



CERTIFICATION



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Technical Evaluation Report

TER 1101-01

Wind Pressure Performance of
Kingspan® GreenGuard® XPS
Insulation Board Used in Exterior Wall
Covering Assemblies

Kingspan® Insulation LLC

Product:

**Kingspan® Insulation LLC –
GreenGuard® Extruded
polystyrene (XPS) Insulation
Board**

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Subject to Renewal:

October 1, 2020

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COMPANY
INFORMATION:

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DIVISION: 06 00 00 - WOOD, PLASTICS AND COMPOSITES

SECTION: 06 16 00 - Sheathing

DIVISION: 07 00 00 - THERMAL AND MOISTURE PROTECTION

SECTION: 07 21 00 - Thermal Insulation

1 PRODUCT EVALUATED¹

- 1.1 Kingspan® Insulation LLC – GreenGuard® Extruded polystyrene (XPS) Insulation Board

2 APPLICABLE CODES AND STANDARDS^{2,3}

2.1 Codes

- 2.1.1 *IBC—12, 15, 18: International Building Code®*
2.1.2 *IRC—12, 15, 18: International Residential Code®*

2.2 Standards and Referenced Documents

- 2.2.1 *ANSI/AWC NDS: National Design Specification (NDS) for Wood Construction*
2.2.2 *ASCE/SEI 7: Minimum Design Loads and Associated Criteria for Buildings and Other Structures*
2.2.3 *ASTM C578: Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation*
2.2.4 *ASTM E2178: Standard Test Method for Air Permeance of Building Materials*
2.2.5 *ASTM E330: Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference*
2.2.6 *ASTM E331: Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference*

¹ Building codes require data from valid research reports be obtained from approved sources. An approved agency, which is an approved source, is defined as “an established and recognized agency that is regularly engaged in...furnishing product certification where such agency has been approved...” Being approved, defined as “acceptable to the building official,” is accomplished via accreditation using ISO/IEC 17065 evaluation procedures meeting code requirements of independence, adequate equipment, and experienced personnel. DrJ is an ISO/IEC 17065 ANSI-Accredited Product Certification Body – Accreditation #1131.

Through ANSI accreditation, DrJ certification can be used to obtain product approval in any country that is an IAF MLA Signatory and covered by an IAF MLA Evaluation per the Purpose of the MLA – “certified once, accepted everywhere.” Manufacturers can go to jurisdictions in any IAF MLA Signatory Country and have their products readily approved by authorities having jurisdiction using DrJ’s ANSI accreditation.

For more information on any of these topics or our mission, product evaluation policies, product approval process, and engineering law, see drjcertification.org.

² Unless otherwise noted, all references in this TER are from the 2018 version of the codes and the standards referenced therein (e.g., *ASCE 7*, *NDS*, *ASTM*). This material, design, or method of construction also complies with the 2000-2015 versions of the referenced codes and the standards referenced therein. As required by code, where this TER is not approved, the building official shall respond in writing stating the reasons this TER was not approved. For any variations in state and local codes, see Section 8.

³ All terms defined in the applicable building codes are italicized.

2.2.7 *SBCA ANSI/FS 100: Standard Requirements for Wind Pressure Resistance of Foam Plastic Insulating Sheathing Used in Exterior Wall Covering Assemblies*

