimum size to support cladding weight (see 10.4)

Figure 1: Exterior Wall Covering Assembly Using Furring

NOTE: For example, in the *IRC* [Table R301.2\(2\)](#) shows the negative pressure for components and cladding in 90 MPH, Exposure B, Zone 5 and an effective area of 10 square feet as 19.5 psf. Where furring is used as shown in [Figure 1](#), the allowable value shown in [Table 1](#) must be greater than 19.5. Thus, for 16" o.c. framing and an interior finish as described in [Table 1](#), any of the products listed could be used. If there is not an interior finish, any of the products listed could be used except for the $\frac{3}{4}$ " EPS and $\frac{3}{4}$ " XPS. This example is specific to the products tested and listed in [Section 1](#). Any individual product may be tested to show compliance with the required design wind pressure.

5.2.1.2. Where the foam plastic sheathing is directly constrained by a code-compliant cladding material (i.e., no gap between the cladding and FPIS), as shown in [Figure 2](#), the components and cladding design positive wind pressure determined in accordance with [Table R301.2\(2\)](#) of the *IRC* or [Section 1609.6](#) of the *IBC* shall not exceed the allowable wind pressure value of the FPIS product in accordance with [Table 1](#).

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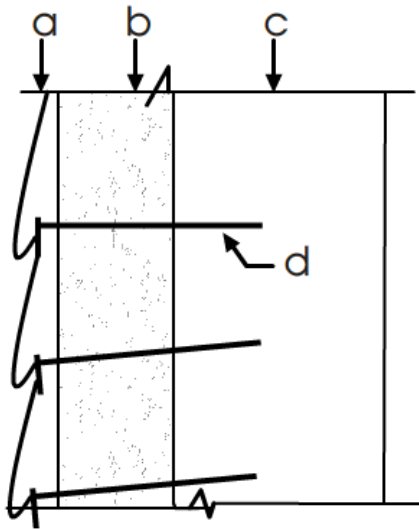


Figure 2: Exterior Wall Covering Assembly – Cladding Attached Directly through Foam Sheathing

Exterior Wall Covering Assembly:

- a – Cladding material.
- b – Foam Plastic Insulated Sheathing
- c – Wall framing per code (i.e., wood or steel studs)
- d – Cladding fastener per code and of minimum size to support cladding weight (see 10.4)

NOTE: For example, in the *IRC Table R301.2(2)* shows the positive pressure for components and cladding in 90 MPH, Exposure B, 90, Zone 5 and an effective area of 10 square feet as 14.6 psf. Where the cladding is attached directly to the framing through the foam sheathing layer as shown in [Figure 2](#), the allowable value shown in [Table 1](#) must be greater than 14.6. Thus, for 16" o.c. framing with or without an interior finish as described in [Table 1](#), any of the products listed could be used, because they exceed the 14.6 psf value.

FPIS Material ⁴	FPIS Thickness (in)	Allowable Design Wind Pressure Resistance (psf)			
		Walls with Interior Finish ⁵		Walls without Interior Finish	
		16" o.c. framing	24" o.c. framing	16" o.c. framing	24" o.c. framing
EPS (Type II, ASTM C578)	¾"	21.8	NP	NP	NP
	1"	38.8	19.4	27.2	NP
	≥1-½"	89.0	39.5	62.3	27.7
Polyiso (Type 1, ASTM C1289)	½"	33.3	NP	23.3	NP
	¾"	56.4	25.1	39.5	17.6
	1"	67.5	30.0	47.2	21.0
	≥1-½"	77.4	34.4	54.1	24.1
XPS (Type X, ASTM C578)	½" ⁴	28.3 ⁴	NP	19.8 ⁴	NP
	¾"	21.4	NP	NP	NP
	1"	38.0	29.0	26.6	20.3
	≥1-½"	78.2	34.7	54.7	24.3

For SI: 1 inch = 25.4 mm, 1 pound per square foot (psf) = 0.0479 kPa.

Table Notes:

- Linear interpolation shall not be permitted.
- Tabulated resistance values apply to positive and negative wind pressure design loads as applicable.
- NP = not permitted (allowable design wind pressure less than 17.4 psf)
- Facers are permissible for EPS and XPS products manufactured in accordance with ASTM C578. For ½" XPS, the values in [Table 2](#) are based on use of polymeric film facers although facers are not required for FPIS products that meet the requirements of [Section 6](#) without the use of facers. The values for all other thicknesses of XPS and all EPS thicknesses shown in [Table 2](#) are based on the absence of any facer, although facers may be used for FPIS products provided the requirements of [Section 6](#) are satisfied with the use of facers. Polyiso products are required to have facers in accordance with ASTM C1289.
- Interior finish material shall be minimum ½"-thick gypsum wall board complying with ASTM C1396 and installed in accordance with the locally applicable building code.

Table 1: Allowable Design Wind Pressure Resistance for FPIS Products in Exterior Wall Covering Assemblies ^{1,2,3}

User Note: The allowable design wind pressure resistance values in [Table 2](#) apply only to the FPIS product's ability to resist bending load from wind pressure. Other components such as siding and framing or connections may limit the design wind pressure resistance of the exterior wall or exterior wall covering assembly.

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5.2.1.3. FPIS material types ([Section 1](#)) addressed in [Table 1](#) shall be permitted to be substituted with other types of FPIS material having equal or greater flexural strength as indicated in ASTM C578 or ASTM C1289. This is permitted provided, if facers are included, the facers on the substituted type of FPIS are not different than those used on the product listed in [Section 1](#).

NOTE: For example ASTM C578, [Table 1](#) shows the required flexural strength of Type II EPS as 35 psi; a Type IX EPS could be substituted since it has a minimum flexural strength of 50 psi, provided any facers used are the same as the Type II product. Similar substitutions can be made for XPS per [Table 1](#) in ASTM C578 or for Polyiso per [Table 1](#) of ASTM C1289.

