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Standard Specification for Insulated Vinyl Siding[1]

This standard is issued under the fixed designation D7793; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification establishes requirements for insulated vinyl siding, which is vinyl siding with integral foam plastic insulating material, where the vinyl siding is manufactured from rigid PVC compound. Compliance with this standard requires insulated vinyl siding to demonstrate a thermal insulation value of R-2.0 or greater. Other performance requirements and test methods addressed by this standard include materials properties and dimensions, warp, shrinkage, impact strength, expansion, appearance, thermal distortion resistance, and windload resistance. Methods of indicating compliance with this specification are also provided.

NOTE 1—Insulated vinyl siding is composed of two major components: the vinyl siding and the insulating material. It is intended that the vinyl siding portion comply with Specification D3679. Applicable portions of Specification D3679 are included in this specification. Additional requirements that pertain only to the insulation as a separate material, or to the combination of vinyl siding and insulation as a whole, are also included. For further explanation, see Appendix X1.

1.2 Insulated vinyl siding shall be tested with the insulation material in place or removed, as specified in the applicable requirement or test method.

1.3 The use of PVC recycled plastic in this product shall be in accordance with the requirements in Section 4.

1.4 Insulated vinyl siding produced to this specification shall be installed in accordance with Practice D4756. Reference shall also be made to the manufacturer's installation instructions for the specific product to be installed.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 2—There is no known ISO equivalent to this standard.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C297/C297M Test Method for Flatwise Tensile Strength of Sandwich Constructions

C578 Specification for Rigid, Cellular Polystyrene Thermal Insulation

C591 Specification for Unfaced Preformed Rigid Cellular PolyisocyanurateThermal Insulation

C1199 Test Method for Measuring the Steady-State Thermal Transmittance of Fenestration Systems Using Hot Box Methods

C1289 Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board

C1363 Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus

D618 Practice for Conditioning Plastics for Testing

D635 Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

D696 Test Method for Coefficient of Linear Thermal Expansion of Plastics Between −30°C and 30°C with a Vitreous Silica Dilatometer

D1042 Test Method for Linear Dimensional Changes of Plastics Caused by Exposure to Heat and Moisture

D1183 Practices for Resistance of Adhesives to Cyclic Laboratory Aging Conditions

D1435 Practice for Outdoor Weathering of Plastics

D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

D2457 Test Method for Specular Gloss of Plastic Films and Solid Plastics

[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.24 on Plastic Building Products.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

D3679 Specification for Rigid Poly(Vinyl Chloride) (PVC) Siding
D3892 Practice for Packaging/Packing of Plastics
D4226 Test Methods for Impact Resistance of Rigid Poly-(Vinyl Chloride) (PVC) Building Products
D4756 Practice for Installation of Rigid Poly(Vinyl Chloride) (PVC) Siding and Soffit
D5206 Test Method for Windload Resistance of Rigid Plastic Siding
D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens
D7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products (Withdrawn 2015)[3]
D7445 Specification for Rigid Poly(Vinyl Chloride) (PVC) Siding with Foam Plastic Backing (Backed Vinyl Siding)
E84 Test Method for Surface Burning Characteristics of Building Materials
E1753 Practice for Use of Qualitative Chemical Spot Test Kits for Detection of Lead in Dry Paint Films
G147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests

2.2 *American Society of Civil Engineers (ASCE):*[4]
ASCE 7-10 Minimum Design Loads for Buildings and Other Structures

2.3 *International Code Council*
International Building Code
International Residential Code

2.4 *International Code Council–Evaluation Services (ICC-ES):*
AC05 Acceptance Criteria for Sandwich Panel Adhesives

2.5 *International Standards Organization (ISO):*
ISO/IEC Guide 65 General requirements for bodies operating product certification systems

2.6 *Structural Building Components Association:*
ANSI/SBCA FS 100-2012 Standard Requirements for Wind Pressure Resistance of Foam Plastic Insulating Sheathing Used in Exterior Wall Covering Assemblies

2.7 *Vinyl Siding Institute, Inc.*
VSI Vinyl Siding Installation Manual (2015)

2.8 *Federal Standards:*
6 CFR Part 460 Labeling and Advertising of Home Insulation

3. Terminology

3.1 *Definitions:*

3.1.1 *center-pinning*—an installation technique in which the siding panel is fastened tightly through the nail slot at the center length of the panel, in order to cause thermal expansion and contraction to occur equally in both directions from the center.

3.1.2 *cohesive failure*—in the context of tensile testing, internal separation of the adhesive within the adhesive layer, resulting in attachment of adhesive material to the surface of both substrates

3.1.3 *insulation; insulating material*—foam plastic material that is combined at the factory with a vinyl siding profile to form insulated vinyl siding.

3.1.4 *insulated vinyl siding*—a vinyl cladding product sold with manufacturer-installed foam plastic insulating material as an integral part of the cladding product. The vinyl cladding portion of insulated vinyl siding meets the definition of vinyl siding.

3.1.5 *nominal*—the value that a manufacturer consistently uses to represent a specific property or dimension of a vinyl siding product in public claims including, but not limited to, product literature, advertisements, quotations, and certificates of conformance.

3.1.6 *process average thickness*—the rolling, arithmetic mean of average specimen thicknesses measured in accordance with 6.5 for a specific product during all productions runs for the most recent six-month period.

3.1.7 *vertical coverage*—The net vertical distance of the wall covered by a single insulated vinyl siding panel, disregarding any portions of the panel that are overlapped by adjacent panels above or below.

3.1.8 *temperate northern climate*—in weather testing, a North American metropolitan area testing site located within 73 to 100°W longitude and 37 to 45°N latitude.

3.1.9 *vinyl siding*—a shaped material, made principally from rigid poly(vinyl chloride) (PVC), that is used to clad exterior walls of buildings. In this standard, vinyl siding refers to the rigid profile to which the insulation is attached.

3.1.10 *wind load design pressure rating*—the maximum wind pressure that an insulated vinyl siding product is rated to withstand, based on testing under Test Method D5206.

3.1.10.1 *standard wind load design pressure rating*—the wind load design pressure rating for a siding product when installed 1) over a sheathing material designed and attached such that it is capable of resisting 100% of positive and negative wind pressures occurring under design conditions at the building location; and 2) with the standard fastening method specified in building codes, general installation instructions, and the siding manufacturer's instructions.

3.1.10.2 *alternative wind load design pressure rating*—the wind load design pressure rating for a siding product when installed over a sheathing not designed and attached such that it is capable of resisting 100% of positive and negative wind pressures occurring under design conditions at the building location, or when the siding is not fastened in the standard way; as specified by the manufacturer.

3.1.10.3 *Discussion*—The standard test conditions, configuration, and fastening method used in this specification are specified in 6.14, while alternative sheathing and installation conditions are specified by the manufacturer and must be reflected in the product's installation instructions. Alternative

[3] The last approved version of this historical standard is referenced on www.astm.org.
[4] Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, http://www.asce.org.

ratings apply only when the specified sheathing and fastening conditions are used. See Annex A1 for information on differences between the standard wind load design pressure rating and alternative wind load design pressure ratings, and how to determine standard and alternative design pressure ratings.

4. Materials and Manufacture

4.1 *Vinyl Siding:*

4.1.1 The vinyl siding, exclusive of foam plastic insulating material, shall be made of one or more layers of poly(vinyl chloride) (PVC) compound. Any layers of materials other than poly (vinyl chloride) (PVC) compound shall be kept to less than 20 % by volume. This limitation does not apply to the insulation material.

4.1.2 Where rigid PVC recycled plastic as defined in Guide D7209 is used, the vinyl siding containing the PVC recycled plastic shall meet all of the requirements of Sections 3, 4, and 5.

4.1.3 The vinyl siding material, exclusive of insulation material, when tested in accordance with Test Method D635, shall not exceed an average extent of burn of 4 in. (100 mm), with an average time of burn not to exceed 10 seconds. A minimum sample thickness of 0.035 in. (0.9 mm) is required. (**Warning—**The flammability testing data, conclusions, and recommendations of Test Method D635 relate solely to the measurement and description of properties for classification of the vinyl siding material in response to flame under controlled laboratory conditions and shall not be used for the description or appraisal of the fire hazard of vinyl siding under actual fire conditions.)

4.2 *Foam Plastic Insulation:*

4.2.1 The foam plastic insulation shall be made of one of the following materials:

4.2.1.1 Expanded polystyrene complying with Specification C578.

4.2.1.2 Extruded polystyrene complying with Specification C578

4.2.1.3 Polyisocyanurate complying with Specification C591 or Specification C1289

4.2.2 The foam plastic insulation shall have a Flame Spread Index not greater than 75 and a Smoke Developed Index not greater than 450 when tested separately under Test Method E84.