3 PERFORMANCE EVALUATION

- 3.1 The wind pressure resistance performance of GreenGuard® XPS Insulation Board was evaluated for use as part of an exterior wall covering assembly in accordance with the following code sections:
 - 3.1.1 IBC Section 104.11 and 1404.8.
 - 3.1.2 IRC Section R104.11, R703.1.2 and R703.3, and Table R703.3(1).
- 3.2 This TER evaluates the wind pressure resistance performance of GreenGuard® XPS Insulation Board for use as exterior wall sheathing in compliance with the building codes listed in Section 2.
 - 3.2.1 When used as over-sheathing⁴ on light-frame, masonry, or concrete exterior walls, GreenGuard® XPS Insulation Board is not required to meet the wind pressure requirements of this TER.
 - 3.2.2 This TER does not address wind pressure resistance requirements for GreenGuard® XPS Insulation Board used as part of an Exterior Insulation Finish System (EIFS). Refer to the EIFS manufacturer's installation instructions for building code compliance.
- 3.3 GreenGuard® XPS Insulation Board shall comply with the material standard listed in Section 4 and shall be applied to exterior wall construction in accordance with the general requirements of Section 5.1, as well as the prescriptive wind pressure resistance requirements of Section 5.2.
- 3.4 GreenGuard® XPS Insulation Board used in accordance with this TER that is required to resist wind pressure in exterior wall covering assemblies shall also comply with the product marking requirements of Section 10 and the conditions of use listed in Section 9.
- 3.5 GreenGuard® XPS Insulation Board was also evaluated for the following:
 - 3.5.1 Use as an air barrier material in accordance with IRC Section N1102.4.1.1 and IECC Section C402.5.1.1 and R402.4.1.1.
 - 3.5.2 Use as a water-resistant barrier (WRB) in accordance with IRC Section R703.2 and IBC Section 1404.2⁵.
- 3.6 Only products in this TER with thicknesses ranging from 1" to 3" are certified for wind pressure resistance. Results of testing for other thicknesses are provided for informational purposes only.
 - 3.6.1 For the scope of this TER, only products with thicknesses ranging from 1" to 3" are subject to an ongoing quality control program for performance to meet wind requirements, in accordance with *ANSI/SBCA FS100*.
- 3.7 Any code compliance issues not specifically addressed in this section are outside the scope of this TER.
- 3.8 Any engineering evaluation conducted for this TER was performed on the dates provided in this TER and within Dr.J's professional scope of work.

4 PRODUCT DESCRIPTION AND MATERIALS

- 4.1 GreenGuard® XPS Insulation Board used in accordance with this TER shall comply with the following material standards:
 - 4.1.1 XPS manufactured in compliance with *ASTM C578*, Type IV.
- 4.2 GreenGuard® XPS Insulation Board is produced under a proprietary manufacturing process and formed into rigid insulation panels.

⁴ Over-sheathing definition: As used in this TER, over-sheathing refers to the application of foam sheathing over and directly on the surface of wall sheathing material or solid wall construction, such as masonry or concrete, whereby the substrate is capable of resisting the full design transverse wind load required by the applicable building code or latest edition of *ASCE 7*. 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.

⁵ 2015 IBC Section 1405.2 Note the changes of minimum thickness for covering types

- 4.2.1 GreenGuard® XPS Insulation Board is manufactured with or without edge treatments and facers as follows:
 - 4.2.1.1 CM – square edges
 - 4.2.1.2 SL – shiplap edges
 - 4.2.1.3 SLX – shiplap edges and clear plastic facers on both sides
 - 4.2.1.4 PGU – 7/16" XPS with a reinforcing polyolefin fabric on one side and a clear plastic facer on the other side
- 4.3 GreenGuard® XPS Insulation Board is manufactured in 4x8 sheets in ½", ¾", 1", 1½", 2", and 3" thicknesses.

5 APPLICATIONS

5.1 General Requirements

- 5.1.1 The following are minimum installation requirements for GreenGuard® XPS Insulation Board when applied to light-frame wall framing members.
 - 5.1.1.1 Light-frame wood framing members supporting GreenGuard® XPS Insulation Board shall have a nominal thickness of not less than 2" (1½" actual).
 - 5.1.1.2 Light-frame steel framing members shall have a flange width of not less than 1½" (including bend radius at web and lip).
 - 5.1.1.3 Framing members shall be spaced a maximum of 24" o.c.
 - 5.1.1.3.1 GreenGuard® XPS Insulation Board shall be attached to the wall framing in accordance with the manufacturer's installation instructions and this TER.
 - 5.1.1.3.2 All sheathing edges shall be supported by wall framing or blocking.

