



Standard Specification for Cellular Polypropylene Thermal Insulation¹

This standard is issued under the fixed designation C 1631; 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 approval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers the types, physical properties, and dimensions of cellular polypropylene intended for use as thermal insulation for temperatures from - 150 to + 240°F (-101 to + 116°C).

1.2 The use of thermal insulation materials covered by this specification is regulated by codes that, when adopted by an authority having jurisdiction, address fire properties for specific applications.

NOTE 1—Both fire properties and specific fire-test-response characteristics may be addressed by specifications, where codes or government regulations do not apply.

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

1.4 The physical properties addressed by this specification are impacted by end use conditions. For design purposes, obtain physical properties from the manufacturer.

1.5 *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.*

2. Referenced Documents

2.1 ASTM Standards:²

- C 165 Test Method for Measuring Compressive Properties of Thermal Insulations
- C 168 Terminology Relating to Thermal Insulation
- C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
- C 272 Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions

- C 303 Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation
- C 390 Practice for Sampling and Acceptance of Thermal Insulation Lots
- C 518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
- C 870 Practice for Conditioning of Thermal Insulating Materials
- C 1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus
- C 1363 Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
- D 1600 Terminology for Abbreviated Terms Relating to Plastics
- D 1622 Test Method for Apparent Density of Rigid Cellular Plastics
- D 2126 Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
- D 3575 Test Methods for Flexible Cellular Materials Made From Olefin Polymers
- E 84 Test Method for Surface Burning Characteristics of Building Materials
- E 96/E 96M Test Methods for Water Vapor Transmission of Materials
- E 176 Terminology of Fire Standards
- 2.2 *Underwriters Laboratories Standard³*
- UL 723 Test for Surface Burning Characteristics of Building Materials

3. Terminology

3.1 Definitions:

3.1.1 Terms used in this specification are defined in Terminology C 168.

3.1.2 Terms used in this specification that relate to fire standards are defined in Terminology E 176.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *XPP*—letter designations for the extruded cellular polypropylene thermal insulation classified by this specification that identifies the product as extruded cellular polypropylene.

³ Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, <http://www.ul.com>.

¹ This specification is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.22 on Organic and Nonhomogeneous Inorganic Thermal Insulations.

Current edition approved April 1, 2008. Published April 2008. Originally approved in 2005. Last previous edition approved in 2005 as C 1631-05

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.

3.2.2 *PP*—used in this specification to represent polypropylene in accordance with Terminology **D 1600**.

4. Classification

4.1 This specification covers types of XPP thermal insulations currently commercially available as described by the physical property requirements in **Table 1**.

5. Ordering Information

5.1 Acquisition documents shall specify the following:

5.1.1 Title, number, and year of this specification,

5.1.2 Type (see **Table 1**),

5.1.3 *R*-value or profile / thickness required (see **Tables 1 and 2**),

5.1.3.1 *Thermal Resistance/Thickness Relationship*—The thermal resistance (*R*-value) and the thermal resistivity (*R*value/ inch) of XPP thermal insulation varies with profile / thickness. Therefore, when ordering, specify the *R*-value or the profile / thickness, or both. For additional information, see Test Methods **C 177**, **C 518**, **C 1114**, or **C 1363**.

5.1.4 Density, if other than specified in **Table 1**,

5.1.5 Tolerance, if other than specified,

5.1.6 Length and width required (see **Table 2**),

5.1.7 Edges, if other than straight edges are required,

5.1.8 *Profiled/Tapered Insulation*—special ordering information. In addition to other applicable requirements in Section **5** (**Note 2**), acquisition documents for profiled/tapered XPP thermal insulation shall specify the following:

5.1.8.1 *Shop Drawings*—When ordering a specific profile shaped foam, the initial engineer design drawings shall be provided, including tolerances.

5.1.9 Sampling, if different (see **10.1**),

5.1.10 If a certificate of compliance is required (see **14.1**), and

5.1.11 If marking is other than specified (see **15.1**).

NOTE 2—Physical properties of profiled/tapered insulation shall be determined on blocks of XPP thermal insulation before the insulation is tapered.

6. Materials and Manufacture

6.1 XPP thermal insulation shall be formed by the expansion of polypropylene base resin in an extrusion process. XPP thermal insulation shall be of uniform density.