4.3 *Adhesives:*

4.3.1 The suitability for outdoor use of an adhesive used to bond the vinyl siding and the insulation, if any, shall be determined by the following procedure.

4.3.1.1 Prepare a minimum of 10 specimens consisting of two Douglas fir-larch blocks or other appropriate substrates, bonded by the adhesive, in accordance with Test Method C297/C297M. Each block is to be 2.0 inches square. The adhesive shall be applied and cured in accordance with the adhesive manufacturer's instructions.

(1) The material selected for use as the substrate shall be capable of withstanding the accelerated aging described in 4.3.1.2 without damage or deterioration of the substrate.

NOTE 3—Other appropriate substrates, such as metal or plastic, compatible with the adhesive according to the manufacturer's guidelines, can be used in place of the Douglas fir-larch blocks. Because in accordance with 4.3.1.4.1 at least 75 % of samples must fail in a cohesive mode, a substrate should be selected that is expected to be stronger than the adhesive and which will form a tight bond with the adhesive.

4.3.1.2 Subject 50 percent of the specimens to accelerated aging under Test Method D1183, Test Condition C, for three cycles. The low-temperature portion of the cycle is not required to be colder than -40°F (-40°C) and the relative humidity during this portion of the cycle shall not be greater than 10 % RH.

4.3.1.3 Condition and test all of the specimens in accordance with Test Method C297/C297M.

4.3.1.4 *Acceptable Performance*—Acceptable performance of the adhesive is demonstrated by one of the following means:

(1) When tested in accordance with 4.3.1.3, the samples demonstrate performance in accordance with either (*a*), (*b*), or (*c*).

(a) For a valid test, the mode of failure for no fewer than 75 % of the specimens shall be cohesive. Only specimens that failed cohesively are counted in the following. The average ultimate tensile strength of the samples that were subjected to accelerated aging shall not be less than 80 % of the average ultimate tensile strength of the specimens that were subjected to conditioning only.

(b) None of five aged specimens fails cohesively under a tensile load less than or equal to 100 psi at a pull rate (crosshead speed) of 0.02 in./min. Only specimens that fail cohesively or do not fail are counted. Specimens that fail non-cohesively under a load at or below 100 psi are discarded and another specimen is tested until five specimens have either failed cohesively, or have not failed at or below 100 psi. Adhesives qualified under this method are limited to use with foam insulation having a tensile strength not greater than 100 psi.

(c) The following applies when the average elongation at yield of the specimens that were subjected to conditioning only is 200 % or greater: the average stress of the aged specimens is not less than 80 percent of that of the specimens that were subjected to conditioning only, when measured at an elongation 75 % of the elongation at yield for each specimen.

(2) As an alternative, adhesives that are covered by a current report, issued by an agency accredited under ISO Guide 65, as a Type I, Class 2 adhesive in accordance with Acceptance Criteria AC05, will have exhibited acceptable performance under the above procedure.

NOTE 4—Compatibility of the adhesive with the vinyl siding and insulation used in the insulated vinyl siding is evaluated separately, under 5.2.4.

4.4 *Insulated Vinyl Siding:*

4.4.1 Insulated vinyl siding shall not contain elemental lead (Pb) or compounds of that material other than traces incidental to raw materials or the manufacturing process. This limitation applies to both PVC substrate and to any cap or film material, as well as the insulation material. Compliance with this requirement shall be demonstrated by one of the methods in 6.16.

5. Physical Requirements

5.1 *Requirements Applicable to Vinyl Siding*—The provisions of 5.1.1 – 5.1.8 apply only to the vinyl siding, exclusive of any insulation material. Where necessary to perform testing, the insulation material shall be removed.

5.1.1 *Length and Width*—The nominal length and width of the vinyl siding shall be as agreed upon between the purchaser and the seller. The actual length shall not be less than ¼ in. (6.4 mm) of the nominal length and the actual width shall be within ±1⁄16 in. (1.6 mm) of the nominal width when measured in accordance with 6.3 and 6.4.

5.1.2 *Thickness*—These requirements pertain only to measurements of the portions of the vinyl siding that are exposed after installation of the panel, measured in accordance with the procedure in 6.5. The average thickness of each specimen shall be no less than 0.035 in. No individual measurement shall be thinner than 0.003 in. below the nominal thickness. The process average thickness as defined in 3.1.6 shall be no thinner than 0.001 in. below the nominal thickness.

5.1.3 *Camber*—A full length of vinyl siding (typically 10 or 12 ft (3.05 or 3.61 m)) shall not have a camber greater than ⅛ in. (3.2 mm) when measured in accordance with 6.6.

5.1.4 *Heat Shrinkage*—The average heat shrinkage shall not exceed 3.0 % when determined by the method described in 6.7.

5.1.5 *Impact Resistance*—The vinyl siding shall have a minimum impact strength of 60 in.•lbf (6.78 J) when tested in accordance with 6.8.

5.1.6 *Gloss*—The gloss of smooth and embossed vinyl siding shall be uniform across the exposed surface. The average of all readings for a panel determined in 6.11.2.5 shall not differ from the manufacturer's specified gloss value more than the permitted variation in Table 1, and each individual reading shall not vary more than 10 points from the average. Gloss of smooth and embossed vinyl siding shall be tested in accordance with 6.11.

5.1.7 *Uniformity of Color*—The color specified shall be uniform on the exposed surface of the vinyl siding panels, except in the case of variegated colors. When tested in accordance with 6.13, the total color change, ΔE, between a production specimen and the appropriate reference specimen or agreed-upon color coordinates shall not vary by more than 1.5, and the chromatic coordinates thereof shall not change by more than $\pm\Delta a_H = 1.0$ and $\pm\Delta b_H = 1.0$.

5.1.8 *Weathering*—The vinyl siding shall maintain a uniform color and be free of any visual surface or structural changes such as peeling, chipping, cracking, flaking, and pitting when tested in accordance with 6.10.

5.1.9 *Coefficient of Linear Expansion*—The vinyl siding shall have a coefficient of linear expansion not greater than 4.5 by 10^{-5} in./in./°F (8.1 by 10^{-5} mm/mm/°C) when tested in accordance with 6.9.

TABLE 1 Gloss Values

Manufacturer's Specified Gloss Value	Permitted difference from Manufacturer's Specified Gloss Value
Less than or equal to 35	±8
Greater than 35	±10

5.2 *Requirements Applicable to Insulated Vinyl Siding*—The provisions of 5.2.1–5.2.5 apply to insulated vinyl siding, including the integral foam insulation material. Testing shall be conducted on both the vinyl siding and the insulating material, or with the insulating material in place, as described in the referenced test method.

5.2.1 *Thermal Distortion*—The insulated vinyl siding shall be free of bulges, waves, and ripples, and an overlap shall not open more than ¼ in. (6 mm) when tested to a minimum temperature of 150°F (66°C) in accordance with the procedure in 6.12.

5.2.2 *Wind Load Resistance*—The siding shall withstand a minimum static test pressure and a standard wind load design pressure rating shall be determined.

5.2.2.1 *Minimum Test Pressure*—Insulated vinyl siding shall be able to withstand a minimum test pressure of 22.5 lbf/ft^2 (1077 Pa) when tested in accordance with 6.14. The average maximum sustained static pressure determined in 6.14 shall be equal to or greater than this value. If the manufacturer of insulated vinyl siding provides documentation to support compensation for pressure equalization, the test pressure shall be determined from Annex A1 using the documented pressure equalization factor.

NOTE 5—The static test pressure of 22.5 lbf/ft^2 (1077 Pa) for insulated siding was established to withstand structural loading conditions that occur in wind exposures of approximately 110 mph (177 km/h) (V_{ASD}) for mean roof heights of 30 ft (9.1 m) and less in exposure category B, and corresponds to 30.0 lbf/ft^2 (1436 Pa) negative design pressure, to match the default wind design conditions of Table R703.3(1) in the 2015 International Residential Code. Provision is made for compensation for pressure equalization specific to the product if supporting documentation is provided, using procedures in Annex A1.

NOTE 6—Refer to Annex A1 for an explanation as to how the negative design pressure was established, and for applications where the effective negative design pressure as specified in ASCE 7-10 is different from 30.0 lbf/ft^2 (1436 Pa) (for example, wind-zone areas greater than about 110 mph (177 km/h) (V_{ASD}) (225 km/h (V_{ULT})) or mean roof height above 30 ft (9.1 m), or exposures other than exposure category B).

