Designation: C578 – 19

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

This standard is issued under the fixed designation C578; 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 U.S. Department of Defense.

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 Additional requirements for Types IV and XIII for pipe, tank, and equipment thermal insulation for temperatures from –320 to +165°F (–196 to +73.9°C) are contained in Annex A1.

1.2 The use of thermal insulation materials covered by this specification is potentially regulated by codes that address fire performance. For some end uses, specifiers need to also address the effect of moisture and wind pressure resistance. Guidelines regarding these end use considerations are included in Appendix X1.

1.3 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.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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:*[3]

C165 Test Method for Measuring Compressive Properties of Thermal Insulations

C168 Terminology Relating to Thermal Insulation

C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

C203 Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation

C272 Test Method for Water Absorption of Core Materials for Sandwich Constructions

C303 Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation

C335 Test Method for Steady-State Heat Transfer Properties of Pipe Insulation

C390 Practice for Sampling and Acceptance of Thermal Insulation Lots

C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

C550 Test Method for Measuring Trueness and Squareness of Rigid Block and Board Thermal Insulation

C870 Practice for Conditioning of Thermal Insulating Materials

C1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions

C1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation

C1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus

C1303 Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation

[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.

C1363 Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
C1512 Test Method for Characterizing the Effect of Exposure to Environmental Cycling on Thermal Performance of Insulation Products
D1600 Terminology for Abbreviated Terms Relating to Plastics
D1621 Test Method for Compressive Properties of Rigid Cellular Plastics
D1622 Test Method for Apparent Density of Rigid Cellular Plastics
D2126 Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
D2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
E84 Test Method for Surface Burning Characteristics of Building Materials
E96/E96M Test Methods for Water Vapor Transmission of Materials
E176 Terminology of Fire Standards

2.2 *CAN/ULC Standard*[4]
CAN/ULC S770 Standard Test Method for the Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams

3. Terminology

3.1 *Definitions:*

3.1.1 Terms used in this specification are defined in Terminology C168.

3.1.2 Terms used in this specification that relate to fire standards are defined in Terminology E176.

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 D1600.

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] Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, http://www.ul.com.

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*—It is possible that the thermal resistance (*R*-value) and the thermal resistivity (*R*-value/inch) of RCPS thermal insulation will vary with thickness. Therefore, when ordering, specify the *R*-value or the thickness, or both. For additional information, see Practice C1045.
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).

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.

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

7.1 *Inspection Requirements:*

7.1.1 The physical requirements listed in this section are defined as inspection requirements (refer to Practice C390).

TABLE 1 Physical Property Requirements of RCPS Thermal Insulation

NOTE 1—It is possible that values for properties listed in this table will 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 X1.7 for information purposes.

NOTE 4—Values quoted are maximum values for 1.00 in. (25.4 mm) thick samples with natural skins intact. Lower values will result for thicker materials. Where water vapor permeance is a design issue, consult manufacturer.

NOTE 5—It is acceptable to determine the values for thermal resistance listed in this table on product at a thickness other than 1 in. (25.4 mm) in accordance with 7.2.2.1. When tested at a thickness other than 1 in. (25.4 mm), the thermal resistance per inch shall meet the minimum requirement.

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

Classification	Type XI	Type I	Type VIII	Type II	Type IX	Type XIV	Type XV	Type XII	Type X	Type XIII	Type IV	Type VI	Type VII	Type V
Compressive resistance at yield or 10 % deformation, whichever occurs first (with skins intact), min, psi (kPa)	5.0 (35)	10.0 (69)	13.0 (90)	15.0 (104)	25.0 (173)	40.0 (276)	60.0 (414)	15.0 (104)	15.0 (104)	20.0 (138)	25.0 (173)	40.0 (276)	60.0 (414)	100.0 (690)
Thermal resistance of 1.00-in. (25.4-mm) thickness, min, $F{\cdot}ft^2{\cdot}h/Btu$ ($K{\cdot}m^2/W$) Mean temperature: 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)
Flexural strength, min, psi (kPa)	10 (70)	25 (173)	30 (208)	35 (240)	50 (345)	60 (414)	75 (517)	40 (276)	40 (276)	45 (310)	50 (345)	60 (414)	75 (517)	100 (690)
Water vapor permeance of 1.00-in. (25.4-mm) thickness (See Note 4.), max, perm ($ng/Pa{\cdot}s{\cdot}m^2$)	5.0 (287)	5.0 (287)	3.5 (201)	3.5 (201)	2.5 (143)	2.5 (143)	2.5 (143)	1.5 (86)	1.5 (86)	2.0 (114)	1.5 (86)	1.1 (63)	1.1 (63)	1.1 (63)
Water absorption by total immersion, max, volume %	4.0	4.0	3.0	3.0	2.0	2.0	2.0	0.3	0.3	1.0	0.3	0.3	0.3	0.3
Dimensional stability (change in dimensions), max,%	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Oxygen index, min, volume %	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Density, min, lb/ft^3 (kg/m^3)	0.70 (12)	0.90 (15)	1.15 (18)	1.35 (22)	1.80 (29)	2.40 (38)	3.00 (48)	1.20 (19)	1.30 (21)	1.60 (26)	1.45 (23)	1.80 (29)	2.20 (35)	3.00 (48)