5.2 Wind Pressure Requirements

5.2.1 General:

- 5.2.1.1 Where the application exceeds the limitations set forth herein, design shall be permitted in accordance with accepted engineering procedures, experience, and technical judgment.
- 5.2.1.2 When fastened directly to light-frame wall members (i.e., studs), GreenGuard® XPS Insulation Board shall comply with the requirements of Section 5.2, in accordance with IBC Section 104.11, IRC Section R104.11 and ASTM C578, as applicable.
- 5.2.1.3 When installed as over-sheathing, GreenGuard® XPS Insulation Board shall not be required to comply with this TER.

5.2.2 *Specific Requirements:*

5.2.2.1 When using *ASCE 7-16* as referenced by the *2018 IBC* for the conditions listed in Section 5.2.2.2, the wind pressures listed in *ASCE 7* shall be multiplied by a factor of 0.6 to convert them to ASD level loads and then compared to the values in Table 1.

TABLE 1. ALLOWABLE WIND PRESSURE RESISTANCE VALUES (PSF) FOR KINGSPAN® GREENGUARD® XPS INSULATION BOARDS USED IN EXTERIOR WALL COVERING ASSEMBLIES

Kingspan® XPS Products ²	Sheathing Thickness (in)	Allowable (ASD) Components & Cladding Design Wind Pressure (psf)	
		16" o.c. Framing	24" o.c. Framing
GreenGuard® XPS Insulation Board	½	19.5	NP
	¾	25.9	20.5
	1	38.4 ³	30.6
	1½	72.8	41.3
	2	122	53.7 ³
	3	260	139.4
GreenGuard® PLYGOOD® Ultra (PGU)	7/16	78.6	61.4

SI: 1in = 25.4 mm, 1 pound per square foot (psf) = 0.0479 kPa., NP = not permitted

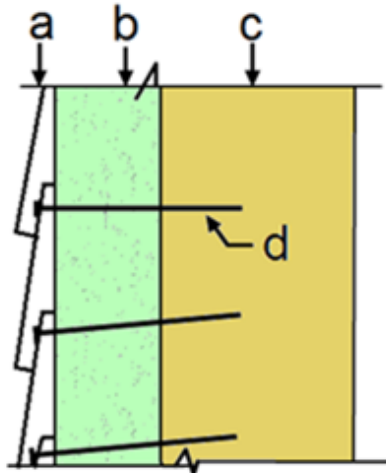
1. Linear interpolation shall not be permitted.
2. Table 1 shall be used in accordance with requirements of **Section 6.1**. Allowable design wind pressure ratings are based on *ASTM E330* testing in accordance with *IBC Section 1609* and *IRC Section 301.2*. These values were determined in accordance with *ANSI/SBCA FS100* for a fully-blocked condition (i.e., all horizontal and vertical sheathing joints supported on blocking or framing members) using a PEF of 1.0.
3. Based on yield load in accordance with *ANSI/SBCA FS100*.
4. Table values for the 3" GreenGuard® XPS Insulation Board are limited to sheathing panels installed with the length dimension parallel to the framing.
5. Design values are applicable to the bending strength of the product only. Fastening to resist wind loads must be achieved by separate specification for attachment of the foam and/or the cladding system over the foam sheathing in addition to the manufacturer's minimum attachment requirements.

5.2.2.2 The minimum thickness of GreenGuard® XPS Insulation Board shall comply with Table 1, for one of the following two conditions:

5.2.2.2.1 Where the GreenGuard® XPS Insulation Board is directly constrained by a code-compliant cladding material (i.e., no gap between the cladding and GreenGuard® XPS Insulation Board product, as shown in Figure 1), the components and cladding design wind pressure determined in accordance with *IRC Section R301.2* or *IBC Section 1609.1* shall not exceed the allowable wind pressure value of the FPIS product per Table 1.