(1) The design-pressure values can be negative (suction loads) or positive. The negative values are the largest in magnitude and are the values used in this specification.

NOTE 7—In that the insulated vinyl siding is being tested as a weather-resistant exterior product applied to an existing exterior structural wall, forces (negative) working to pull the insulated vinyl siding off the wall, fasteners, or disengage locks will be the most important criteria for testing. Positive wind forces test the integrity of the total wall sections, and do not provide a measure of the performance of the insulated vinyl siding.

5.2.2.2 *Standard Wind Load Design Pressure Rating*—The standard wind load design pressure rating shall be determined from the results of testing in accordance with 6.14, using the procedures described in A1.3.

NOTE 8—The standard design pressure rating is valid for applications where the siding is installed over sheathing and its fastening that are capable of independently resisting both positive and negative wind pressures occurring under design conditions at the building location. For applications over other sheathing, a different design pressure rating is applicable, and is determined in accordance with A1.3. Determination of a rating other than the standard design pressure rating is not required by this section.

5.2.2.3 *Alternative Design Pressure Ratings*—Design pressure ratings other than the standard wind load design pressure

rating, for use with different sheathing materials or using different installation or fastening, are permitted to be determined in accordance with testing under 6.14, using the procedures in Annex A1.

5.2.3 *Nail Slot Allowance for Thermal Expansion*—For vinyl siding panels utilizing nail slots to allow for thermal expansion and contraction, the nail slot shall be sized to allow for the expected range of expansion and contraction over a range of 100°F. Compliance with this requirement shall be demonstrated either by the test method in 6.15 or by sizing of the nail slots according to the specifications in the following sections. The instrument used shall be capable of measuring to the nearest 0.01 in. The manufacturing tolerance shall not exceed -0.030 inches.

5.2.3.1 For panels shorter than 6 ft (1829 mm) in length, the minimum nail slot width shall be ⅜ in. (11.4 mm).

5.2.3.2 For panels 6 ft (1829 mm) in length or longer the minimum nail slot width shall be determined according to the following formula. The minimum width shall be the width resulting from application of the formula, rounded to the next lower quarter-inch. Regardless of the results of the calculation, the minimum nail slot width for panels 6 feet or longer shall be 1 in. (25.4 mm).

$$WS = P_c \times (\alpha \times 100°F \times L) + T_c \quad (1)$$

where:

WS = Minimum width of nail slot, in.
P_c = Center-pinning coefficient: 1 if manufacturer's instructions require panel to be center-pinned; 1.5 if center-pinning is not required
α = Coefficient of linear thermal expansion, 4.5×10^{-5} in./in./°F or actual known coefficient for vinyl siding used, as determined by 6.9
L = Length of panel, inches
T_c = Centering tolerance: 0.25 in.

5.2.4 *Compatibility of Adhesives*—When subjected to cyclical conditioning and tested in accordance with 6.17, samples composed of the vinyl siding and insulation bonded with the adhesive, if any, used in the insulated vinyl siding shall not exhibit a decrease in average ultimate tensile strength greater than 20 %, compared to samples not subjected to cyclical conditioning. This requirement is not applicable to insulated vinyl siding that does not contain any adhesive.

5.2.5 *Thermal Insulation Value*—The thermal insulation value (R-value) of the insulated vinyl siding shall be not less than R-2.0 when measured in accordance with 6.18.

6. Test Methods

6.1 *General*—The inspection and test procedures contained in this section are used to determine the conformance of products to the requirements of this specification.

NOTE 9—Each producer who represents its products as conforming to this specification typically uses statistically based sampling plans that are appropriate for each manufacturing process to verify on-going compliance. Specifications for quality control programs are beyond the scope of this Standard Specification. Additional sampling and testing of the product, as agreed upon between the purchaser and the manufacturer, are not precluded by this section.

6.2 *Conditioning and Test Conditions*—Condition the test specimen in accordance with Procedure A of Practice D618 and test under those conditions, unless otherwise specified herein.

6.3 *Length*—Lay the specimen on a flat surface and measure with a steel tape that has been verified as accurate to within ±1⁄16 in. (1.6 mm) against a calibrated standard. Measure the length of a vinyl siding panel to the nearest 1⁄16 in. (1.6 mm) at the center, the butt edge, and the bottom of the top lock. The average of the three measurements is the actual length.

6.4 *Width*—Interlock two specimens, each at least 26 in. (660 mm) long, in the normal mode for installation. Lay the two specimens on a flat surface. Measure to the nearest 1⁄16 in. (1.6 mm), the distance between the lowest butt edge of the top specimen and the lowest butt edge of the bottom specimen. Commencing approximately one in. (25 mm) from one end of the specimens, make five measurements at 6-in. (152-mm) intervals, making sure that the measurement is made perpendicular to the butt edge. Average the measurements. The average constitutes the exposed width of vinyl siding.

6.5 *Thickness*—Thickness shall be measured in accordance with Test Method A of Test Method D5947. The micrometer shall be calibrated in accordance with Section 8 of Test Method D5947. The thickness of the vinyl siding shall be measured at a minimum of five locations equally spaced across the entire portion of the vinyl siding that will be exposed after installation. All measurements shall be taken to the nearest 0.001 in. Calculate and report the average of these measurements. Also report the thinnest individual measurement.

6.6 *Camber*—Place a full length of vinyl siding (typically 10 or 12 ft (3.05 or 3.61 m)) on a flat surface alongside a straightedge at least as long as the vinyl siding specimen. Measure the maximum space between the edge of the vinyl siding specimen and the straightedge for each edge to the nearest 1⁄16 in. (1.6 mm).

6.7 *Heat Shrinkage:*

6.7.1 *Apparatus:*

6.7.1.1 *Scriber,* similar to that described in Test Method D1042, with the exception that the needle points shall be separated by 10 ± 0.01 in. (254 ± 0.254 mm).

6.7.1.2 *Test Media,* a controlled-temperature water bath of 5 gal (10 L) or more, equipped with an efficient stirrer that will maintain uniform temperature throughout. Heater and temperature-control devices must maintain the water at 160 ± 1°F (71 ± 0.5°C). Use a wire rack to raise and lower specimens into the water bath. As an alternative to the use of a water bath, heat the specimens for 30 min in a uniformly heated forced-air oven maintained at a temperature of 160 ± 1°F (71 ± 0.5°C).

6.7.1.3 Make measurements with any device capable of measuring the distance between two scribe marks to the nearest 0.01 in. (0.254 mm).

6.7.2 *Procedure:*

6.7.2.1 Cut three specimens from the vinyl siding panel, each 1 in. (25.4 mm) wide by 12 in. (305 mm) long. Cut one specimen from the center and one from each of the extreme edges of the flat surface. The long axis shall be parallel to the machine direction.

6.7.2.2 Condition specimens at 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 10 % relative humidity for at least 24 hours.

6.7.2.3 Make a slight mark with the scribe on each specimen so that a reference point will be clearly visible.

6.7.2.4 Place specimens in the test medium.

6.7.2.5 Remove specimens after 30 min and place on a flat surface until cool.

6.7.2.6 Repeat conditioning in accordance with 6.7.2.2.

6.7.2.7 Make a second mark with the scribe on each specimen, using the same center.

6.7.2.8 Measure the distance, D, between the scribe marks to the nearest 0.01 in. (0.254 mm).

6.7.2.9 Calculate the percent shrinkage as (D/10) × 100.

6.7.2.10 Report the average shrinkage of the three specimens tested.

6.8 *Impact Resistance*—Test impact resistance of vinyl siding in accordance with Test Method D4226, Procedure A, impactor head configuration H.25. 4 in.-lb increments (0.5 in. height increments with 8 lb falling weight) shall be used. Minimum sample dimensions shall be 1.5 by 1.5 in. Samples shall be tested with the normally exposed surface facing up. Insulated vinyl siding shall be tested with any insulation material removed. Conditioning time for quality-control tests shall be at least one hour.

6.8.1 For purposes of evaluating failure of the specimen under subsection 3.2.1 of Test Method D4226, a ductile tear of less than 0.2 in. (5 mm) in length shall not be considered a failure. Any brittle break of any dimensions is considered a failure.

6.9 *Coefficient of Linear Expansion*—Conduct this test in accordance with Test Method D696, separately for samples of the vinyl siding and samples of the insulation.