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)

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 C390 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 C390). 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.

7.2.2.1 Test 1 in. (25.4 mm) thick specimens for determination of compliance with thermal resistance, compressive resistance, water vapor permeance, water absorption, dimensional stability and density property requirements in Table 1. If

1 in. (25.4 mm) thickness product is not produced the next available commercially manufactured product thickness greater than 1 in. (25.4 mm) thickness shall be tested and reported.

7.2.3 Compliance with qualification requirements shall be in accordance with Practice C390.

7.3 *Long Term Thermal Resistance (LTTR)*—Determine and report values in accordance with Test Method C1303 or CAN/ULC S770. LTTR shall apply to types IV, V, VI, VII, and X only. The composition of the test stacks used for the test measurements[5] shall be reported.

7.4 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.

7.5 *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 XIII*—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) thickness or greater shall be 0.50 ± 0.06 in. (12.7 ± 1.5 mm). For RCPS thermal insulation less than 1.00 in. (25.4 mm) in thickness, the minimum width of the cut shall be 0.25 ± 0.06 in. (6.4 ± 1.5 mm). The ship-lap cut shall be made on opposite faces of the board for both length and width. The resulting joint shall be smooth and uniform.

8.6.2 For RCPS thermal insulation manufactured with tongue-and-groove edges, the tongue of one shall fit snugly into the groove of a second. The resulting joint shall be smooth and uniform.

9. Workmanship, Finish, and Appearance

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

9.2 *Crushing and Depressions*—RCPS thermal insulation shall have no crushed or depressed areas on any surface exceeding 0.13 in. (3.3 mm) in depth on more than 10 % of the total surface area.

9.3 The total number of voids on the board surface shall not exceed an average of 1 per square foot with dimensions larger than 0.13 by 0.13 by 0.13 in. (3.3 by 3.3 by 3.3 mm).

10. Sampling

10.1 Unless otherwise specified in the purchase order or contract, the material shall be sampled in accordance with Practice C390.

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 C870. Samples shall be held at equilibrium conditions until they are transferred into the testing equipment. Samples to be used for density test, dimensional stability test, and water vapor transmission test shall be conditioned at 73.4 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity for a minimum of 40 h prior to the start of tests. Samples to be used for the compressive resistance test, oxygen index test, water absorption test, flexural strength test, and thermal resistance test shall be conditioned as specified in the applicable test procedure.

11.1.2 RCPS thermal insulations that incorporate a blowing agent other than air or pentane shall be aged for either 90 ± 2 days at 140 ± 2°F (60 ± 1°C) or 180 ± 5 days at 73.4 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity prior to conditioning and thermal resistance testing. Air circulation shall be provided so that all surfaces of the insulation are exposed to the surrounding environmental conditions.

[5] Supporting data can be found in Oak Ridge National Lab Report number ORNL/TM-2012/214. Evaluation of Experimental Parameters in the Accelerated Aging of Closed-Cell Foam Insulation, December 2012.

11.1.3 Where boards are tested with skins-in-place, this condition shall be noted in the test report.

11.2 *Dimensions and Density*—Test in accordance with Test Method C303 or Test Method D1622.

11.3 *Trueness and Squareness*—Test in accordance with Test Method C550.

11.4 *Thermal Resistance*—Test in accordance with Test Methods C177, C518, C1114, C1363 or Practices C1045 or C1058. Tests shall be conducted with a temperature differential of 40 ± 2°F (22 ± 1°C). In case of dispute,Test Method C177 shall be the referee method. The mean temperature for thermal resistance testing shall be 75 ± 2°F (24 ± 1°C). Three specimens are to be tested and the average thermal resistance for the three specimens tested is to be reported.