5.2.2. For FPIS products of the same material type but with thicknesses greater than the maximum thickness addressed in [Table 1](#) ($1\frac{1}{2}$ "), the values for $1\frac{1}{2}$ " thickness shall be permitted to be used provided, if facers are included, the facer on the thicker FPIS product is not less structural than that used on the thinner FPIS product.

5.2.3. FPIS panels addressed in [Table 1](#) shall be permitted to be oriented with length dimension parallel or perpendicular to wall framing members. When perpendicular to framing members, horizontal joints shall be supported by blocking, unless use of unblocked joints are qualified in accordance with [IBC Section 104.11](#), [IRC Section R104.11](#), [ASTM C578](#) and [ASTM C1289](#), as applicable.

5.2.4. All FPIS products listed in [Table 1](#) shall be permitted to have facers, but facers shall not be required, except for:

5.2.4.1. Polyiso FPIS shall have a facer on both sides in accordance with [ASTM C1289](#).

5.2.4.2. $\frac{1}{2}$ " XPS shall be faced on both sides.

6. Quality Control Requirements:

6.1. FPIS products listed in [Section 1](#) and used as exterior wall sheathing in accordance with [Section 2](#) shall be produced under a quality assurance program administered by an approved agency. An approved quality assurance manual shall be developed in collaboration with the approved agency. The quality assurance manual shall specify quality assurance testing and process control requirements in accordance with [Section 6.2](#).

6.2. FPIS products shall be periodically sampled and tested by an approved agency to assess compliance with the appropriate representative minimum quality control flexural strength value listed in [Table 2](#). Quality control inspection tests shall be conducted in accordance with [Section 6.2.1](#).

6.2.1. Six specimens from a minimum of three sampled FPIS panels shall be tested in accordance with ASTM C203 Method 1, Procedure D for each condition in Section 6.2.1.1 through 6.2.1.3 as required. The displacement rate of the applied bending load shall be 0.625" per minute. The test specimen shall be full thickness with facings (if any) intact. The span-to-thickness ratio shall be 10. The width of the specimen shall be one-third of the span, but not less than 3". The flexural strength (maximum fiber stress) at mid-span shall be determined for each specimen using the maximum applied load (force) for mid-span deflections not exceeding one-fifth of the span or 1.6", whichever is less. The least maximum flexural strength value from the six specimens shall be taken as the inspection flexural strength value and shall meet or exceed the appropriate reference (representative minimum) quality control flexural strength value shown in Table 2.

6.2.1.1. For all FPIS products, specimens with their length dimension corresponding to the cross (width) dimension of the sampled FPIS product shall be evaluated in accordance with [Section 6.2.1](#) with the back-side of the FPIS panel specimen under tension.

6.2.1.2. For all FPIS products, specimens with their length dimension corresponding to the length dimension of the sampled FPIS product shall be evaluated in accordance with Section 6.2.1 with the back-side of the FPIS panel specimen under tension.

6.2.1.3. For FPIS products with different facers on each side, the test conditions indicated in [Sections 6.2.1.1](#) and [6.2.1.2](#) shall be repeated with the front (opposite) side of the FPIS panel specimen under tension.

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FPIS Material	Sheathing Thickness (in.)	Maximum Fiber Stress (psi)
EPS (ASTM C578, Type II)	0.75	41.1 ³
	1.0	41.1
	1.5	40.7
	2.0	41.7
XPS (ASTM C578, Type X)	0.5 ²	49.5 ^{2,4}
	0.75	30.5 ³
	1.0	30.5
	1.5	38.4
Polyiso (ASTM C1289, Type 1)	0.5	83.9 ⁴
	0.75	76.0 ³
	1.0	67.7
	1.5	53.3
For SI: 1 inch = 25.4 mm, 1 pound per square foot (psf) = 0.0479 kPa. Table Notes: 1. Linear interpolation is not permitted. 2. ½" XPS values are based on the presence of a polymeric facer. 3. Maximum fiber stress based on 4" specimen width. 4. Maximum fiber stress based on 8" specimen width.		

Table 2: Representative Minimum Values for Maximum Fiber (Bending) Stress

Note: Refer to References [10.1](#) and [10.2](#) for the basis of QCFS values reported in [Table 2](#).

7. Product Marking:

- 7.1. All FPIS products shall be marked in accordance the [ASTM C578](#) or [ASTM C1289](#) as applicable to the type of material and bear the label of an approved agency on the packaging or individual FPIS panels. The marking shall indicate conformance with this TER in regard to wind pressure resistance and required application in accordance with this TER for conditions of use requiring wind pressure resistance of exterior wall sheathing.

8. Conditions of Use:

- 8.1. The insulated sheathing products listed in [Section 1](#) of this report comply with, or are suitable alternatives to, the applicable sections of the 2003, 2006 and 2009 *International Building Code (IBC)* and the 2003, 2006 and 2009 *International Residential Code (IRC)* and are subject to the following conditions:
- 8.1.1. These products shall be installed in compliance with:
- 8.1.1.1. The manufacturer's instructions
 - 8.1.1.2. The applicable building code
 - 8.1.1.3. This TER
- 8.1.2. The FPIS manufacturer shall provide the building official and purchaser with evidence of code compliance for matters beyond the wind pressure resistance scope of this TER.

9. Equivalency:

- 9.1. The 2009 *IRC Section R104.11* specifically states that, "The provisions of this code are not intended to prevent the installation of any material... or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material...or method of construction shall be approved where the building official finds that...the...material, method...is, for the purpose intended, at least the equivalent of that prescribed in this code."
- 9.1.1. The testing and engineering analysis performed provides the basis for the use of the FPIS materials listed in [Section 1](#) as a wall covering in all locations that require resistance to wind pressure as described herein.