6.9.1 *Alternative Specimen Preparation for Vinyl Siding Samples*—Specimens prepared from strips cut from extruded vinyl siding are permitted to be used in testing under Test Method D696. Where such specimens are used, they shall be cut with the long dimension parallel to the long axis of the vinyl siding panel. Guides shall be used in accordance with Test Method D696 to prevent bending or twisting of the specimen in the dilatometer.

6.10 *Weatherability:*

6.10.1 A minimum of three samples shall be exposed at each of at least three test sites. Test sites shall be located in a northern temperate climate, represented by Cleveland, Ohio or Louisville, Kentucky; a hot, humid climate represented by Miami, Florida; and a hot, dry climate represented by Phoenix, Arizona. The samples shall be exposed for a minimum of 24 months.

6.10.2 Samples shall consist of a flat section of vinyl siding with minimum dimensions of 2 by 3¾ in. (25 by 95 mm).

6.10.3 Samples shall be representative of the product to be evaluated. Samples shall be taken either from commercial products or from laboratory samples. Laboratory samples shall be produced in the same manner as the commercial products to be evaluated.

NOTE 10—Production of laboratory samples in the same manner includes use of the same method of forming the product. For example, if the commercial product is extruded, the laboratory specimen shall be extruded; if the commercial product is injection molded, the laboratory specimen shall be injection molded, and so forth.

6.10.4 Select a minimum of four specimens per sample per test site to allow for three test specimens and one file specimen for each sample evaluated.

6.10.5 Mark each specimen permanently to ensure retention of identity during and after exposure testing.

NOTE 11—Use of a vibrating engraver leaves a permanent mark that satisfies this criterion.

6.10.6 All exposures shall be conducted at an angle of 45° South, plywood-backed, in accordance with Practice D1435 and G147.

6.10.7 After a minimum of 24 months of exposure, remove the samples and inspect each exposed test specimen for appearance and surface condition. Record observations and inspection date in a permanent record.

6.11 *Gloss:*

6.11.1 *Apparatus*—Measure gloss using a 75° geometry glossmeter that meets the requirements of the Apparatus section of Test Method D2457.

6.11.2 *Procedure:*

6.11.2.1 Gloss measurements shall be made in accordance with the procedure in Section 9 of Test Method D2457, unless otherwise specified herein.

6.11.2.2 Measure gloss on one piece of vinyl siding on at least three widely separated sections across the width of the exposed surface of the panel. At least one reading shall be taken on each face of the panel. Use a new surface area for each reading to avoid scratches caused by instrument contact. The area tested must be flat. If a flat area on the exposed surface cannot be found due to the style or depth of embossing of the panel being tested, then a non-exposed area of the panel shall be chosen in its place. Such locations shall be representative of the gloss of the area that will be exposed after installation.

6.11.2.3 Measure gloss parallel to the direction of embossing. When the embossing pattern is not apparent, measure the gloss in the direction of extrusion.

6.11.2.4 Each reading shall be within the appropriate limit specified in 5.1.6.

6.11.2.5 The average of all readings shall be used to represent the gloss of the sample.

6.12 *Thermal Distortion:*

6.12.1 *Test Specimen/Apparatus:*

6.12.1.1 The test specimen shall consist of three courses of insulated vinyl siding, a minimum of 6 ft (1.83 m) in length, mounted on a flat, rigid frame in accordance with the manufacturer's installation instructions.

(1) Horizontal Siding—The middle course shall consist of two lengths of insulated vinyl siding, both with a factory-fabricated end, one section overlapping the other section. The end of the overlapping section shall be located not less than 3 in. (76 mm) and not more than 6 in. (152 mm) from the center of the course. Unless specified otherwise by the manufacturer's installation instructions, the insulation of the two lengths of insulated vinyl siding shall be butted firmly together.

(2) Vertical Siding—The middle course shall consist of a single, uninterrupted insulated vinyl siding panel, without overlap.

6.12.1.2 A thermocouple or other heat-sensing element shall be located at the horizontal midpoint of the back side of the middle course of insulated vinyl siding. The heat-sensing element shall be in contact with the back of the vinyl cladding. Any insulation or backing material removed to facilitate placement of the heat sensing element shall be replaced.

6.12.1.3 Radiant-heat rod, 600 W for each linear foot (0.31 m), mounted parallel to the middle course and approximately 32 in. (810 mm) away from the surface of the insulated vinyl siding.

6.12.1.4 Temperature-control device, used to regulate the temperature of the radiant-heat rod, shall be able to maintain the conditions specified in 6.12.2.1.

6.12.1.5 Gap measurement device. A cylindrical pin gauge, ¼ ± 0.005 in. (6 ± 0.127 mm) in diameter is used to evaluate the size of any gap in the overlapped sections of horizontal insulated vinyl siding during the heating period. The pin gauge is attached to a rod such that the gauge can be inserted into a gap while held parallel to the plane of the insulated vinyl siding. The rod shall be sufficiently long to permit insertion of the gauge from beyond the edge to the test frame, not interfere with the exposure of the sample to radiant heat, and otherwise not interfere with conduct of the test.

6.12.2 *Procedure:*

6.12.2.1 Heat the test panel (middle course of insulated vinyl siding) at a rate of 3.0 to 6.0°F/min (1.7 to 3.3°C/min) until a minimum temperature of 150°F (66°C) is achieved as measured by the heat-sensing element on the midpoint of the backside of the middle course. For temperatures equal to or greater than 130°F (54°C), the rate of heating is permitted to be not less than 2.0°F/min (1.1°C/min), provided that the average heating rate from the ambient temperature to 150°F (66°C) is within 3.0 to 6.0°F/min (1.7 to 3.3°C/min). When a temperature of 150°F (66°C) is attained, shut off the heat source.

6.12.2.2 During this heating period, observe the middle course of the insulated vinyl siding for surface distortion and observe for any opening or gap at the end of the overlapped section. If the overlap appears to have opened to approximately ¼ in. (6 mm), attempt to insert the gap measurement device into the opening. If the device can be inserted into the opening to any depth at any location along the overlap, the opening shall be considered to be at least ¼ in. (6 mm).

6.12.2.3 *Failure is defined as:*

(1) the appearance of bulges, waves, or ripples on any surface of the middle course of the insulated vinyl siding; or

(2) occurrence of a gap or opening ¼ in. (6 mm) or greater at any point along the end of the overlapped section, as determined by use of the gap measurement device, at any time before a temperature of 150°F (66°C) is reached.

6.13 *Color Uniformity*—Calculate the difference between the L_H, a_H, and b_H color coordinates for a production specimen to those of either the appropriate reference specimen or the agreed upon color coordinates for that specific color product in accordance with Test Method D2244. Calculate the total difference ΔE between the production specimen and the reference specimen in accordance with Test Method D2244.

6.14 *Wind Load Resistance*—Conduct the test on wind load resistance of finished insulated vinyl siding in accordance with Test Method D5206. The average maximum sustained static test pressure determined from this testing is used in 5.2.3. For purposes of determining compliance with the minimum test pressure and standard design pressure requirements in 5.2.3, the test structure shall be constructed with vertical studs 16 inches on center. The siding shall be tested with insulation attached to the vinyl siding. The siding in the test installation shall be installed over wood sheathing with a nominal thickness of 7/16 to ½ inch, and fastened as follows:

6.14.1 *Fastener Type*—Roofing nail, smooth shank, 0.120 in. (⅛ in. nominal; 3.2 mm) shank diameter, 5/16 in. (7.9 mm) head diameter, length as necessary to penetrate into sheathing and stud a total of 1 ¼ in. (32 mm). For vertical siding, length as necessary to penetrate the thickness of the sheathing plus ¼ in. (6.4 mm).

6.14.2 *Fastener Spacing*—Every 16 in. (406 mm) into center of stud for horizontal siding. For vertical siding, every 12 inches into sheathing only.

6.14.3 Fasteners shall not be driven tightly against the siding. Allow approximately 1/32 in. (0.8 mm) clearance between the fastener head and siding surface.

NOTE 12—The installation details described 6.14 conform to the minimum requirements of the 2015 International Residential Code and the VSI Vinyl Siding Installation Manual.

6.15 *Nail Slot Allowance for Thermal Expansion*—As an alternative to conformance with the nail slot width specification in 5.2.3.1 or 5.2.3.2, provision for thermal expansion and contraction shall be demonstrated through the following test procedure.

6.15.1 *Samples*—At least three samples of each profile in which the insulated vinyl siding is produced shall be provided. The length of each sample shall be at least 50 % of the longest length in which the profile is produced, and not shorter than 12 ft (3658 mm).