11.4.1 It is possible that Test Method C335 will be applicable to insulation used in pipe applications.

11.5 *Compressive Resistance*—Test in accordance with Test Method C165, 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 (with skins intact), or test in accordance with Test Method D1621. Five Specimens are to be tested. For anisotropic materials (for example, extruded insulation), specimens are to be equally spaced specimens in the cross machine direction of the board. The average compressive resistance for the five specimens tested is to be reported.

11.6 *Flexural Strength*—Test in accordance with Test Methods C203, Method I, Procedure B. All test specimens shall be 1.00 ± 0.06 in. (25.4 ± 1.5 mm) or less in thickness. For samples less than or equal to 1.00 ± 0.06 in. in thickness (Note 2), cut test specimens from samples keeping both original major surfaces intact. If skins are present on only one major surface, test specimens with that surface in tension. For samples of greater thickness, trim test specimens to 1.00 ± 0.06 in. thickness retaining one original major surface. Specimens shall be tested with the original major surface in tension. For isotropic products (EPS) three specimens shall be tested. Report the average as the value for flexural strength. For anisotropic products (XPS) except type XIII, three specimens shall be tested for both the length and cross directions of the sample. Report the average of these two series of tests as the value for flexural strength. For XPS Type XIII, three specimens shall be tested for the length (machine) direction of the sample.

NOTE 3—Type XIII XPS is exempted from the cross-machine flexural testing because it is used in mechanical insulation applications where cross-machine flexural strength is irrelevant.

11.6.1 Specimens less than 1.00 ± 0.06 in. (25.4 ± 1.5 mm) in thickness are capable of continuing to flex without specimen failure (break). In such cases, flexural strength testing shall be performed using thicker specimens and the thickness shall be noted in the test report.

11.7 *Water Vapor Permeance*—Test in accordance with Test Methods E96/E96M, using anhydrous calcium chloride as the desiccant at 73.4 ± 4°F (23 ± 2°C). Test three specimens and report the average of these three test as the value for water vapor permeance.

11.7.1 Test 1.00 in. (25.4 mm) thick specimens. If 1.00 in. (25.4 mm) thick product is not produced the next available commercially manufactured product thickness greater than 1.00 in. (25.4 mm) thickness shall be tested and the thickness reported.

11.8 *Water Absorption*—Test in accordance with Test Method C272. 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). Immerse the specimens horizontally under 1 in. (25 mm) head of water. Hold materials that float under water by using a loose net or other means which will not greatly affect the exposed surface area of the specimen. Test three specimens and report the average of these three tests as the value for water absorption.

11.8.1 Report water absorption in units of % by volume determined by multiplying the water absorption % by weight obtained by testing in accordance with Test Method C272 by the specimen specific gravity.

11.9 *Dimensional Stability*—Test in accordance with Test Method D2126 for 7 days (168 h) using the following conditions:

Temperature, °F (°C)	Relative Humidity, %
158 ± 4 (70 ± 2)	97 ± 3
−40 ± 6 (−40 ± 3)	ambient

11.9.1 Test three specimens for each condition and report the average of these three tests as the value for dimensional stability for each condition.

11.10 *Oxygen Index*—Test in accordance with Test Method D2863.

12. Inspection

12.1 Unless otherwise specified, Practice C390 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 C390 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 Manufacturer's name or trademark, and

15.1.4 Thermal Properties

15.1.4.1 R-value for all Types (note the exceptions to this requirement in Annex A1).

15.1.5 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. Follow the manufacturer's instructions carefully. If a manufacturer's fact sheet is not provided with the material shipment, request this and review it carefully.

16. Keywords

16.1 block/board; cellular polystyrene; foam plastic; polystyrene; RCPS; rigid cellular polystyrene; thermal insulation

ANNEX

(Mandatory Information)

A1. REQUIREMENTS FOR TYPE IV AND XIII RCPS INTENDED FOR USE AS PIPE, TANK, AND EQUIPMENT THERMAL INSULATION AT TEMPERATURES FROM –320 to +165°F (–196 to +73.9°C)

A1.1 All the requirements for Types IV and XIII shown in the main body of this standard specification are applicable to the pipe, tank, and equipment thermal insulation covered in this annex.

A1.2 This annex covers additional thermal conductivity values required for use at temperatures from –320 to +165°F (–195.6 to +73.9°C).

NOTE A1.1—Temperatures less than –297°F (–183°C) can generate oxygen-enriched environments. When organic insulation system materials are exposed to oxygen enriched environments, an increased risk of ignition and fire can exist. Care should be taken to address any safety concerns.