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10. Test and Engineering Substantiating Data:

- 10.1. [Wind Pressure Testing of Wall Assemblies with Foam Sheathing and Vinyl Siding Products](#), NAHBRC, Report # 4107003013108, dated January 31, 2008
- 10.2. [Positive Wind Pressure Testing of Foam-Sheathed Wall Assemblies](#), NAHBRC, Report # 4108007062508, dated July 10, 2008
- 10.3. Engineering analysis (Excel Spreadsheet) of data from 10.1 and 10.2 prepared for the Foam Sheathing Coalition by Jay H. Crandell, P.E, ARES Consulting, West River, MD, (available at www.foamsheathing.org)
- 10.4. Attaching Exterior Wall Coverings through Foam Sheathing to Wood or Steel Wall Framing, *FSC Tech Matters*, (available at www.foamsheathing.org)
- 10.5. Additional technical information and related manufacturer's instructions can be found at each of the manufacturer's websites:
 - 10.5.1. Atlas Roofing Corporation – www.atlasroofing.com
 - 10.5.2. Dow Chemical Company – www.building.dow.com
 - 10.5.3. Johns Manville – www.jm.com
 - 10.5.4. Owens Corning – www.owenscorning.com
 - 10.5.5. Rmax Operating, LLC – www.rmax.com

11. Report Date:

- 11.1. This TER shall be re-evaluated one year from the issue date.
- 11.2. For information on the status of this report, contact Qualtim.



Responsibility Statement

The information contained herein is a product, engineering or building code evaluation performed in accordance with the referenced building code, testing and/or analysis using generally accepted engineering practices. Product, design and code compliance quality control is the responsibility of the referenced company. Consult the referenced company for the proper detailing and application for the intended purpose. Consult your local jurisdiction or design professional to assure compliance with the local building code. Qualtim, Inc. (www.qualtim.com) and SBC Research Institute (www.sbcricri.info) do not make any warranty, express or implied, or assume any legal liability or responsibility for the use, application of, and/or reference to opinions, findings, conclusions, or recommendations included in this report.

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Appendix A – Code References Used in This Report

IBC References

104.11 Alternative materials, design and methods of construction and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be *approved* where the *building official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, *fire resistance*, durability and safety.

104.11.1 Research reports. Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved* sources.

104.11.2 Tests. Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the *building official* shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the *building official* shall approve the testing procedures. Tests shall be performed by an *approved agency*. Reports of such tests shall be retained by the *building official* for the period required for retention of public records.

1404.8 Plastics. Plastic panel, apron or spandrel walls as defined in this code shall not be limited in thickness, provided that such plastics and their assemblies conform to the requirements of Chapter 26 and are constructed of *approved* weather-resistant materials of adequate strength to resist the wind loads for cladding specified in Chapter 16.

1609.1.1 Determination of wind loads. Wind loads on every building or structure shall be determined in accordance with Chapter 6 of ASCE 7 or provisions of the alternate all-heights method in Section 1609.6. The type of opening protection required, the basic wind speed and the exposure category for a site is permitted to be determined in accordance with Section 1609 or ASCE 7. Wind shall be assumed to come from any horizontal direction and wind pressures shall be assumed to act normal to the surface considered.

Exceptions:

1. Subject to the limitations of Section 1609.1.1.1, the provisions of ICC 600 shall be permitted for applicable Group R-2 and R-3 buildings.
2. Subject to the limitations of Section 1609.1.1.1, residential structures using the provisions of the AF&PA WFCM.
3. Subject to the limitations of Section 1609.1.1.1, residential structures using the provisions of AISI S230.
4. Designs using NAAMM FP 1001.
5. Designs using TIA-222 for antenna-supporting structures and antennas.
6. Wind tunnel tests in accordance with Section 6.6 of ASCE 7, subject to the limitations in Section 1609.1.1.2.

1609.6 Alternate all-heights method. The alternate wind design provisions in this section are simplifications of the ASCE 7 Method 2—Analytical Procedure.

1609.6.1 Scope. As an alternative to ASCE 7 Section 6.5, the following provisions are permitted to be used to determine the wind effects on regularly shaped buildings, or other structures that are regularly shaped, which meet all of the following conditions:

1. The building or other structure is less than or equal to 75 feet (22 860 mm) in height with a height-to-least width ratio of 4 or less, or the building or other structure has a fundamental frequency greater than or equal to 1 hertz.
2. The building or other structure is not sensitive to dynamic effects.

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3. The building or other structure is not located on a site for which channeling effects or buffeting in the wake of upwind obstructions warrant special consideration.
4. The building shall meet the requirements of a simple diaphragm building as defined in ASCE 7 Section 6.2, where wind loads are only transmitted to the main wind-force-resisting system (MWFRS) at the diaphragms.
5. For open buildings, multspan gable roofs, stepped roofs, sawtooth roofs, domed roofs, roofs with slopes greater than 45 degrees (0.79 rad), solid free-standing walls and solid signs, and rooftop equipment, apply ASCE 7 provisions.

1609.6.1.1 Modifications. The following modifications shall be made to certain subsections in ASCE 7: in Section 1609.6.2, symbols and notations that are specific to this section are used in conjunction with the symbols and notations in ASCE 7 Section 6.3.

1609.6.2 Symbols and notations. Coefficients and variables used in the alternative all-heights method equations are as follows:

C_{net} = Net-pressure coefficient based on $K_d[(G)(C_p) - (GC_{pi})]$, in accordance with Table 1609.6.2(2).

G = Gust effect factor for rigid structures in accordance with ASCE 7 Section 6.5.8.1.

K_d = Wind directionality factor in accordance with ASCE 7 Table 6-4.

