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Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation[1]

This standard is issued under the fixed designation C 578; 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.

This standard has been approved for use by agencies of the Department of Defense.

ε^1 NOTE—Table 1 was editorially revised in June 2009.

1. Scope

1.1 This specification[2] covers the types, physical properties, and dimensions of cellular polystyrene boards with or without facings or coatings made by molding (EPS) or extrusion (XPS) of expandable polystyrene. Products manufactured to this specification are intended for use as thermal insulation for temperatures from -65 to +165°F (-53.9 to +73.9°C). This specification does not apply to laminated products manufactured with any type of rigid board facer including fiberboard, perlite board, gypsum board, or oriented strand board.

1.1.1 For Type XIII only, this specification covers the physical properties, and dimensions of cellular polystyrene intended for use as thermal insulation for temperatures from −297 to +165°F (−183 to +73.9°C).

1.2 Consult the manufacturer for specific recommendations and properties in cryogenic conditions.

1.2.1 This specification does not cover cryogenic properties except for the k-factors for Type XIII in Appendix X1. For Type XIII in specific cryogenic applications, the manufacturer and purchaser shall agree upon the actual temperature limits and physical property requirements in addition to the k-factors in Appendix X1.

1.3 The use of thermal insulation materials covered by this specification may be regulated by building codes that address fire performance. For some end uses, specifiers should also address the effect of moisture. Guidelines regarding these end use considerations are included in Appendix X1.

1.4 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.

1.5 *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:*[3]

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 203 Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
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 BoardType Thermal Insulation
C 335 Test Method for Steady-State Heat Transfer Properties of Pipe 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 550 Test Method for Measuring Trueness and Squareness of Rigid Block and Board Thermal Insulation
C 870 Practice for Conditioning of Thermal Insulating Materials

[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.

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[2] This specification is similar to ISO 4898-1984, "Cellular Plastics–Specification for Rigid Cellular Materials Used in the Thermal Insulation of Buildings," in title only. The scope and technical content are significantly different.

ISO standards are available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[3] 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.

C 1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions
C 1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation
C 1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus
C 1303 Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation
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 1621 Test Method for Compressive Properties Of Rigid Cellular 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 2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
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

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 *EPS*—letter designation for the molded expanded polystyrene thermal insulation classified by this specification. It is defined as cellular plastic product manufactured from pre-expanded polystyrene beads subsequently molded into desired shapes and sizes resulting in a product which is rigid with closed cellular structure.

3.2.2 *RCPS*—letter designations for the rigid cellular polystyrene thermal insulation classified by this specification that identifies the product as rigid cellular polystyrene.

3.2.3 *PS*—used in this specification to represent polystyrene in accordance with Terminology D 1600.

3.2.4 *XPS*—letter designation for the extruded expanded polystyrene thermal insulation classified by this specification. It is defined as cellular plastic product manufactured in a one stage process by extrusion and expansion of the base polymer in the presence of blowing agent(s) resulting in a product which is rigid with closed cellular structure.

4. Classification

4.1 This specification covers types of RCPS 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 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 RCPS thermal insulation may vary with thickness. Therefore, when ordering, specify the *R*-value or the thickness, or both. For additional information, see Practice C 1045.

5.1.4 Density, if other than specified in Table 1,

5.1.5 Tolerance, if other than specified (see 8.2),

5.1.6 Length and width required (see Table 2 and 8.1),

5.1.7 If other than straight edges are required (see 8.3),

5.1.8 If either ship-lap or tongue-and-groove edges are required (see 8.6),

5.1.9 *Tapered Insulation*—special ordering information. In addition to other applicable requirements in Section 5 (Note 1), acquisition documents for tapered RCPS thermal insulation shall specify the following:

5.1.9.1 Minimum starting thickness,

5.1.9.2 Slope, in./ft (mm/m),

5.1.9.3 Average *R*-value,

5.1.9.4 Minimum thickness,

5.1.9.5 *Shop Drawings*— The tapered insulation supplier shall provide shop drawings to illustrate installation patterns and dimensions for each tapered module,

5.1.10 Sampling, if different (see 10.1),

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

5.1.12 If marking is other than specified (see 15.1).

TABLE 1 Physical Property Requirements of RCPS Thermal Insulation

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

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

NOTE 3—In addition to the thermal resistance values in Table 1, values at mean temperatures of 25 ± 2°F (-4 ± 1°C), 40 ± 2°F (4 ± 1°C), and 110 ± 2°F (43 ± 1°C) are provided in X1.8 for information purposes.