A1.3 Consult the manufacturer for specific recommendations and properties in cryogenic conditions.

A1.3.1 The manufacturer and purchaser shall agree upon the actual temperature limits and additional physical property requirements, if any.

A1.4 Apparent Thermal Conductivity

A1.4.1 Apparent Thermal Conductivity (k-Factor) is the inverse of the thermal resistance (R-value) of a 1-in. thick specimen.

A1.4.2 Determine thermal transmission properties in accordance with 11.1 and 11.4 at the mean temperatures of Table A1.1 and report Apparent Thermal Conductivity (k-Factor). The thickness of the specimen shall be 1 in. (25.4 mm) for both the aging described in 11.1 and the testing described in 11.4.

A1.4.3 The mean apparent thermal conductivity of the material tested shall not be greater than the maximum value identified in Table A1.1. The apparent thermal conductivity of individual specimens tested shall not be greater than 110 % of the maximum value identified in Table A1.1.

TABLE A1.1 Types IV and XIII, Apparent Thermal Conductivity

PROPERTY	Type IV	Type XIII
	Apparent Thermal Conductivity, max, BTU-in/hr-ft^2-°F (W/m-°C)	
Mean Temperature:		
110°F (43.3°C)	0.215 (0.031)	0.277 (0.040)
100°F (37.7°C)		0.272 (0.039)
75°F (23.9°C)	0.200 (0.029)	0.259 (0.037)
50°F (10.0°C)	0.190 (0.027)	0.246 (0.035)
40°F (4.4°C)		0.241 (0.035)
25°F (–3.9°C)		0.234 (0.034)
0°F (–17.8°C)	0.171 (0.025)	0.221 (0.032)
–25°F (–31.7°C)		0.212 (0.031)
–50°F (–45.6°C)	0.155 (0.022)	0.203 (0.029)
–75°F (–59.4°C)		0.195 (0.028)
–100°F (–73.3°C)	0.149 (0.021)	0.181 (0.026)
–150°F (–101.1°C)	0.139 (0.020)	0.152 (0.022)
–200°F (–128.9°C)	0.119 (0.017)	0.124 (0.018)
–250°F (–156.7°C)	0.093 (0.013)	0.097 (0.014)

NOTE A1.2—Measurements of apparent thermal conductivity (k-Factor) at mean temperatures below about –250°F (–156.7°C) are difficult to perform. It is a normal practice for pipe, tank, and equipment insulation to measure k-Factor at a mean temperature down to about –250°F (–156.7°C) and then to extrapolate the values to temperatures down to –320°F (–195.6°C). This extrapolation is considered acceptable and accurate because of the predictable nature of the k-Factor versus mean temperature curve at the cryogenic temperatures between –250°F (156.7°C) and –320°F (–195.6°C).

A1.5 Product Marking

A1.5.1 The marking requirements in 15.1 shall be followed except for:

A1.5.1.1 The R-value need not be marked on each shipping container.

A1.5.1.2 The k-Factor shall be marked on each shipping container, bundle, or piece.

A1.5.2 A manufacturer's fact sheet is not required.

APPENDIX

(Nonmandatory Information)

X1. END-USE CONSIDERATIONS

X1.1 Combustibility Characteristics

X1.1.1 The fire performance of the material should be addressed through standard end-use fire test methods established by the appropriate governing documents.

X1.2 Test Method E84/UBC Standard No. 8-1/UL 723

X1.2.1 These tests do not define the hazard that may be presented by RCPS thermal insulation under actual fire conditions. It is retained for reference in this specification as laboratory test data required by some building codes.

X1.3 Water Vapor Transmission

X1.3.1 Most thermal insulations function where there is both a temperature and moisture vapor pressure differential across the insulation. The water vapor permeability of RCPS thermal insulation may be a significant element to be considered when developing the specification for the vapor retarder component of the thermal package for a specific end use condition.

X1.4 Water Absorption

X1.4.1 This characteristic may have significance when this specification is used to purchase material for end uses requiring extended exposure to water. The water absorption of thermal insulations is an important property to the degree that significant content can degrade thermal performance.