P_{net} = Design wind pressure to be used in determination of wind loads on buildings or other structures or their components and cladding, in psf (kN/m²).

q_s = Wind stagnation pressure in psf (kN/m²) in accordance with Table 1609.6.2(1).

1609.6.3 Design equations. When using the alternative all-heights method, the MWFRS, and components and cladding of every structure shall be designed to resist the effects of wind pressures on the building envelope in accordance with Equation 16-34.

$$P_{net} = q_s K_z C_{net} [IK_{zt}] \text{ (Equation 16-34)}$$

Design wind forces for the MWFRS shall not be less than 10 psf (0.48 kN/m²) multiplied by the area of the structure projected on a plane normal to the assumed wind direction (see ASCE 7 Section 6.1.4 for criteria). Design net wind pressure for components and cladding shall not be less than 10 psf (0.48 kN/m²) acting in either direction normal to the surface.

2308.9.3 Bracing. Braced wall lines shall consist of braced wall panels that meet the requirements for location, type and amount of bracing as shown in Figure 2308.9.3, specified in Table 2308.9.3(1) and are in line or offset from each other by not more than 4 feet (1219 mm). Braced wall panels shall start not more than 12½ feet (3810 mm) from each end of a braced wall line. Braced wall panels shall be clearly indicated on the plans. Construction of braced wall panels shall be by one of the following methods:

1. Nominal 1-inch by 4-inch (25 mm by 102 mm) continuous diagonal braces let into top and bottom plates and intervening studs, placed at an angle not more than 60 degrees (1.0 rad) or less than 45 degrees (0.79 rad) from the horizontal and attached to the framing in conformance with Table 2304.9.1.
2. Wood boards of 5/8 inch (15.9 mm) net minimum thickness applied diagonally on studs spaced not over 24 inches (610 mm) o.c.
3. Wood structural panel sheathing with a thickness not less than 3/8 inch (9.5 mm) for 16-inch (406 mm) or 24-inch (610 mm) stud spacing in accordance with Tables 2308.9.3(2) and 2308.9.3(3).
4. Fiberboard sheathing panels not less than 1/2 inch (12.7 mm) thick applied vertically or horizontally on studs spaced not over 16 inches (406 mm) o.c. where installed with fasteners in accordance with Section 2306.6 and Table 2306.6.
5. Gypsum board [sheathing 1/2-inch-thick (12.7 mm) by 4-feet-wide (1219 mm) wallboard or veneer base] on studs spaced not over 24 inches (610 mm) o.c. and nailed at 7 inches (178 mm) o.c. with nails as required by Table 2306.7.
6. Particleboard wall sheathing panels where installed in accordance with Table 2308.9.3(4).
7. Portland cement plaster on studs spaced 16 inches (406 mm) o.c. installed in accordance with Section 2510.

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8. Hardboard panel siding where installed in accordance with Section 2303.1.6 and Table 2308.9.3(5).

For cripple wall bracing, see Section 2308.9.4.1. For Methods 2, 3, 4, 6, 7 and 8, each panel must be at least 48 inches (1219 mm) in length, covering three stud spaces where studs are spaced 16 inches (406 mm) apart and covering two stud spaces where studs are spaced 24 inches (610 mm) apart. For Method 5, each panel must be at least 96 inches (2438 mm) in length where applied to one face of a panel and 48 inches (1219 mm) where applied to both faces. All vertical joints of panel sheathing shall occur over studs and adjacent panel joints shall be nailed to common framing members.

Horizontal joints shall occur over blocking or other framing equal in size to the studding except where waived by the installation requirements for the specific sheathing materials. Sole plates shall be nailed to the floor framing and top plates shall be connected to the framing above in accordance with Section 2308.3.2. Where joists are perpendicular to braced wall lines above, blocking shall be provided under and in line with the braced wall panels.

IRC References

R104.11 Alternative materials, design and methods of construction and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be *approved* where the *building official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code. Compliance with the specific performance-based provisions of the International Codes in lieu of specific requirements of this code shall also be permitted as an alternate.

R104.11.1 Tests. Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the *building official* shall have the authority to require tests as evidence of compliance to be made at no expense to the *jurisdiction*. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the *building official* shall approve the testing procedures. Tests shall be performed by an *approved* agency. Reports of such tests shall be retained by the *building official* for the period required for retention of public records.

R301.2 Climatic and geographic design criteria. Buildings shall be constructed in accordance with the provisions of this code as limited by the provisions of this section. Additional criteria shall be established by the local *jurisdiction* and set forth in Table R301.2(1).

R301.2.1 Wind limitations. Buildings and portions thereof shall be limited by wind speed, as defined in Table R301.2(1) and construction methods in accordance with this code. Basic wind speeds shall be determined from Figure R301.2(4). Where different construction methods and structural materials are used for various portions of a building, the applicable requirements of this section for each portion shall apply. Where loads for wall coverings, curtain walls, roof coverings, exterior windows, skylights, garage doors and exterior doors are not otherwise specified, the loads listed in Table R301.2(2) adjusted for height and exposure using Table R301.2(3) shall be used to determine design load performance requirements for wall coverings, curtain walls, roof coverings, exterior windows, skylights, garage doors and exterior doors. Asphalt shingles shall be designed for wind speeds in accordance with Section R905.2.6.