7. Physical Requirements

7.1 *Inspection Requirements*:

TABLE 2 Common Dimensions of XPP Thermal Insulation

Property	Unit	Requirement
Width	in. (mm)	24 (610) 27 (689)
Length	in. (mm)	120 to 154 (3048 to 3912)
Thickness	in. (mm)	1.8 (46)

7.1.1 The physical requirements listed in this section are defined as inspection requirements (refer to Practice **C 390**).

7.1.2 All dimensional requirements are described in Section **8**.

7.1.3 All workmanship, finish, and appearance requirements are described in Section **9**.

7.1.4 Density shall be in accordance with **Table 1**.

NOTE 3—For lots of 150 units or less, the tightened inspection sampling plan in Practice **C 390** will be followed.

7.2 *Qualification Requirements*:

7.2.1 The physical properties listed in this section of the specification are defined as qualification requirements (refer to Practice **C 390**). Thermal resistance, compressive resistance, water vapor permeance, water absorption, and dimensional stability, shall be in accordance with **Table 1**.

7.2.2 The mean thermal resistance of the material tested shall not be less than the minimum value identified in **Table 1**. The thermal resistances of individual specimens tested shall not be less than 90 % of the minimum value identified in **Table 1**.

7.2.3 Compliance with qualification requirements shall be in accordance with Practice **C 390**.

7.3 **Table 1** describes types of XPP thermal insulation. However, it does not cover all available products on the market. The values stated in **Table 1** shall not be used as design values. It is the buyer's responsibility to specify design requirements and obtain supporting documentation from the material supplier.

7.4 *Surface Burning Characteristics*—XPP thermal insulation is an organic material and is, therefore, combustible. It shall not be exposed to flames or other ignition sources. Test Methods **E 84** or **UL 723** are useful reference laboratory tests. One or the other of these tests is required for certain applications. These tests do not define the hazard that can be presented by XPP thermal insulation under actual fire conditions.

8. Dimensions and Permissible Variations

8.1 The materials covered by this specification are commonly available in the sizes shown in **Table 2**. Other sizes shall be agreed upon between the supplier and the user.

TABLE 1 Physical Property Requirements of XPP Thermal Insulation

Property	Unit	Requirement
Thermal resistance, <i>R</i> -Value/in., min. at mean temperature: 75°F ± 2°F (24 ± 1°C)	F·ft ² ·h/Btu (K·m ² /W)	3.6 (0.63)
Thermal conductivity of, <i>k</i> -factor, max. at mean temperature: 75°F ± 2°F (24 ± 1°C)	Btu /F·ft ² ·h (W /K·m)	0.28 (0.040)
Compressive resistance at yield or 10 % deformation, whichever occurs first (extrusion direction), min.	psi (kPa)	6 (41.4)
Water vapor permeance of 1.00-in. (25.4-mm) thickness, max ^A	perm (ng/Pa·s·m ²)	2 (115)
Water absorption by total immersion, max	Volume %	1.0
Dimensional stability (change in dimensions), max	% change	3.0

^AProducts manufactured at greater than 1 in. shall report permeance of the minimum thickness available.

8.2 *Dimensional Tolerances*—length tolerance shall be $\pm 3\%$ of the total length, the width tolerance shall not exceed -5% to $+15\%$ of the total width and the thickness tolerance shall be $\pm 5\%$ of the total thickness. These or other dimensional tolerance shall be agreed upon between the producer and the end user. If the product is profiled or tapered the dimensional tolerances shall be converted by 5.1.8.

NOTE 4—Applications for this product to not require tight tolerances for the width dimension.

9. Workmanship, Finish and Appearance

9.1 *Defects*—XPP thermal insulation shall have no defects that will adversely affect its service qualities. XPP thermal insulation shall be of uniform texture and free of foreign inclusions, broken edges and corners, slits, and objectionable odors.

10. Sampling

10.1 Unless otherwise specified in the purchase order or contract, the material shall be sampled in accordance with Practice C 390.

11. Test Methods

11.1 *Conditioning and Aging:*

11.1.1 Samples shall be conditioned as required by the test method to either preconditioned moisture equilibrium or conditioned moisture equilibrium, using procedures defined by Practice C 870. Samples shall be held at equilibrium conditions until they are transferred into the testing equipment. Samples to be used for density test, and water vapor transmission test shall be conditioned at $73.4 \pm 4^\circ\text{F}$ ($23\text{C} \pm 2^\circ\text{C}$) and $50 + 5\%$ relative humidity for a minimum of 24 h prior to the start of tests. Samples to be used for the compressive resistance test, water absorption test, dimensional stability test, and thermal resistance test shall be conditioned as specified in the applicable test procedure.