6.15.2 *Test Chamber*—The test chamber shall consist of an environmentally controlled room or compartment capable of providing an air temperature range of at least 0 to 100°F (-18 to 38°C) without exposure of the panel to radiant energy from heating or cooling elements. Air temperature shall be controlled such that a rate of temperature change of 2°F (1.11°C) per minute can be achieved over the full temperature range, and the minimum and maximum temperatures can be maintained for at least 15 minutes. Means for circulating air to provide a uniform air temperature throughout the chamber shall be provided. A vertical wall shall be provided for mounting of samples. The wall shall be insulated such that, with no panels mounted, the inner surface of the wall does not deviate more than 10°F (5.5°C) from the air temperature at the high and low temperature extremes after a holding period of

five minutes. The test chamber shall be of sufficient size to accommodate the longest panel to be tested, including expected thermal expansion of the panel. Means shall be provided to measure the actual temperature of the surface of each panel at a minimum of three evenly-spaced locations along the length of the panel.

6.15.3 *Length Measurement*—A means for measuring the length of each sample throughout the temperature range shall be provided. The method utilized for length measurement shall not be influenced by the temperature of the chamber and shall have a minimum resolution of no greater than 0.0625 in. (1.59 mm).

6.15.4 *Procedure*—Install the sample panels on the wall inside the test chamber, following the manufacturer's instructions for fastener type, spacing, location and tightness. At ambient temperature measure and record the length of each panel and the temperature of the panel, averaged from a minimum of three locations along the length of the panel.

6.15.4.1 *Test Cycle*—Test cycles shall be performed by raising the air temperature to 100 ± 5°F (38 ± 2.75°C) at an average rate of 2°F (1.11°C) per minute, holding the air temperature at 100°F (38 ± 2.75°C) for 15 minutes, lowering the air temperature to 0 ± 5°F (-18 ± 2.75°C) at an average rate of 2°F (1.11°C) per minute, holding at 0°F (-18 ± 2.75°C) for 15 minutes, and returning to ambient temperature at an average rate of 2°F per minute.

6.15.4.2 *Conditioning*—Close the test chamber and perform at least two conditioning cycles using the procedure in 6.15.4.1. No interruption is required between conditioning cycles.

6.15.4.3 *Test*—Following completion of the conditioning cycles, conduct three test cycles using the procedure in 6.15.4.1. It is acceptable for the test cycles to follow immediately upon completion of the final conditioning cycle, and no interruption is required between test cycles. After a minimum holding period of 15 minutes at the high and low extremes of each test cycle, measure and record the length of each panel and the temperature of the panel, averaged from a minimum of three locations along the length of the panel.

6.15.5 *Normalization*—From among the length measurements recorded for all three cycles, identify the shortest and longest length of each panel, and the average panel temperature at the time that length was recorded. Determine the maximum difference in length, ΔL, and the maximum difference in temperature, ΔT, by subtracting the smaller from the larger. Normalize the change in length to the full length of the panel over a 100°F (38°C) temperature range using the following formula:

$$E_t = \Delta L \times (100/\Delta T) \times (L_f/L_t) \quad (2)$$

where:

E_t = Total thermal expansion and contraction of a full length panel over a range of 100°F (38°C)
ΔL = maximum change in length of the tested panel,
ΔT = maximum change in temperature of the tested panel,
L_f = longest length in which the panel is produced, and
L_t = actual length of the panel as tested.

6.15.6 *Acceptable Performance*—When tested according to this procedure, the result of $(E_t \times 2) + 0.25$ in. for each of the three samples for each profile shall not be greater than the width of the nail slot. If the manufacturer's installation instructions require the panel to be center-pinned, the result of $E_t + 0.25$ in. for each of the three samples for each profile shall not be greater than the width of the nail slot.

6.16 *Lead Content:*

6.16.1 Testing for lead content shall be conducted on insulated vinyl siding using a rhodizinate-type lead swab test kit conforming to Practice E1753. Testing shall be performed in accordance with the test kit manufacturer's instructions. The insulated vinyl siding shall be deemed to comply with 4.4.1 if the test shows a negative or not-detected result; that is, the test does not indicate the presence of lead. The test shall be conducted separately on the substrate and on any cap or film material, and on the insulation material.

6.16.2 As an alternative to the method in 6.16.1, and as a means of resolving any ambiguous results from that method, an analytical method capable of detecting lead at least as low as 0.02 percent by sample weight shall be employed. Under this alternative, neither the substrate nor any cap or film shall contain a concentration of lead in excess of 0.02 percent by weight.

6.17 *Compatibility of Adhesives:*

6.17.1 *Sample Preparation*—Combine a flat, 2 by 2 in. section of vinyl siding with a 2 by 2 by 0.75 in. sample of insulation, using the adhesive used in the insulated vinyl siding. The top and bottom surfaces of the insulation are to be parallel. The application rate, thickness, and distribution of the adhesive are to be consistent with its application in the insulated vinyl siding. Prepare a total of at least ten such samples.

6.17.2 *Cyclical Conditioning*—Subject half of the samples to the following conditioning. In an appropriate environmental conditioning chamber, starting at room temperature, increase the temperature of air surrounding the sample to 150°F (66°C) and hold for 15 minutes. Over a period of time not greater than 15 minutes, decrease the surrounding air temperature to -10°F (-23°C), and hold for 15 minutes. Return the surrounding air temperature to 150°F (66°C) over a period of time not greater than 15 minutes. This cycle is repeated for a total of 30 cycles.

6.17.2.1 *Tensile Testing*—Condition and test all of the samples in accordance with Test Method C297/C297M Any of the failure modes listed in Test Method C297/C297M (other than failure at the bond to the loading blocks) shall be counted in calculating the average ultimate tensile strength. Separately determine the average ultimate tensile strength for the samples subjected to cyclical conditioning, and for those not subjected to such conditioning.

6.18 *Thermal Insulation Value*—The thermal insulation value for the insulated vinyl siding shall be determined in accordance with Test Method C1363. Test conditions, test sample selection, configuration and installation, and procedure shall be as specified in the following sections.

6.18.1 *Wind Direction and Velocity*—Testing of the base wall and insulated vinyl siding samples shall be with the

exterior wind direction perpendicular to the plane of the test wall. The calibration procedure in Section 6 of Test Method C1199 shall be used to establish standard room and weather side surface heat transfer coefficients.

6.18.2 *Test Temperatures*—Testing shall be performed at an exterior temperature of 50°F and an interior temperature of 100°F.

6.18.3 *Base Wall*—The base wall for attachment of the insulated vinyl siding shall provide for overall test sample dimensions of 96 ± 6 in. (2438 ± 152 mm) in both the vertical and horizontal axis. The construction of the wall shall be sufficient to hold the test installation without flexing under the imposed wind. The weather side surface of the base wall shall include a solid surface composed of uniform sheet material capable of securely holding standard roofing nails or the fasteners specified by the manufacturer for installation of the insulated vinyl siding under test. The wall shall be fully sealed to prevent movement of air between the chambers.

NOTE 13—The precise materials and construction of the base wall are not specified because its thermal characteristics will be directly measured to establish baseline conditions from which the performance of the insulated vinyl siding alone can be distinguished. A standard framed wall composed of nominal 2 by 4 in. studs on 16 in. (406 mm) centers, covered by nominal ½ in. plywood or oriented strand board (OSB) has been found to be suitable for most test applications.

6.18.4 *Sample Selection*—reserved for any requirements needed for specifying the sample to be used, how many replicates, etc. (if needed).

6.18.5 *Test Installation*—The area covered by the insulated vinyl siding shall be 96 ± 6 in. (2438 ± 152 mm) in both the vertical and horizontal axis. The test installation shall be composed of the number of insulated vinyl siding panels needed to cover the test installation area, and any siding accessories normally used for installation of that insulated vinyl siding.

6.18.5.1 *Overlaps*—The test installation shall include both courses that cover the full width of the test wall with a single panel, and courses composed of two or more adjacent, overlapping panels. The number of courses containing overlapped panels shall be as specified below.

(1) Panels shorter than full width of the test wall—Where the insulated vinyl siding is commercially available in panels shorter in length than the full width of the testing installation, each course shall contain adjacent, overlapped panels. For panels equal to or longer than one-half the test installation width, each course shall contain two panels, with one joint between them. For shorter panels, the number of panels and joints per course is determined by the length of the panels and the overlapping of panels specified in the manufacturer's installation instructions.

(2) Vertical Siding—The test installation for vertical insulated vinyl siding shall contain no overlap joints.