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TABLE R301.2(2)
COMPONENT AND CLADDING LOADS FOR A BUILDING WITH A MEAN
ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B (psf)^{a, b, c, d, e}

	ZONE	EFFECTIVE WIND AREA (feet ²)	BASIC WIND SPEED (mph—3-second gust)																							
			85		90		100		105		110		120		125		130		140		145		150		170	
Wall	4	10	13.0	-14.1	14.6	-15.8	18.0	-19.5	19.8	-21.5	21.8	-23.6	25.9	-28.1	28.1	-30.5	30.4	-33.0	35.3	-38.2	37.8	-41.0	40.5	-43.9	52.0	-56.4
	4	20	12.4	-13.5	13.9	-15.1	17.2	-18.7	18.9	-20.6	20.8	-22.6	24.7	-26.9	26.8	-29.2	29.0	-31.6	33.7	-36.7	36.1	-39.3	38.7	-42.1	49.6	-54.1
	4	50	11.6	-12.7	13.0	-14.3	16.1	-17.6	17.8	-19.4	19.5	-21.3	23.2	-25.4	25.2	-27.5	27.2	-29.8	31.6	-34.6	33.9	-37.1	36.2	-39.7	46.6	-51.0
	4	100	11.1	-12.2	12.4	-13.6	15.3	-16.8	16.9	-18.5	18.5	-20.4	22.0	-24.2	23.9	-26.3	25.9	-28.4	30.0	-33.0	32.2	-35.4	34.4	-37.8	44.2	-48.6
	5	10	13.0	-17.4	14.6	-19.5	18.0	-24.1	19.8	-26.6	21.8	-29.1	25.9	-34.7	28.1	-37.6	30.4	-40.7	35.3	-47.2	37.8	-50.6	40.5	-54.2	52.0	-69.6
	5	20	12.4	-16.2	13.9	-18.2	17.2	-22.5	18.9	-24.8	20.8	-27.2	24.7	-32.4	26.8	-35.1	29.0	-38.0	33.7	-44.0	36.1	-47.2	38.7	-50.5	49.6	-64.9
	5	50	11.6	-14.7	13.0	-16.5	16.1	-20.3	17.8	-22.4	19.5	-24.6	23.2	-29.3	25.2	-31.8	27.2	-34.3	31.6	-39.8	33.9	-42.7	36.2	-45.7	46.6	-58.7
	5	100	11.1	-13.5	12.4	-15.1	15.3	-18.7	16.9	-20.6	18.5	-22.6	22.0	-26.9	23.9	-29.2	25.9	-31.6	30.0	-36.7	32.2	-39.3	34.4	-42.1	44.2	-54.1

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m², 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa.

Notes:

- The effective wind area shall be equal to the span length multiplied by an effective width. This width shall be permitted to be not be less than one-third the span length. For cladding fasteners, the effective wind area shall not be greater than the area that is tributary to an individual fastener.
- For effective areas between those given above, the load may be interpolated; otherwise, use the load associated with the lower effective area.
- Table values shall be adjusted for height and exposure by multiplying by the adjustment coefficient in Table R301.2(3).
- See Figure R301.2(7) for location of zones.
- Plus and minus signs signify pressures acting toward and away from the building surfaces.

TABLE R301.2(3)
HEIGHT AND EXPOSURE ADJUSTMENT COEFFICIENTS FOR TABLE R301.2(2)

MEAN ROOF HEIGHT	EXPOSURE		
	B	C	D
15	1.00	1.21	1.47
20	1.00	1.29	1.55
25	1.00	1.35	1.61
30	1.00	1.40	1.66
35	1.05	1.45	1.70
40	1.09	1.49	1.74
45	1.12	1.53	1.78
50	1.16	1.56	1.81
55	1.19	1.59	1.84
60	1.22	1.62	1.87

R602.10 Wall bracing. Buildings shall be braced in accordance with this section. Where a building, or portion thereof, does not comply with one or more of the bracing requirements in this section, those portions shall be designed and constructed in accordance with Section R301.1.

Exception: Detached one- and two-family *dwelling*s located in Seismic Design Category C are exempt from the seismic bracing requirements of this section. Wind speed provisions for bracing shall be applicable to detached one- and two-family *dwelling*s.

703.1.2 Wind resistance. Wall coverings, backing materials and their attachments shall be capable of resisting wind loads in accordance with Tables R301.2(2) and R301.2(3). Wind-pressure resistance of the siding and backing materials shall be determined by ASTM E 330 or other applicable standard test methods. Where wind-pressure resistance is determined by design analysis, data from approved design standards and analysis conforming to generally accepted engineering practice shall be used to evaluate the siding and backing material and its fastening. All applicable failure modes including bending rupture of siding, fastener withdrawal and fastener head pull-through shall be considered in the testing or design analysis. Where the wall covering and the backing material resist wind load as an assembly, use of the design capacity of the assembly shall be permitted.

R703.4 Attachments. Unless specified otherwise, all wall coverings shall be securely fastened in accordance with Table R703.4 or with other *approved* aluminum, stainless steel, zinc-coated or other *approved* corrosion-resistive fasteners. Where

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the basic wind speed per Figure R301.2(4) is 110 miles per hour (49 m/s) or higher, the attachment of wall coverings shall be designed to resist the component and cladding loads specified in Table R301.2(2), adjusted for height and exposure in accordance with Table R301.2(3).