11.2 *Dimensions and Density*—Test in accordance with Test Method C 303 or Test Method D 1622.

11.3 *Thermal Resistance*—Test in accordance with Test Methods C 177, C 518, C 1114, or C 1363. Tests shall be conducted with a temperature differential of $40 \pm 2^\circ\text{F}$ ($22 \pm 1^\circ\text{C}$). In case of dispute, Test Method C 177 shall be the referee method. The mean temperature for thermal resistance testing shall be $75 \pm 2^\circ\text{F}$ ($24 \pm 1^\circ\text{C}$).

11.4 *Compressive Resistance*—Test in accordance with Test Method C 165, Procedure A, at a crosshead speed of 0.1 in./min/in. of thickness (100 mm/min/m) at yield or 10% deformation, whichever occurs first, or test in accordance with Test Method D 3575.

11.5 *Water Vapor Permeance*—Test in accordance with Test Methods E 96/E 96M, desiccant method, using anhydrous calcium chloride as the desiccant at $73.4 \pm 4^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$).

11.6 *Water Absorption*—Test in accordance with Test Method C 272. The immersion time shall be 24 h and the test specimens shall be 12 by 12 by 1 in. (305 by 305 by 25 mm)

11.7 *Dimensional Stability*—Test in accordance with Test Method D 2126 for 7 days (168 h) using the following conditions:

Temperature, °F (°C)
 240 ± 4 (116 ± 2)
 158 ± 4 (70 ± 2)
 -40 ± 6 (-40 ± 3)

Relative Humidity, %
 ambient
 97 ± 3
 ambient

12. Inspection

12.1 Unless otherwise specified, Practice C 390 shall govern the inspection of material for conformance to inspection requirements. Exceptions to these requirements shall be stated in the purchase contract.

13. Rejection and Rehearing

13.1 Failure to conform to the requirements of this specification shall be cause for rejection. Rejection shall be reported to the producer or supplier promptly and in writing.

13.2 In the case of rejection of a shipment, the producer shall have the right to resubmit the lot for inspection after the removal and replacement of that portion not conforming to requirements.

14. Certification

14.1 Unless otherwise specified in the purchase order or contract, Practice C 390 shall be the basis for the certification. When specified in the purchase order or contract, a report of the test results shall be furnished.

15. Product Marking

15.1 The following shall be marked on each shipping container, bundle, or board:

15.1.1 Insulation specification number,

15.1.2 Type,

15.1.3 Name or trademark of the manufacturer, and

15.1.4 Instructions governing the *R*-value at 75°F (23.9°C) mean temperature for the thermal insulation thickness supplied, as follows: *R* means the resistance to heat flow; the higher the value, the greater the insulation power. This insulation must be installed properly to get the marked *R*-value. Carefully follow the instructions provided by the manufacturer.

16. Keywords

16.1 block/board; C 1631; cellular polypropylene; combustible; compressive strength; dimensional stability; foam plastic; polypropylene; PP; profiled insulation; thermal insulation, thermal resistance; thermal conductivity; water vapor permeance; water absorption; XPP

APPENDIX
(Nonmandatory Information)
X1. END-USE CONSIDERATIONS
X1.1 Thermal Resistance Values at Additional Mean Temperatures

X1.1.1 *Thermal resistance*—The thermal resistance values in **Table X1.1** are provided for information purposes in addition to the thermal resistance values at a mean temperature of $75 \pm 2^\circ\text{F}$ ($24 \pm 1^\circ\text{C}$) provided in **Table 1** of this standard.

TABLE X1.1 Thermal Resistance Values at Additional Mean Temperatures

Property	Unit	Result
Thermal resistance, R-Value/in., min. at mean temperature:		
150°F ± 2°F (65.6°C ± 1°C)	F·ft ² ·h/Btu (K·m ² /W)	3.1 (0.55)
0°F ± 2°F (-18°C ± 1°C)		4.5 (0.80)
-120°F ± 2°F (-84°C ± 1°C)		6.3 (1.11)

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