(3) Horizontal Siding—The number of courses with overlap joints for horizontal insulated vinyl siding shall be based on the vertical coverage of the profile, in accordance with Table 1 or the following formula. For test walls with a insulated vinyl siding installation height other than 96 in (2438 mm), or for insulated vinyl siding profiles not listed in Table 2, the number of courses with overlap joints shall be determined according to the following formula:

$$L = 0.375\left(\frac{H}{V}\right) \tag{3}$$

where:

L = Number of courses with overlap joints in test installation; rounded to the nearest integer
H = Height of test installation, inches
V = Vertical coverage of one panel, inches

(4) The specified number of courses with overlaps joints shall be evenly distributed vertically across the test installation. Adjacent courses shall not contain overlap joints.

6.18.5.2 The bottom edge of the insulated vinyl siding shall be secured with a starter strip or equivalent trim specified by the manufacturer. The sides and top edge of the insulated vinyl siding shall be bound by J-channels or equivalent trim specified by the manufacturer.

6.18.5.3 The insulated vinyl siding and trim shall be installed in the order in which they are installed in the field, in accordance with the manufacturer's installation instructions. Fastening of the insulated vinyl siding and trim to the wall shall be as specified in the manufacturer's installation instructions.

6.18.5.4 *Sealing of Test Installation*—No part of the test installation, including insulated vinyl siding panels, joints, overlaps and perimeter, shall be sealed other than by the means integral to manufacturer-supplied siding panels or trim. Any actions specified in the manufacturer's installation instructions to secure or enable an integral sealing means shall be carried out.

6.18.6 *Procedure*—Conduct a test of the base wall alone, with no insulated vinyl siding installed, in accordance with Test Method C1363. Determine the R-value of the base wall. Install the insulated vinyl siding and conduct a test under the same conditions, and determine the R-value of the base wall-insulated vinyl siding assembly. Determine the R-value of the insulated vinyl siding by subtracting the R-value of the base wall alone from that of the base wall-insulated vinyl siding assembly. Report the R-value of the insulated vinyl siding, rounded to the nearest tenth.

6.18.6.1 Reuse of the R-value determined for the base wall is permitted for subsequent tests of insulated vinyl siding. The

TABLE 2 Courses with Overlaps Joints

Siding Type	Vertical Coverage (in.)	Number of Courses Including Overlaps
Single 6.5	6.5	6
Single 7	7	5
Double 4	8	5
Single 8	8	5
Double 4.5	9	4
Triple 3	9	4
Double 5	10	4
Quad 2.5	10	4
Double 6	12	3
Triple 4	12	3
Double 6.5	13	3
Double 7	14	3
Quad 4.5	18	2
Triple 6	18	2

R-value of the base wall shall be reestablished by testing if the test configuration is changed, the base wall has been removed and reinstalled, ambient temperature or humidity has changed or fluctuated significantly, or any other event has occurred that is likely to affect the R-value of the base wall.

7. Packaging and Package Marking

7.1 The insulated vinyl siding shall be packed in such a manner as to provide reasonable protection against damage in ordinary handling, transportation, and storage.

7.2 Provisions of Practice D3892 shall apply to this specification.

7.3 To aid identification of insulated vinyl siding conforming to all requirements of this specification, producers and distributors shall include a statement of compliance in conjunction with their name and address on product labels, invoices, sales literature, and the like. The following statement is suggested when sufficient space is available: "This insulated vinyl siding conforms to all the requirements established in ASTM Specification D7793 developed cooperatively with the industry and published by ASTM. Full responsibility for the conformance of this product to the specification is assumed by (name and address of producer or distributor)."

7.4 The following abbreviated statement is suggested when available space on labels is insufficient for the full statement: "Conforms to ASTM Specification D7793 (name and address of producer or distributor)."

7.5 The package shall be marked or labeled with the R-value determined in 6.18.

NOTE 14—Marking or labeling done in compliance with 16 CFR Part 460 will normally satisfy this requirement. That and other government regulations may require additional information and statements which are not required by this standard.

7.6 The standard wind load design pressure rating determined in accordance with 5.2.3.2 shall be stated on the product or on the product package by one of the means in 7.6.1 or 7.6.2.

7.6.1 The package shall be marked or labeled with the standard wind load design pressure rating. The marking shall be in the format "Standard Wind Load Design Pressure Rating: ##.# psf (ASD)".

7.6.2 The standard design pressure rating shall be included on a line imprint or other marking on the front (outward-facing) surface of all siding panels. It is not required that the marking be visible after installation, provided that the marking can be revealed and read by detaching the lower edge lock of an adjacent course, without removal of any fasteners. The standard design pressure marking shall be stated at least once per panel. The marking shall be in the format "Std Design Pressure Rating: ##.# psf (ASD)".

7.6.3 At the option of the manufacturer, additional marking or labeling of the package or product with alternative wind load design pressure ratings determined in accordance with 5.2.2.3 for use with alternative sheathings, wall configurations or fastening methods is permitted. The marking shall use the format specified in 7.6, shall indicate the type of sheathing or wall configuration for which it is applicable, and shall refer to the manufacturer's instructions for more information and any installation requirements.

8. Keywords

8.1 insulated siding; insulated vinyl siding; plastic building products; plastic weatherability; recycled plastic; rigid PVC siding; specification; vinyl siding

ANNEX

(Mandatory Information)

A1. WIND LOAD RESISTANCE TEST DESIGN FACTORS

A1.1 Wind Load Criteria

A1.1.1 ASCE 7-10 is the basis for determining the design pressures used in this specification. Design wind loads are determined on an ASD basis in this specification.

NOTE A1.1—In previous editions of ASCE 7, wind loads were determined using wind speed maps based on a 50-year return period. In ASCE 7-10, maps based on a 700-year return period are used which, for any given location, produce a wind speed approximately 30 % greater than that of the previous maps. This larger magnitude (higher return period) wind speed, referred to as the ultimate wind speed, (V_{ULT}), is used directly (with a load factor of 1.0) to determine nominal wind loads on a Strength Design (LRFD) or "ultimate" wind load basis. When Allowable Stress Design (ASD) is used, ASCE 7-10 provides for these ultimate wind loads, determined from the ultimate wind speed map velocities, to be multiplied by a load factor of 0.6. Alternatively, the adjustment can be made directly to the wind velocity, which is the approach taken in this method (see A1.1.2). This procedure produces results consistent with past ASD wind loads.

A1.1.2 It is necessary to determine whether the wind velocity to be used is based on the maps in ASCE 7-10 or on older maps designed for direct application of ASD. Wind velocity, V, based on ASD is used in this method. Wind speeds determined using the maps in ASCE 7-10, referred to as V_{ULT}, are converted to ASD wind speeds, V_{ASD}, by multiplying by the square root of 0.6. Wind speeds based on maps using an ASD basis do not require conversion (see A1.3) Thus:

$$V = V_{ASD} = V_{ULT} \times \sqrt{0.6} \qquad (A1.1)$$

The V determined in this section is used in the following calculations.

A1.1.3 The velocity pressures, q, used in this specification have been computed using the following equation:

$$q = 0.00256\, K_z K_d V^2 I\,(lb/sq.\ ft) = 0.613\, K_z K_d V^2 I\,(N/m^2) \qquad (A1.2)$$

where:

V = wind velocity, mph (km/h). The basic wind speed corresponds to a 3-s gust speed at 33 ft (10.1 m) above ground in exposure category C, as described in ASCE 7-10. A velocity of $V = V_{ASD}$ = 110 mph (177 km/h) was used in this specification. (See Note A1.2 and Note A1.3.)

I = "importance factor" as described in editions of ASCE 7 prior to ASCE 7-10. A value of 1.0 is used. This factor is not used where the wind speed has been determined from a map in ASCE 7-10. (See Note A1.4.)

K_z = "velocity pressure coefficient" as described in ASCE 7-10. A "K_z" of 0.70 is used in the wind pressure calculations, which is the value from ASCE 7-10 for a mean roof height of 30 ft (9.1 m) above ground level and Exposure Category B.

K_d = "wind directionality factor" as described in ASCE 7-10. A "K_d" of 0.85 is used.

A1.1.4 Thus for the given velocity and factors, the velocity pressure, q = 18.43 lbf/ft^2 (882 Pa).

NOTE A1.2—As explained in Note A1.1, the wind velocity used in this method is converted from the V_{ULT} given by wind speed maps in ASCE 7-10 to V_{ASD} using the equation in A1.1.2. A V_{ULT} wind speed of approximately 140 mph from the maps is equivalent to a V_{ASD} of 110 mph, which is the velocity V used in this specification.