Table R703.4

**TABLE R703.4
WEATHER-RESISTANT SIDING ATTACHMENT AND MINIMUM THICKNESS**

SIDING MATERIAL		NOMINAL THICKNESS ^a (inches)	JOINT TREATMENT	WATER-RESISTIVE BARRIER REQUIRED	TYPE OF SUPPORTS FOR THE SIDING MATERIAL AND FASTENERS ^{b,c,d}					
					Wood or wood structural panel sheathing	Fiberboard sheathing into stud	Gypsum sheathing into stud	Foam plastic sheathing into stud	Direct to studs	Number or spacing of fasteners
Horizontal aluminum ^e	Without insulation	0.019 ^f	Lap	Yes	0.120 nail 1½" long	0.120 nail 2" long	0.120 nail 2" long	0.120 nail ^g	Not allowed	Same as stud spacing
		0.024	Lap	Yes	0.120 nail 1½" long	0.120 nail 2" long	0.120 nail 2" long	0.120 nail ^g	Not allowed	
	With insulation	0.019	Lap	Yes	0.120 nail 1½" long	0.120 nail 2½" long	0.120 nail 2½" long	0.120 nail ^g	0.120 nail 1½" long	
Anchored veneer: brick, concrete, masonry or stone		2	Section R703	Yes	See Section R703 and Figure R703.7 ^h					
Adhered veneer: concrete, stone or masonry ⁱ		—	Section R703	Yes Note w	See Section R703.6.1 ^h or in accordance with the manufacturer's instructions.					
Hardboard ^j Panel siding-vertical		⅞	—	Yes	Note m	Note m	Note m	Note m	Note m	6" panel edges 12" inter. sup. ^a
Hardboard ^j Lap siding-horizontal		⅞	Note p	Yes	Note o	Note o	Note o	Note o	Note o	Same as stud spacing 2 per bearing
Steel ^k		29 ga.	Lap	Yes	0.113 nail 1½" Staple-1½"	0.113 nail 2½" Staple-2½"	0.113 nail 2½" Staple-2½"	0.113 nail ^g Staple ^g	Not allowed	Same as stud spacing
Particleboard panels		⅔ – ½	—	Yes	6d box nail (2" × 0.099")	6d box nail (2" × 0.099")	6d box nail (2" × 0.099")	box nail ^g	6d box nail (2" × 0.099"), ⅞ not allowed	6" panel edge, 12" inter. sup.
		⅞	—	Yes	6d box nail (2" × 0.099")	8d box nail (2½" × 0.113")	8d box nail (2½" × 0.113")	box nail ^g	6d box nail (2" × 0.099")	
Wood structural panel siding ^l (exterior grade)		⅞ – ½	Note p	Yes	0.099 nail-2"	0.113 nail-2½"	0.113 nail-2½"	0.113 nail ^g	0.099 nail-2"	6" panel edges, 12" inter. sup.
Wood structural panel lap siding		⅞ – ½	Note p Note x	Yes	0.099 nail-2"	0.113 nail-2½"	0.113 nail-2½"	0.113 nail ^g	0.099 nail-2"	8" along bottom edge
Vinyl siding ^l		0.035	Lap	Yes	0.120 nail (shank) with a 0.313 head or 16 gauge staple with ⅞ to ½-inch crown ^{1,2}	0.120 nail (shank) with a 0.313 head or 16 gauge staple with ⅞ to ½-inch crown ³	0.120 nail (shank) with a 0.313 head or 16 gauge staple with ⅞ to ½-inch crown ³	0.120 nail (shank) with a 0.313 head per Section R703.11.2	Not allowed	16 inches on center or specified by the manufacturer instructions or test report
Wood ^l rustic, drop		⅞ Min	Lap	Yes	Fastener penetration into stud-1"				0.113 nail-2½" Staple-2"	Face nailing up to 6" widths, 1 nail per bearing; 8" widths and over, 2 nails per bearing
Shiplap		19/32 Average	Lap	Yes						
Bevel		⅞	Lap	Yes						
Butt tip		⅞	Lap	Yes						
Fiber cement panel siding ^g		⅞	Note q	Yes Note u	6d common corrosion-resistant nail ^g	6d common corrosion-resistant nail ^g	6d common corrosion-resistant nail ^g	6d common corrosion-resistant (12" × 0.113") nail ^{g,v}	4d common corrosion-resistant nail ^g	6" o.c. on edges, 12" o.c. on intermed. studs
Fiber cement lap siding ^g		⅞	Note s	Yes Note u	6d common corrosion-resistant nail ^g	6d common corrosion-resistant nail ^g	6d common corrosion-resistant nail ^g	6d common corrosion-resistant (12" × 0.113") nail ^{g,v}	6d common corrosion-resistant nail or 11 gage roofing nail ^g	Note t

For SI: 1 inch = 25.4 mm.

- Based on stud spacing of 16 inches on center where studs are spaced 24 inches, siding shall be applied to sheathing approved for that spacing.
- Nail is a general description and shall be T-head, modified round head, or round head with smooth or deformed shanks.
- Staples shall have a minimum crown width of ⅞-inch outside diameter and be manufactured of minimum 16 gage wire.
- Nails or staples shall be aluminum, galvanized, or rust-preventative coated and shall be driven into the studs for fiberboard or gypsum backing.
- Aluminum nails shall be used to attach aluminum siding.
- Aluminum (0.019 inch) shall be unbacked only when the maximum panel width is 10 inches and the maximum flat area is 8 inches. The tolerance for aluminum siding shall be +0.002 inch of the nominal dimension.
- All attachments shall be coated with a corrosion-resistant coating.
- Shall be of approved type.
- Three-eighths-inch plywood shall not be applied directly to studs spaced more than 16 inches on center when long dimension is parallel to studs. Plywood ⅞-inch or thinner shall not be applied directly to studs spaced more than 24 inches on center. The stud spacing shall not exceed the panel span rating provided by the manufacturer unless the panels are installed with the face grain perpendicular to the studs or over sheathing approved for that stud spacing.
- Wood board sidings applied vertically shall be nailed to horizontal nailing strips or blocking set 24 inches on center. Nails shall penetrate 1½ inches into studs, studs and wood sheathing combined or blocking.