X1.5 Freeze/Thaw Exposure

X1.5.1 RCPS insulating boardstock is sometimes used in applications that may subject the insulation to various types of freeze/thaw exposure conditions. These conditions may vary significantly in service. Exposure conditions to be considered include actual temperatures, liquid water availability, and freeze/thaw cycle frequency and duration. Boardstock integrity, as well as thermal/physical property retention may be affected by actual end-use conditions. The ability of RCPS thermal insulation to maintain thermal performance and critical physical attributes after exposure to standardized freeze/thaw exposure conditions may be determined using Test Method C1512. Consult the manufacturer for specific product, insulation system, and application recommendations.

X1.6 Specification C578/HH-I-524C Cross Reference

X1.6.1 Federal Specification HH-I-524C was cancelled on Jan. 17, 1985. For the convenience of specifiers who may have contracts written in terms of HH-I-524C, the following is a cross-reference table. The letters N\A indicate that the type designation has been deleted because products meeting the requirements are no longer available.

HH-I-524C Type Designation	Specification C578 Type Designation
I	I
II	II
III	N\A
IV	IV
V	V

X1.6.2 Additional type designations have been established since the cancellation of HH-I-524C to better define the variety of RCPS thermal insulations available.

X1.7 Thermal Resistance Values at Additional Mean Temperatures

X1.7.1 *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 ± 2°F (24 ± 1°C) provided in Table 1 of this standard.

X1.8 Wind Pressure Resistance for RCPS Thermal Insulation used as Wall Sheathing

X1.8.1 When required, the wind pressure performance of RCPS thermal insulation boards used as sheathing in exterior

TABLE X1.1 Thermal Resistance Values at Additional Mean Temperatures

Classification	Type XI	Type I	Type VIII	Type II	Type IX	Type XIV	Type XV	Type XII	Type X	Type IV	Type VI	Type VII	Type V
Thermal resistance of 1.00-in. (25.4-mm) thickness, min, $F \cdot ft^2 \cdot h/Btu$ ($K \cdot m^2/W$)													
Mean temperature:													
25°F (-3.9°C)	3.45	4.20	4.40	4.60	4.80	4.80	4.90	5.20	5.60	5.60	5.60	5.60	5.60
±2°F (±1°C)	(0.61)	(0.74)	(0.77)	(0.81)	(0.84)	(0.84)	(0.86)	(0.92)	(0.99)	(0.99)	(0.99)	(0.99)	(0.99)
40°F (4.4°C)	3.30	4.00	4.20	4.40	4.60	4.60	4.70	5.00	5.40	5.40	5.40	5.40	5.40
±2°F (±1°C)	(0.58)	(0.70)	(0.74)	(0.77)	(0.81)	(0.81)	(0.83)	(0.88)	(0.95)	(0.95)	(0.95)	(0.95)	(0.95)
110°F (43.3°C)	2.90	3.25	3.45	3.65	3.85	3.85	3.95	4.30	4.65	4.65	4.65	4.65	4.65
±2°F (±1°C)	(0.51)	(0.57)	(0.61)	(0.64)	(0.69)	(0.69)	(0.70)	(0.76)	(0.82)	(0.82)	(0.82)	(0.82)	(0.82)
Density, min, lb/ft^3 (kg/m^3)	0.70	0.90	1.15	1.35	1.80	2.40	3.0	1.20	1.30	1.45	1.80	2.20	3.00
	(12)	(15)	(18)	(22)	(29)	(38)	(48)	(19)	(21)	(25)	(29)	(35)	(48)

above-grade wall covering assemblies shall be properly addressed using appropriate end-use standards or addressed through appropriate test methods with results reviewed and reported for compliance with building code requirements by an approved agency. Flexural strength values determined in accordance with 11.6 or reported in Table 1 are not appropriate for calculation of wind pressure performance because loading conditions and specimen preparation are not representative of actual end use conditions.

X1.8.2 Exterior wall assemblies and components must be capable of adequately resisting wind pressure acting on them as a whole and on particular layers, assemblies, or components. The required design wind pressure resistances are specified in the applicable building code, standards, or by user specification for special circumstances. In general, there are two installation or use conditions which dictate the need to consider wind pressure resistance for thermal insulation boards (panels) when used as wall sheathing:

X1.8.2.1 *Condition 1*—Wind pressure resistance not needed. In this installation case, thermal insulation boards are placed over another wall sheathing material or solid wall and covered with a cladding material, both of which are capable of resisting the full applicable design wind pressure.

X1.8.2.2 *Condition 2*—Wind pressure resistance needed. When Condition 1 is not met, thermal insulation boards will need to resist wind pressure acting in the inward direction (positive wind pressure), outward direction (negative wind pressure), or both directions if it is not constrained by another material in either direction.