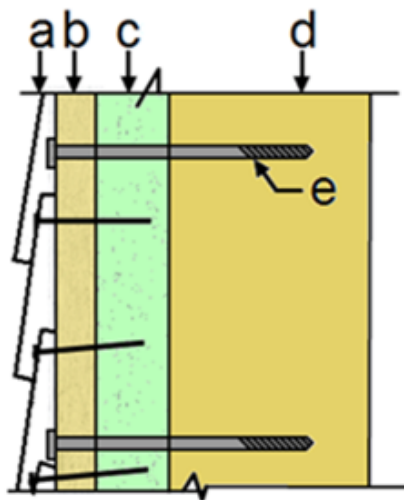
5.2.2.2.2 Where a code-compliant cladding system is installed over but not directly on the surface of the GreenGuard® XPS Insulation Board such that there is a space between the sheathing and the cladding (e.g., furring is used over GreenGuard® XPS Insulation Board product, as shown in Figure 2), the components and cladding design wind pressure determined in accordance with *IRC Section R301.2* or *IBC Section 1609.1* shall not exceed the allowable wind pressure value of GreenGuard® XPS Insulation Board, per Table 1.





- a. Cladding material and fasteners
- b. GreenGuard® Insulation Board
- c. Wall framing per code (i.e., wood or steel studs)
- d. Cladding fastener per code and of minimum size to support cladding weight

FIGURE 1. EXTERIOR WALL COVERING ASSEMBLY WITH CLADDING INSTALLED DIRECTLY OVER GREENGUARD® INSULATION BOARD



- a. Cladding material and fasteners
- b. Wood or steel furring (which battens the foam sheathing to the wall framing and creates an airspace between the foam sheathing and the cladding)
- c. GreenGuard® Insulation Board
- d. Wall framing per code (i.e., wood or steel studs)
- e. Furring fastener by design and with minimum size to support cladding weight

FIGURE 2. EXTERIOR WALL COVERING ASSEMBLY WITH CLADDING & FURRING INSTALLED OVER GREENGUARD® INSULATION BOARD

5.2.2.3 The basic wind speed for GreenGuard® XPS Insulation Board shall not exceed the values in Table 2.

TABLE 2. BASIC WIND SPEED VALUES (MPH) FOR KINGSPAN® GREENGUARD® XPS INSULATION BOARDS USED IN EXTERIOR WALL COVERING ASSEMBLIES BASED ON ASCE 7-10 THREE-SECOND GUST

Kingspan® XPS Products	Sheathing Thickness (in)	Components & Cladding Basic Wind Speed (mph)	
		16" o.c. Framing	24" o.c. Framing
GreenGuard® XPS Insulation Board	½	115	NP
	¾	130	115
	1	160	140
	1½	200	160
	2	200	180
	3	200	200
	7/16 PGU	200	190

SI: 1 in = 25.4 mm, 1 mph = 1.61 km/h
 1. Allowable wind speeds are based on the following: Mean roof height – 30', Exposure B, 10 sq. ft. effective wind area.