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

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

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

Classification	Type XI	Type I	Type VIII	Type II	Type IX	Type XIV	Type XV	Type XII	Type X	Type II	Type XIII	Type IV	Type IX	Type VI	Type XIV	Type VII
Compressive resistance at yield or 10 % desistformance ation, y whicheldver occur 10 %s first deform (with skins intact), mion, psi whichever occurs first (with skins intact), min, psi (kPa)	5.0 (35)	10.0 (69)	13.0 (90)	15.0 (104)	25.0 (173)	40.0 (276)	60.0 (414)	15.0 (104)	15.0 (104)	15.0 (104)	20.0 (138)	25.0 (173)	25.0 (173)	40.0 (276)	40.0 (276)	60.0 (414
Thermal resistance of 1.00-in. (25.4-mm) thickness, min, F·ft²·h/Btu (K·m²/W) Mean temperature:																
Thermal resistance of 1.00-in. (25.4-mm) thickness, min, F·ft²·h/Btu (K·m²/W)																
75 ± 2°F (24 ± 1°C)	3.1 (0.55)	3.6 (0.63)	3.8 (0.67)	4.0 (0.70)	4.2 (0.74)	4.2 (0.74)	4.3 (0.76)	4.6 (0.81)	5.0 (0.88)	4.0 (0.70)	3.9 (0.68)	5.0 (0.88)	4.2 (0.74)	5.0 (0.88)4.2		
75 ± 2°F (24 ± 1°C)	3.1 (0.55)	3.6 (0.63)	3.8 (0.67)	4.0 (0.70)	4.2 (0.74)	4.2 (0.74)	4.3 (0.76)	4.6 (0.81)	5.0 (0.88)	3.9 (0.68)	5.0 (0.88)	5.0 (0.88)	5.0 (0.88)	5.0 (0.88)		
(0. 74)	5.0 (0.88)	4.3 (0.76)	5.0 (0.88)													
Mean temperature: 75 ± 2°F (24 ± 1°C)																
Flexural strength, min, psi (kPa)	10.0 (70)	25.0 (173)	30.0 (208)	35.0 (240)	50.0 (345)	60.0 (414)	75.0 (517)	40.0 (276)	40.0 (276)	35.0 (240)	45.0 (310)	50.0 (345)	50.0 (345)	60.0 (414)	60.0 (414)	75.0 (517
Water vapor permea nce of 1.00-in. (25.4-mm) thickness (See Note 5.), max, perm (ng/Pa·s·m²)	5.0 (287)	5.0 (287)	3.5 (201)	3.5 (201)	2.5 (143)	2.5 (143)	2.5 (143)	1.5 (86)	1.5 (86)	3.5 (201)	1.5 (86)	1.5 (86)	2.5 (143)	1.1 (63)	2.5 (143)	1.1 (63)
Water vapor permeance of 1.00-in. (25.4-mm) thickness (See Note 5.), max, perm (ng/Pa·s·m²)	5.0 (287)	5.0 (287)	3.5 (201)	3.5 (201)	2.5 (143)	2.5 (143)	2.5 (143)	1.5 (86)	1.5 (86)	3.5 (201)	1.5 (86)	1.5 (86)	2.5 (143)	1.1 (63)	2.5 (143)	1.1 (63)
Water absorption by total immersion, max, volume %	4.0	4.0	3.0	3.0	2.0	2.0	2.0	0.3	0.3	3.0	0.5	0.3	2.0	0.3	2.0	0.3
Water absorption by total immersion, max, volume %	4.0	4.0	3.0	3.0	2.0	2.0	2.0	0.3	0.3	3.0	0.5	0.3	2.0	0.3	2.0	0.3
Dimensional stability (change in dimensions), max,%	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.02
Dimensional stability (change in dimensions), max,%	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.02
Oxygen index, min, volume %	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Density, min, lb/ft³ (kg/m³)	0.70 (12)	0.90 (15)	1.15 (18)	1.35 (22)	1.80 (29)	2.40 (38)	2.85 (46)	1.20 (19)	1.30 (21)	1.35 (22)	1.60 (26)	1.55 (25)	1.80 (29)	1.80 (29)	2.40 (38)	2.20 (35)

† Duplicate rows, Type II, Type IX, Type XIV, and Type XV were editorially removed in June 2009.