NOTE A1.3—In ASCE 7-10 the default wind speeds are given for exposure category C, and a table is provided to adjust this wind speed for other exposure categories. Since most insulated vinyl siding is installed on buildings located in exposure category B, the velocity pressure coefficient, K_z is included in the equation to make this adjustment.

NOTE A1.4—Editions of ASCE 7 prior to ASCE 7-10 included an importance factor to represent the relative significance of the building and the consequences of its loss. Because most insulated vinyl siding is installed on residential and light commercial buildings, the importance factor was set at 1.0 by default. ASCE 7-10 has removed the importance factor from the velocity pressure equation, and instead provides a different wind speed map for each of the building importance categories (referred to as risk categories in ASCE 7-10). Thus the importance factor will already have been incorporated into the wind speed determined from the appropriate map, and the importance factor is not used for determining velocity pressure using wind speeds from ASCE 7-10 maps.

A1.1.5 ASCE 7-10 recommends various internal and external pressure coefficients, which include gust response factors. These coefficients vary with the effective area of the cladding component, the location of the cladding component relative to building corners, and the configuration of the building (open versus enclosed). The internal and external pressure coefficients are taken from Table 26.11-1 and Figure 30.4-1 of ASCE 7-10. The effective area is taken as 10 square feet (the area of one piece of siding), an enclosed building is assumed, and factors for the building corners are used. The pressure coefficients are as follows:

$$\textit{Internal Pressure Coefficient} = \pm 0.18 \qquad \text{(A1.3)}$$

$$\textit{External Pressure Coefficient} = +1.00 \textit{ and } -1.40$$

A1.1.6 The design pressure is calculated by multiplying the velocity pressures by the algebraic sum of the internal and external pressure coefficients.

A1.2 Design Pressure

NOTE A1.5—Because the wind velocity has already been adjusted from an ultimate basis to an ASD basis at the beginning of these calculations, the design pressure determined in this step is an ASD load. This correlates to the design pressure requirements stated in tables in the 2015 International Residential Code and other codes which have also been adjusted to an ASD basis. However, the required design pressures in some other codes and design standards have not been adjusted to an ASD basis. Where required design pressures are based on ultimate wind loads determined from ASCE 7-10 wind speeds, those loads must be multiplied by 0.60 to match the design pressure determined from this equation. A1.2

$$\textit{Positive Design Pressure} = (18.43)\,(1.00+0.18) = 21.74\ \textit{psf} \qquad \text{(A1.4)}$$

$$\textit{Negative Design Pressure} = (18.43)(-1.40-0.18) = -29.12\ \textit{psf}$$

A1.2.1 The negative values (suction loads) are the largest in magnitude and are the design values used in this specification. Research conducted by various organizations[5,6] has shown that a certain amount of pressure equalization occurs through residential siding products installed with sheathing under high dynamic pressures. In light of this pressure equalization, the design pressure in the ASCE 7-10 wind load standards is reduced by a factor of 0.5 for insulated vinyl siding.

A1.2.2 Therefore, the required test pressures are calculated as follows:

$$P_t = D_P \times PEF \times 1.5 \qquad \text{(A1.5)}$$

where:

P_t = test pressure, lbf/ft^2 (Pa),

D_P = design pressure, lbf/ft^2 (Pa),

PEF = pressure equalization factor, insulated vinyl siding, 0.5, and

1.5 = safety factor.

A1.2.2.1 If documentation in support of the use of compensation for pressure equalization other than 0.5 is provided, use the calculation in A1.2.2, substituting the appropriate pressure equalization factor.

A1.2.3 Using the above equations, in a 110 mph (177 km/h) (V_{ASD}) wind zone area specifying a design pressure of -29.12 lbf/ft^2 (1394 Pa) for a building 30 ft (9.1 m) in height or less, the required minimum uniform load test pressure for insulated vinyl siding is 21.84 lbf/ft^2 (1046 Pa).

A1.2.3.1 For compliance with 5.2.2, the referenced design pressure has been rounded to -30.0 lbf/ft^2 (1436 Pa) to match the standard design conditions specified by the 2015 International Residential Code. When tested under Test Method D5206, the siding must attain an average maximum sustained static test pressure equal to or greater than the corresponding minimum test pressure of 22.5 lb/ft^2 (1077 Pa).

A1.2.4 For applications where the effective design pressure is greater than -30.0 lbf/ft^2 (1436 Pa) (for example, wind zone

[5] Vinyl Siding Pressure Equalization Factor, Architectural Testing, Inc. Report No. 01-40776.01, September 2002.

[6] Morrison, M.J., Cope A.D. "Wind Performance and Evaluation Methods of Multi-Layered Wall Assemblies." *Structures Congress*, 2735-2748, Portland, OR, 2015.

areas greater than 110 mph (177 km/h) (V_{ASD}), mean roof height over 30 ft (9.1 m), or exposure conditions other than Exposure B), refer to ASCE 7-10 for the effective design pressure. To be shown to be suitable for the application, when tested under Test Method D5206 the siding must attain an average maximum sustained static test pressure equal to or greater than the minimum test pressure determined by the formula in A1.2.2, using the design pressure, D_P, determined for the application using the procedure in A1.1.2 through A1.2.

A1.2.5 These loading conditions apply only to siding installed without an air space directly over sheathing of a type and fastening method that is capable of independently resisting both positive and negative wind design pressures at the building location. Examples of such sheathing include oriented strand board (OSB) and plywood fastened to resist the design wind pressures. For applications where the siding is installed over open studding, without sheathing, rapid pressure equalization does not occur and pressure equalization factor (PEF) is set to 1.0. In these applications, the load the siding will see is equal to the total design pressure. The static test pressure required for products used under these conditions is as follows:

$$P_t = D_P \times PEF \times 1.5 \quad \text{(A1.6)}$$

where:

P_t = static test pressure, lbf/ft^2 (Pa),
D_P = design pressure, lbf/ft^2 (Pa), and
PEF = pressure equalization factor, 1.0, and
1.5 = safety factor.

A1.2.5.1 Therefore in a 110 mph (177 km/h) wind zone area specifying a design pressure of -29.12 lbf/ft^2 (1394 Pa) for a building 30 ft (9.1 m) in height or less, siding installed without sheathing would require a uniform load test pressure of 43.72 lbf/ft^2 (2093 Pa).

NOTE A1.6—Building codes and insulated vinyl siding installation instructions require insulated vinyl siding to be installed over sheathing, so calculation of minimum test pressure for siding installed without sheathing is essentially moot. However, the calculation has been retained for completeness and comparison with other installation conditions.

A1.2.6 When siding is installed over sheathing that is not capable of independently resisting both positive and negative wind pressures occurring under design conditions at the building location, a greater percentage of the total wind pressure is transferred to the siding and its fasteners. This has the effect of partially or completely countering the effect of the pressure equalization factor. In these cases a value between 0.5 and 1.0 is used for the pressure equalization factor (PEF).

A1.2.6.1 In addition, in cases where failure of the siding would result in failure of the exterior wall covering assembly (that is, siding and sheathing) a safety factor of greater than 1.5 is indicated.

A1.2.6.2 If the adjusted PEF for a given combination of siding and sheathing is known, and an appropriate safety factor is used, a minimum test pressure can be determined using the equation in A1.2.1. However, it is normally more appropriate to make an adjustment for alternative sheathings when determining the design pressure rating, as discussed in A1.3.

NOTE A1.7—Where the sheathing is not capable of independently resisting both positive and negative wind pressures occurring under design conditions at the building location, the layer of siding over the sheathing, and its fastening through the sheathing, act to reinforce the sheathing such that the whole wall covering (siding-sheathing) assembly is capable of resisting such wind pressures. Because the siding is tested by itself (not as part of a siding-sheathing assembly) in Test Method D5206, the adjustment of test pressure (before the test) or of the design pressure (after the test) ensures that the wind load resistance of the assembly as a whole is reflected in the rating of the siding.

NOTE A1.8—In some high wind hazard regions, such as south Florida, the exterior wall covering assembly may also be required to meet wind-borne debris impact resistance criteria which would affect the choice of sheathing material to be used together with siding. Such considerations are beyond the scope of this standard.