- 5.2.2.4 Except as noted in Table 1, footnote 4, GreenGuard® XPS Insulation Board can be oriented with the length dimension parallel or perpendicular to the wall framing members. When perpendicular to framing members, horizontal joints shall be supported by blocking, unless use of unblocked joints qualifies in accordance with IBC Section 104.11, IRC Section R104.11 and ASTM C578, as applicable.
- 5.3 *Water-Resistive Barrier*
 - 5.3.1 GreenGuard® Insulation Product (Note: Applies to both XPS Insulation Boards and PGU) may be used as a WRB as prescribed in IRC Section R703.2 and IBC Section 1403.2⁶, when installed on exterior walls as described in this section.
 - 5.3.2 GreenGuard® Insulation Products shall be installed with board joints placed directly over exterior framing spaced a maximum of 24" (610 mm) o.c. The fasteners used to attach the board shall be installed in accordance with Section 6.
 - 5.3.3 All seams and joints between boards shall be butt jointed and sealed with an approved construction tape in accordance with Section 6. Approved construction tapes include 1 $\frac{7}{8}$ " GreenGuard® Seam Tape or equivalent except:
 - 5.3.3.1 7/16" PGU approved construction tape shall be a minimum 3" GreenGuard® Seam Tape or equivalent.
 - 5.3.4 A separate WRB may also be provided. If a separate WRB method is used, taping of the sheathing joints is not required.
 - 5.3.5 Flashing must be installed at all sheathing penetrations and shall comply with all applicable code sections.
- 5.4 *Air Barrier*
 - 5.4.1 GreenGuard® XPS Insulation Board may be used as an air barrier material as prescribed in IRC Section N1102.4.1.1 and IECC Section R402.4.1.1 and C402.5.1.
 - 5.4.2 When used as part of a continuous air barrier, GreenGuard® XPS Insulation Board shall be installed as follows:
 - 5.4.2.1 All sheathing panel edges at the top and bottom of the wall assemblies and all butted joints between sheathing panels shall be sealed with an approved seam tape, self-adhering flashing or sealant.
- 5.5 Where the application exceeds the limitations set forth herein, design shall be permitted in accordance with accepted engineering procedures, experience, and technical judgment.

6 INSTALLATION

- 6.1 Installation shall comply with the manufacturer's installation instructions and this TER. In the event of a conflict between the manufacturer's installation instructions and this TER, the more restrictive shall govern.
- 6.2 *GreenGuard® XPS Insulation Board Installation*
 - 6.2.1 Refer to the manufacturer's installation instructions, in addition to this TER, for complete details and requirements.
 - 6.2.2 All required wall bracing shall be installed prior to insulation board installation.
 - 6.2.3 The insulation boards should be oriented with the printed side facing the exterior side of the building.
 - 6.2.3.1 Except as noted in Table 1, footnote 4, GreenGuard® XPS Insulation Board can be oriented with the length dimension parallel or perpendicular to the wall framing members. When perpendicular to framing members, horizontal joints shall be supported by blocking, unless use of unblocked joints qualifies in accordance with IBC Section 104.11, IRC Section R104.11 and ASTM C578, as applicable.
 - 6.2.4 Secure the sheathing to framing members with fasteners capable of resisting the imposed loads in accordance with NDS. Fasteners will vary, depending on the substrate and cladding materials.

⁶ 2015 IBC Section 1404.2

- 6.2.4.1 Fastener heads shall be a minimum of 3/8" diameter. Do not allow the fastener head to penetrate the sheathing facer. Use of washers at the fastener head is recommended.
 - 6.2.4.2 Space fasteners 12" o.c. in both the field and perimeter.
 - 6.2.4.3 Minimum penetration of the fasteners into the substrate is 3/4".
- 6.3 *Cladding Installation*
- 6.3.1 Wind pressure rating adjustments for vinyl siding installed directly over GreenGuard® XPS Insulation Board shall comply with IRC Section R703.11.2 for buildings constructed under the *IRC* or *IBC*.
 - 6.3.2 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 the GreenGuard® XPS Insulation Board.
 - 6.3.3 Wall assemblies that include GreenGuard® XPS Insulation Board 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 IRC Section R602.10, IBC Section 2308.6, or a design in accordance with IRC Section R301 or IBC Section 2305, as applicable.
 - 6.3.4 Wall assemblies with GreenGuard® XPS Insulation Board 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.