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- k. Hardboard siding shall comply with CPA/ANSI A135.6.
- l. Vinyl siding shall comply with ASTM D 3679.
- m. Minimum shank diameter of 0.092 inch, minimum head diameter of 0.225 inch, and nail length must accommodate sheathing and penetrate framing $1\frac{1}{2}$ inches.
- n. When used to resist shear forces, the spacing must be 4 inches at panel edges and 8 inches on interior supports.
- o. Minimum shank diameter of 0.099 inch, minimum head diameter of 0.240 inch, and nail length must accommodate sheathing and penetrate framing $1\frac{1}{2}$ inches.
- p. Vertical end joints shall occur at studs and shall be covered with a joint cover or shall be caulked.
- q. See Section R703.10.1.
- r. Fasteners shall comply with the nominal dimensions in ASTM F 1667.
- s. See Section R703.10.2.
- t. Face nailing: one 6d common nail through the overlapping planks at each stud. Concealed nailing: one 11 gage $1\frac{1}{2}$ inch long galv. roofing nail through the top edge of each plank at each stud.
- u. See Section R703.2 exceptions.
- v. Minimum nail length must accommodate sheathing and penetrate framing $1\frac{1}{2}$ inches.
- w. Adhered masonry veneer shall comply with the requirements of Section R703.6.3 and shall comply with the requirements in Sections 6.1 and 6.3 of ACI 530/ASCE 5/TMS-402.
- x. Vertical joints, if staggered shall be permitted to be away from studs if applied over wood structural panel sheathing.
- y. Minimum fastener length must accommodate sheathing and penetrate framing .75 inches or in accordance with the manufacturer's installation instructions.
- z. Where approved by the manufacturer's instructions or test report siding shall be permitted to be installed with fasteners penetrating not less than .75 inches through wood or wood structural sheathing with or without penetration into the framing.

R703.11.2 Foam plastic sheathing. 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.

R703.11.2.1 Basic wind speed not exceeding 90 miles per hour and Exposure Category B. Where the basic wind speed does not exceed 90 miles per hour (40 m/s), the Exposure Category is B and gypsum wall board or equivalent is installed on the side of the wall opposite the foam plastic sheathing, the minimum siding fastener penetration into wood framing shall be $1\frac{1}{4}$ inches (32 mm) using minimum 0.120-inch diameter nail (shank) with a minimum 0.313-inch diameter head, 16 inches on center. The foam plastic sheathing shall be minimum $\frac{1}{2}$ -inch-thick (12.7 mm) (nominal) extruded polystyrene per ASTM C578, $\frac{1}{2}$ -inch-thick (12.7 mm) (nominal) polyisocyanurate per ASTM C1289, or 1-inch-thick (25 mm)(nominal) expanded polystyrene per ASTM C578.

R703.11.2.2 Basic wind speed exceeding 90 miles per hour or Exposure Categories C and D. Where the basic wind speed exceeds 90 miles per hour (40 m/s) or the Exposure Category is C or D, or all conditions of Section R703.11.2.1 are not met, the adjusted design pressure rating for the assembly shall meet or exceed the loads listed in Tables R301.2(2) adjusted for height and exposure using Section R301.2(3). The design wind pressure rating of the vinyl siding for installation over solid sheathing as provided in the vinyl siding manufacturer's product specifications shall be adjusted for the following wall assembly conditions:

1. For wall assemblies with foam plastic sheathing on the exterior side and gypsum wall board or equivalent on the interior side of the wall, the vinyl siding's design wind pressure rating shall be multiplied by 0.39.
2. For wall assemblies with foam plastic sheathing on the exterior side and no gypsum wall board or equivalent on the interior side of wall, the vinyl siding's design wind pressure rating shall be multiplied by 0.27.

R703.11.2.3 Manufacturer specification. Where the vinyl siding manufacturer's product specifications provide an *approved* design wind pressure rating for installation over foam plastic sheathing, use of this design wind pressure rating shall be permitted and the siding shall be installed in accordance with the manufacturer's installation instructions.

R703.12 Adhered masonry veneer installation. Adhered masonry veneer shall be installed in accordance with the manufacturer's instructions.

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ASTM C578- Table 1-Physical Property Requirements of RCPS Thermal Insulation.

TABLE 1 Physical Property Requirements of RCPS Thermal Insulation

NOTE 1—The values for properties listed in this table may be affected by the presence of a surface skin which is a result of the manufacturing process. The values for Type XIII properties listed in this table must be generated on material with the surface skin removed. Where products are tested with skins-in-place, this condition shall be noted in the test report.

NOTE 2—Type III has been deleted because it is no longer available.

NOTE 3—In addition to the thermal resistance values in Table 1, values at mean temperatures of $25 \pm 2^\circ\text{F}$ ($-4 \pm 1^\circ\text{C}$), $40 \pm 2^\circ\text{F}$ ($4 \pm 1^\circ\text{C}$), and $110 \pm 2^\circ\text{F}$ ($43 \pm 1^\circ\text{C}$) are provided in X1.8 for information purposes.

NOTE 4—For Type XIII, in addition to the Thermal resistance property requirements shown in Table 1, there are Apparent Thermal Conductivity property values shown for informational purposes in Table X1.2 of Appendix X1.

NOTE 5—Values quoted are maximum values for 1.00 in. (25.4 mm) thick samples with natural skins intact. Lower values will result for thicker materials. Where water vapor permeance is a design issue, consult manufacturer.

NOTE 6—Types XI, I, VIII, II, IX, XIV and XV are typically EPS insulation. Types XII, X, XIII, IV, VI, VII and V are typically XPS insulation.