A1.3 Wind Design Pressure Rating (Maximum Allowable Pressure)

A1.3.1 A design pressure rating is the maximum wind pressure that a particular siding product is rated to be able to withstand. It is used in building design and building codes to determine the acceptability of a siding product for use under the design wind conditions for a specific application. To be acceptable, a siding's design pressure rating must be equal to or greater than the design pressure for the specific building at the specific location. The design pressure rating is determined from the average maximum sustained static test pressure for a siding product produced by testing under Test Method D5206, the pressure equalization factor, and a safety factor.

A1.3.2 *Standard Design Pressure Rating*—The standard design pressure rating is used for applications where the siding is installed over a sheathing type and fastening method that is capable of independently resisting both positive and negative wind pressures occurring under design conditions at the building location.

A1.3.2.1 The standard design pressure rating assumes that the siding is fastened to the building in the standard manner, with the minimum fastener type, size, spacing, and penetration depth prescribed in Chapter 7 of the International Residential Code and the VSI Vinyl Siding Installation Manual. The installation of the siding for testing under Test Method D5206 must be consistent with these minimum fastening requirements. However, this does not prevent additional testing, using different fastening, to support design pressure ratings for other applications, such as special high wind installations.

A1.3.2.2 The pressure equalization factor and safety factor are the same as those used to determine the test pressure in A1.2.1, using the following equation:

$$D_{Rstd} = \frac{P_m}{(PEF \times SF)} \quad \text{(A1.7)}$$

where:

D_{Rstd} = standard design pressure rating, lbf/ft^2 (Pa),
P_m = average maximum sustained static test pressure, lbf/ft^2 (Pa),
PEF = pressure equalization factor, 0.5, and
SF = safety factor, 1.5.

A1.3.3 *Alternative Design Pressure Ratings*—Design pressure ratings for applications other than the standard conditions described above can be developed. Common circumstances where this is done include the use of alternative fastening methods in order to achieve a higher design pressure rating,

and cases where the sheathing is not capable of independently resisting wind pressures under design conditions, which necessitates a reduction in the siding's design pressure rating.

A1.3.3.1 *Alternative Fastening*—Where an alternative fastening method is specified by the manufacturer, the siding is permitted to be tested under Test Method D5206 using the specified fastening. The resulting average maximum sustained static test pressure is used in the above equation to determine the alternative design pressure rating. In order for this alternative rating to be realized, the siding must be installed using the alternative method, and the rating must be clearly tied to installation requirements in manufacturer's literature and instructions.

A1.3.3.2 *Alternative Sheathing*—An adjusted design pressure rating for use of the siding over sheathings not capable of independently resisting both positive and negative wind pressures occurring under design conditions at the building location, as discussed in A1.2.6, can be calculated using the above equation if the appropriate PEF and safety factor are specified.

A1.3.3.3 Alternative PEF and safety factor values have been documented (see 2009 and 2012 International Residential Code, section R703.11.2) for one type of sheathing, foam plastic insulating sheathing complying with ANSI/SBCA FS 100. Two wall assembly cases are considered: 1) where the interior surface of the wall is covered with gypsum wall board or equivalent; and 2) where the interior surface of the wall is not covered with gypsum wall board or equivalent. In both cases the siding is installed directly over foam sheathing, which is then attached directly to framing, without intervening sheathing. The PEF and safety factor for each case are as follows:

Case	PEF	Safety Factor
Case 1	0.7	2.0
Case 2	1.0	2.0

A1.3.3.4 Adjustment of the standard design pressure rating is not necessary when foam plastic insulating sheathing is installed directly over sheathing that is capable of independently resisting both positive and negative wind pressures occurring under design conditions at the building location, or where the sheathing is fastened in a way that allows it to independently resist the design wind pressure. For such cases the standard design pressure rating is applied.

A1.4 Design Wind Speeds

A1.4.1 The wind velocity maps in ASCE 7-10 provide one source of design wind speeds for particular geographic regions. The velocities on these maps are stated in terms of "ultimate," 700-year return interval speeds. To be used in the procedure in this Annex, those velocities need to be converted to the ASD equivalent in accordance with A1.1.2, and the resulting velocity V used in the equation in A1.1.3. The 2012 and 2015 International Building Code and 2015 International Residential Code also contain maps based on ultimate wind speeds.

A1.4.2 Other maps are available that do not require conversion of wind velocities. Examples include the wind map in the 2012 International Residential Code, on which the velocities have already been converted from those on the ASCE 7-10 maps. Maps from previous editions of ASCE 7 used ASD velocities and do not require conversion. However, only editions since 1995 used the 3-second gust basis that is used in this Annex. The 1998, 2002, and 2005 editions of ASCE 7 continued the use of 3-second gust wind basis, but with improved hazard modeling of hurricane wind speeds first made in the 1998 edition. These previous editions also do not have the benefit of further improved hurricane hazard modeling that was incorporated into the maps used in ASCE 7-10.

APPENDIX

(Nonmandatory Information)

X1. VINYL SIDING, BACKED SIDING, AND INSULATED VINYL SIDING

X1.1 Relationships among types of vinyl siding

X1.1.1 Conventional vinyl siding is covered by ASTM D3679, Specification for Rigid Poly(Vinyl Chloride) (PVC) Siding. D3679 includes provisions for the materials and performance of vinyl siding, including minimum PVC composition and percentage of recycled material, dimensional requirements, impact resistance, resistance to surface distortion and deterioration, thermal expansion, windload resistance, etc.

X1.1.2 Backed vinyl siding is vinyl siding that includes an integral foam plastic backing material, and is covered by Specification D7445. That specification includes many of the same requirements as are found in D3679, which are applied to the vinyl siding "skin" of the product. Additional requirements, which apply to the foam backing itself, or to the full product including both siding and foam, are also included in Specification D7445

X1.1.3 Insulated vinyl siding, which is the subject of this standard specification, may be thought of as backed vinyl siding that is able to meet enhanced requirements. Chief among those is the requirement that insulated vinyl siding demonstrate a minimum thermal resistance, or R-value. While the foam backing of backed vinyl siding may, or may not, impart some R-value, it is not required to demonstrate that. To be considered "insulated vinyl siding" the product must demonstrate that it delivers the minimum R-value.

X1.1.4 As with backed vinyl siding, insulated vinyl siding is composed of a vinyl siding "skin" and foam plastic insulation. The vinyl siding portion must meet specific requirements for vinyl siding, which parallel with those in D3679. As with backed vinyl siding, insulated vinyl siding is subjected to additional requirements that apply to the foam or to the full product including siding and foam. In some cases the minimum specification or performance level is higher for insulated vinyl siding compared to backed vinyl siding. This is consistent with the intent that insulated vinyl siding be understood as offering enhanced performance and tangible benefits over the more basic backed vinyl siding.

REFERENCES

(1) ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. Chapter 26, 1977.

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(3) AAMA, CW 11-85, American Architectural Manufacturers Assn., Design Windloads for Buildings and Boundary Layer Wind Tunnel Testing, American Architectural Manufacturers Assn., 1827 Walden Office Square - Suite 550, Schaumburg, IL.

(4) Thom, H. C. S., New Distribution of Extreme Winds in the United States , American Society of Civil Engineers, Environmental Engineering Conference Preprint 431, Dallas, TX, Feb. 6, 1967.

(5) Sachs, Peter, Wind Forces in Engineering, Pergamon Press, Elmsford, NY 1972.

(6) MacDonald, A. J., Wind Loading on Buildings, Applied Sciences Publishers, Ltd., Essex, England, 1975.

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SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D7793 - 16) that may impact the use of this standard. (June 1, 2017)

(1) Section 2 was revised to update the reference to ASCE 7 and to add references referred to elsewhere in the standard.
(2) Section 2 was revised to add references to building codes and to the VSI Vinyl Siding Installation Manual.
(3) Section 3 was revised to add definitions of design wind load pressure rating, standard wind load design pressure rating, and alternative wind load design pressure rating.
(4) Subsection 5.2.2 was revised to clarify current requirements and put non-mandatory information in Notes, and to provide for the determination of standard and alternative wind load design pressure ratings.
(5) Subsection 6.14 was revised to provide the standard test conditions for determining compliance with the minimum test pressure and standard wind load design pressure rating.
(6) Section 7 was modified with new provisions specifying marking of the standard design pressure and alternative design pressures.
(7) Annex A1 was revised to reflect recent changes in ASCE 7 and to improve clarity.
(8) Subsection A1.2 was revised to add provisions for adjusting the minimum required test pressure for applications of siding over certain alternative sheathing types.

Committee D20 has identified the location of selected changes to this standard since the last issue (D7793 - 13) that may impact the use of this standard. (November 1, 2016)

(1) Revised 4.3 to provide for alternative methods for tensile testing of adhesives.