NOTE 1—Physical properties of tapered insulation should be determined on blocks of RCPS thermal insulation before the insulation is tapered.

5.1.13 *Type XIII*—Special ordering information. In addition to other applicable requirements in Section 5, acquisition documents for Type XIII thermal insulation shall specify if presence of surface skins is required.

TABLE 2 Common Dimensions of RCPS Thermal Insulation

Type	XI, I, VIII, II, IX, XIV, XV	X, IV, XII	VI, VII	V	XIII
Width, in. (mm)	12 to 48 (305 to 1219)	16, 24, 48 (406, 610, 1219)	24 (610)	16 (406)	14 to 20 (356 to 508)
Length, in. (mm)	48 to 192 (1219 to 4877)	48, 96 108 (1219, 2438, 2743)	48, 96, (1219, 2438)	96 (2438)	36 to 112 (914 to 2845)
Thickness, in. (mm)	⅜ to 24 (9.5 to 610)	½ to 4 (13 to 102)	1 to 4 (25 to 102)	1 to 4 (25 to 102)	7 to 10 (178 to 254)

6. Materials and Manufacture

6.1 RCPS thermal insulation shall be formed by the expansion of polystyrene resin beads or granules in a closed mold, or by the expansion of polystyrene base resin in an extrusion process. RCPS thermal insulation shall be of uniform density and have essentially closed cells. All RCPS thermal insulation shall contain sufficient flame retardants to meet the oxygen index requirements of Table 1.

7. *Physical Requirements* Physical Requirements

7.1 *Inspection Requirements*:

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 2—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, flexural strength, water vapor permeance, water absorption, dimensional stability, and oxygen index shall be in accordance with Table 1. The average test value based upon testing the number of test specimens required by the specified test method for each physical property or Section 11 of this specification shall be used to determine compliance.

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 RCPS thermal insulation. However, it does not cover all available products on the market. The values stated in Table 1 are not intended to 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 *Combustibility Characteristics* —RCPS thermal insulation is an organic material and is, therefore, combustible. It shall not be exposed to flames or other ignition sources. The values obtained by the oxygen index test (see Table 1 and 11.10) do not necessarily indicate or describe the fire risk of the materials and are used in this specification primarily to distinguish between insulations formulated with flame retardants and those not so formulated.

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.

8.2 *Dimensional Tolerances*—Unless otherwise specified, the length tolerance shall not exceed ±0.03 in./ft (±2.5 mm/m) of length; the width tolerance shall not exceed ±0.06 in./ft (±5.0 mm/m) of width; and the thickness tolerance shall not exceed ±0.06 in./in. (±59.5 mm/m) of thickness. For products less than 1.00 in. (25.4 mm) in thickness, the thickness tolerance shall not exceed ±0.06 in. (1.5 mm).

8.2.1 Dimensional Tolerances for RCPS Type III - the length tolerance shall not exceed +1, –0 in (+25.4, –0 mm); the width tolerance shall not exceed +0.5, –0 in (+12.7, –0 mm); and the thickness tolerance shall not exceed +0.5, –0 in (+12.7, –0 mm).

8.3 *Edge Trueness*— Unless otherwise specified, RCPS thermal insulation shall be furnished with true edges. Edges shall not deviate more than 0.03 in./ft (2.5 mm/m) of length or width.

8.4 *Face Trueness*— RCPS thermal insulation shall not deviate from absolute trueness by more than 0.03 in./ft (2.5 mm/m) of length or width.

8.5 *Squareness*—RCPS thermal insulation shall not deviate from squareness by more than 0.06 in./ft (5.0 mm/m) of length or width.

8.6 *Ship-Lap and Tongue-and-Groove Edges*—When specified, RCPS thermal insulation shall be furnished with either ship-lap or tongue-and-groove edges.

8.6.1 For RCPS thermal insulation manufactured with ship-lap edges, the depth of the ship-lap cut shall be one half the board thickness +0.06, –0 in. (+1.5, –0 mm). The minimum width of the cut for RCPS thermal insulation of 1.00-in. (25.4-mm)