7 TEST ENGINEERING SUBSTANTIATING DATA

- 7.1 Test reports and data supporting the following material properties:
 - 7.1.1 Air barrier material in accordance with *ASTM E2178*.
 - 7.1.2 Water-resistive barrier in accordance with *ASTM E331*.
 - 7.1.3 Wind pressure resistance in accordance with *SBCA ANSI/FS 100*.
- 7.2 *Attaching Exterior Wall Coverings through Foam Sheathing to Wood or Steel Wall Framing, FSC Tech Matters.*
- 7.3 Some information contained herein is the result of testing and/or data analysis by other sources which conform to IBC Section 1703 and relevant professional engineering law. DrJ relies on accurate data from these sources to perform engineering analysis. DrJ has reviewed and found the data provided by other professional sources to be credible.
- 7.4 Where appropriate, DrJ's analysis is based on design values that have been codified into law through codes and standards (e.g., *IBC*, *IRC*, *NDS*®, and *SDPWS*). This includes review of code provisions and any related test data that aids in comparative analysis or provides support for equivalency to an intended end-use application. Where the accuracy of design values provided herein is reliant upon the published properties of commodity materials (e.g., lumber, steel, and concrete), DrJ relies upon the grade mark, stamp, and/or design values provided by raw material suppliers to be accurate and conforming to the mechanical properties defined in the relevant material standard.

8 FINDINGS

- 8.1 When used and installed in accordance with this TER and the manufacturer's installation instructions, the product(s) listed in Section 1.1 are approved for the following:
- 8.1.1 Performance for use as a WRB in accordance with IRC Section R703.2 and IBC Section 1404.2⁷.
 - 8.1.2 Performance for use as an air barrier in accordance with IRC Section N1102.4.1.1 and IECC Section R402.4.1.1.
 - 8.1.3 Transverse load resistance due to components and cladding pressures on building surfaces as defined in Section 5.
- 8.2 IBC Section 104.11 (IRC Section R104.11 and IFC Section 104.9 are similar) states:
- 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, not less than the equivalent of that prescribed in this code...Where the alternative material, design or method of construction is not *approved*, the *building official* shall respond in writing, stating the reasons the alternative was not *approved*.
- 8.3 This product has been evaluated in the context of the codes listed in Section 2 and is compliant with all known state and local building codes. Where there are known variations in state or local codes applicable to this evaluation, they are listed here.
- 8.3.1 No known variations

9 CONDITIONS OF USE

- 9.1 GreenGuard® XPS Insulation Board listed herein complies with, or is a suitable alternative to, the applicable sections of the IBC and IRC and is subject to the following conditions.
- 9.1.1 These products shall be installed in compliance with the manufacturer's instructions, the applicable building code and this TER.
 - 9.1.2 The manufacturer shall provide the building official and purchaser with evidence of code compliance for matters beyond the wind pressure resistance scope of this TER.
- 9.2 Where required by the *building official*, also known as the authority having jurisdiction (AHJ) in which the project is to be constructed, this TER and the installation instructions shall be submitted at the time of *permit* application.
- 9.3 Any generally accepted engineering calculations needed to show compliance with this TER shall be submitted to the AHJ for review and approval.
- 9.4 Design loads shall be determined in accordance with the building code adopted by the *jurisdiction* in which the project is to be constructed and/or by the Building Designer (e.g., *owner* or *registered design professional*).
- 9.5 At a minimum, this product shall be installed per Section 6 of this TER.
- 9.6 This product is manufactured under a third-party quality control program in accordance with IBC Section 104.4 and 110.4 and IRC Section R104.4 and R109.2.
- 9.7 The actual design, suitability, and use of this TER, for any particular building, is the responsibility of the *owner* or the owner's authorized agent. Therefore, the TER shall be reviewed for code compliance by the *building official* for acceptance.

⁷ 2015 IBC Section 1405.2

- 9.8 The use of this TER is dependent on the manufacturer's in-plant QC, the ISO/IEC 17020 third-party quality assurance program and procedures, proper installation per the manufacturer's instructions, the building official's inspection, and any other code requirements that may apply to demonstrate and verify compliance with the applicable building code.

10 IDENTIFICATION

- 10.1 The product(s) listed in Section 1.1 are identified by a label on the board or packaging material bearing the manufacturer's name, product name, TER number, and other information to confirm code compliance.
- 10.2 Additional technical information can be found at www.kingspaninsulation.us.

11 REVIEW SCHEDULE

- 11.1 This TER is subject to periodic review and revision. For the most recent version of this TER, visit drjcertification.org.
- 11.2 For information on the current status of this TER, contact [DrJ Certification](#).