Classification	Type XI	Type I	Type VIII	Type II	Type IX	Type XIV	Type XV	Type XII	Type X	Type XIII	Type IV	Type VI	Type VII	Type V
Compressive resistance at yield or 10 % deformation, whichever occurs first (with skins intact), min, psi (kPa)	5.0 (35)	10.0 (69)	13.0 (90)	15.0 (104)	25.0 (173)	40.0 (276)	60.0 (414)	15.0 (104)	15.0 (104)	20.0 (138)	25.0 (173)	40.0 (276)	60.0 (414)	100.0 (690)
Thermal resistance of 1.00-in. (25.4-mm) thickness, min, $\text{F}\cdot\text{ft}^2\cdot\text{h}/\text{Btu}$ ($\text{K}\cdot\text{m}^2/\text{W}$)	3.1 (0.55)	3.6 (0.63)	3.8 (0.67)	4.0 (0.70)	4.2 (0.74)	4.2 (0.74)	4.3 (0.76)	4.6 (0.81)	5.0 (0.88)	3.9 (0.68)	5.0 (0.88)	5.0 (0.88)	5.0 (0.88)	5.0 (0.88)
Mean temperature: $75 \pm 2^\circ\text{F}$ ($24 \pm 1^\circ\text{C}$)														
Flexural strength, min, psi (kPa)	10.0 (70)	25.0 (173)	30.0 (208)	35.0 (240)	50.0 (345)	60.0 (414)	75.0 (517)	40.0 (276)	40.0 (276)	45.0 (310)	50.0 (345)	60.0 (414)	75.0 (517)	100.0 (690)
Water vapor permeance of 1.00-in. (25.4-mm) thickness (See Note 5.), max, perm ($\text{ng}/\text{Pa}\cdot\text{s}\cdot\text{m}^2$)	5.0 (287)	5.0 (287)	3.5 (201)	3.5 (201)	2.5 (143)	2.5 (143)	2.5 (143)	1.5 (86)	1.5 (86)	1.5 (86)	1.5 (86)	1.1 (63)	1.1 (63)	1.1 (63)
Water absorption by total immersion, max, volume %	4.0	4.0	3.0	3.0	2.0	2.0	2.0	0.3	0.3	1.0	0.3	0.3	0.3	0.3
Dimensional stability (change in dimensions), max, %	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Oxygen index, min, volume %	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Density, min, lb/ft^3 (kg/m^3)	0.70 (12)	0.90 (15)	1.15 (18)	1.35 (22)	1.80 (29)	2.40 (38)	2.85 (46)	1.20 (19)	1.30 (21)	1.60 (26)	1.55 (25)	1.80 (29)	2.20 (35)	3.00 (48)

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ASTM C1289 – Table 1 – Physical Properties [of Polyiso Thermal Insulation Boards]

TABLE 1 Physical Properties^A

Product Type	Type I Class 1	Type I Class 2	Type II Class 1	Type II Class 2	Type III	Type IV	Type V	Type VI
Facer covering one surface	aluminum foil	aluminum foil	fibrous felt or glass fiber mat membrane	polymer-bonded glass fiber mat membrane	perlite insulation board	cellulosic fiber insulating board	oriented strand board or wafer-board	perlite insulation board
Facer covering opposite surface	aluminum foil	aluminum foil	fibrous felt or glass fiber mat membrane	polymer-bonded glass fiber mat membrane	fibrous felt or glass fiber mat membrane	fibrous felt or glass fiber mat membrane	fibrous felt or glass fiber mat membrane or aluminum foil	perlite insulation board
Physical Property								
Compressive strength, psi (kPa), min ^B	16 (110)	16 (110)	Grade 1 16 (110) Grade 2 20 (138) Grade 3 25 (172)	16 (110)	16 (110)	16 (110)	16 (110)	16 (110)
Dimensional stability ^B								
Percent linear change, thickness, max								
–40°F (–40°C) amb, RH	2.0	1.5	2.0	2.0	2.0	2.0	2.0	2.0
158°F (70°C)/ 97 % RH	2.0	1.5	4.0	4.0	4.0	4.0	4.0	4.0
200°F (93°C)/ amb RH	4.0	1.5	4.0	4.0	4.0	4.0	4.0	4.0
Percent linear change, thickness, max								
–40°F (–40°C) amb, RH	2.0	1.5	2.0	2.0	2.0	2.0	2.0	2.0
158°F (70°C)/ 97 % RH	2.0	1.5	4.0	4.0	4.0	4.0	4.0	4.0
200°F (93°C)/ amb RH	4.0	1.5	4.0	4.0	4.0	4.0	4.0	4.0
Percent linear change, length and width, max								
–40°F (–40°C) amb, RH	2.0	1.5	2.0	2.0	2.0	2.0	2.0	2.0
158°F (70°C)/ 97 % RH	2.0	1.5	2.0	2.0	4.0	4.0	4.0	4.0
200°F (93°C) amb, RH	4.0	1.5	2.0	2.0	4.0	4.0	4.0	4.0
Flexural strength (modulus of rupture) ^B								
psi (kPa), min	40 (275)	40 (275)	40 (275)	40 (275)	40 (275)	40 (275)	40 (275)	50 (345)
(Break load) lbf (N), min	8 (35)	8 (35)	17 (75)	17 (75)	17 (75)	17 (75)	17 (75)	33 (147)
Tensile strength, psf (kPa), min ^B	500 (24)	500 (24)	500 (24)	500 (24)	500 (24)	500 (24)	500 (24)	500 (24)
Perpendicular to board surface								
Water absorption 2h percent by volume, max ^B	1.0	1.0	1.5	1.5	1.0	2.0	1.0	1.5
Water vapor transmission, perm (ng/Pa·s·m ²), max	0.3 (17.2) ^B	0.3 (17.2) ^B	1.0 (57.2) ^B	4.0 (228.8) ^B	^C	^C	^C	^C

^A Because core foam thickness and facer type, thickness, and permeability can all influence the magnitude of values measured for these physical properties, a nominal 1 in. foam core product has been described for referee purposes. Consult manufacturers regarding specific foam-facer composite products and other product thicknesses. When appropriate, physical property values as agreed between buyer and seller shall replace those listed in Table 1 as qualification requirements described in 10.3.

^B Nominal 1-in. (25.4-mm) product.

^C Not applicable.