**Designation: C 1289 – 03**

# Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board[1]

This standard is issued under the fixed designation C 1289; 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 covers the general requirements for faced thermal insulation boards composed of rigid cellular polyisocyanurate surfaced with other materials. The insulation boards are intended for use at temperatures between −40 and 200°F (−40 and 93°C). This specification does not cover cryogenic applications. Consult the manufacturer for specific recommendations and properties in cryogenic conditions. For specific applications, the actual temperature limits shall be agreed upon by the manufacturer and the purchaser.

1.2 This standard is intended to apply to rigid cellular polyurethane-modified polyisocyanurate thermal insulation board products that are commercially acceptable as non-structural panels useful in building construction. The term polyisocyanurate encompasses the term polyurethane. For engineering and design purposes, users should follow specific product information provided by board manufacturers regarding physical properties, system design considerations and installation recommendations.

1.3 The use of thermal insulation materials covered by this specification may be regulated by building codes, or other agencies that address fire performance, or both. The fire performance of the material should be addressed through standard fire test methods established by the appropriate governing documents.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only and may be approximate. For conversion to metric units other than those contained in this standard, refer to IEEE/ASTM SI 10.

1.5 The following safety hazards caveat pertains only to the test methods, Section 11, in this specification. *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 The following documents, of the issue in effect on the date of material purchase, form a part of this specification to the extent specified herein:

2.2 *ASTM Standards:* [2]

C 168 Terminology Relating to Thermal Insulating Materials

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 208 Specification for Cellulosic Fiber Insulating Board

C 209 Test Methods for Cellulosic Fiber Insulating Board

C 303 Test Method for Density of Preformed Block-Type Thermal Insulation

C 390 Criteria for Sampling and Acceptance of Preformed Thermal Insulation Lots

C 518 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

C 550 Test Method for Measuring Trueness and Squareness of Rigid Block Thermal Insulation

C 728 Specification for Perlite Thermal Insulation Board

C 1045 Practice for Calculating Thermal Transmission Properties from Steady-State Heat Flux Measurements

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 Estimating the Long-Term Change in the Thermal Resistance of Unfaced Rigid Closed Cell Plastic Foams by Slicing and Scaling Under Controlled Laboratory Conditions

C 1363 Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus

D 226 Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing

[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] 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.

D 1621 Test Method for Compressive Properties of Rigid Cellular Plastics
D 2126 Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
E 84 Test Method for Surface Burning Characteristics of Building Materials
E 96 Test Methods for Water Vapor Transmission of Materials
IEEE/ASTM SI 10–Standard for Use of the International System of Units (SI): (The Modernized Metric System)

2.3 *ANSI Standard:*
Voluntary Product Standard ANSI A 208.1 Wood Particleboard[3]

2.4 *CAN/ULC Standard:*
CAN/ULC-S770-00 Standard Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams[4]

## 3. Terminology

3.1 For complete descriptions of terms used in this specification, refer to Terminology C 168.

3.2 The term polyisocyanurate encompasses the term polyurethane (see 1.2).

## 4. Classification

4.1 The faced thermal insulation boards composed of rigid cellular polyisocyanurate covered by this specification are classified as follows:

4.1.1 *Type I*—Faced with aluminum foil on both major surfaces of the core foam.

4.1.1.1 *Class 1*—Non-reinforced core foam.

4.1.1.2 *Class 2*—Glass fiber reinforced core foam.

4.1.2 *Type II*:

4.1.2.1 *Class 1*—Faced with organic/inorganic/asphaltsaturated/polymer-bonded/fibrous felt or uncoated/asphaltcoated/polymer-bonded/glass fiber mat membrane facers on both major surfaces of the core foam.

4.1.2.1.1 *Grade 1*—16 psi (110 kPa), min, compressive strength.

4.1.2.1.2 *Grade 2*—20 psi (138 kPa), min, compressive strength.

4.1.2.1.3 *Grade 3*—25 psi (172 kPa), min, compressive strength.

4.1.2.2 *Class 2*—Faced with polymer-bonded glass fiber mat membrane facers on both major surfaces of the core foam.

4.1.3 *Type III*—Faced with a perlite insulation board on one major surface of the core foam and an organic/inorganic/asphalt-saturated/polymer-bonded/fibrous felt or uncoated/asphalt-coated/polymer-bonded/glass fiber mat membrane facer on the other major surface of the core foam.

4.1.4 *Type IV*—Faced with a cellulosic fiber insulating board on one major surface of the core foam and an organic/inorganic/asphalt-saturated/polymer-bonded/fibrous felt or uncoated/asphalt-coated/polymer-bonded/glass fiber mat membrane facer on the other major surface of the core foam.

4.1.5 *Type V*—Faced with oriented strand board or waferboard on one major surface of the foam and an organic/inorganic/asphalt-saturated/polymer-bonded/fibrous felt or uncoated/asphalt-coated/polymer-bonded/glass fiber mat membrane facer on the other major surface of the core foam.

4.1.6 *Type VI*—Faced with a perlite insulation board on both major surfaces of the core foam.

NOTE 1—These general statements refer to generic composition descriptions of facer materials, bonded fibrous felts, and mats that are currently commercially accepted in the marketplace for these products, using terms common to these competing products. Felts may contain organic fibers, inorganic fibers, or mixtures of organic and inorganic fibers and may be suitably bonded in one of several alternative ways using organic binders or conventional asphalt saturation to produce suitable membrane facers. Glass fiber mats can be used uncoated, or asphalt coated or otherwise polymer bonded to also produce suitable membrane facers.

## 5. Ordering Information

5.1 Orders shall include the following information:

5.1.1 Title, designation, and year of issue of C 1289,

5.1.2 Quantity of material being ordered,

5.1.3 Product name and manufacturer's name, address, and telephone number,

5.1.4 Type or Class, or both, if Type 1; type, class, and grade or type and class, if Type II, (see Section 4),

5.1.5 R-value and specific thickness, as required (see 7.2),

5.1.6 Tolerance if other than specified (see 8.1),

5.1.7 Size(s) required (see 8.6),

5.1.8 Type of edge (see 8.3 and 8.4),

5.1.9 Sampling, if different (see 10.1),

5.1.10 If a certificate of compliance is required (see 10.2, 10.3, 10.4, 11.1.3.1, Table 1 and Table 2),

5.1.11 If packaging is other than specified (see 13.1), and

5.1.12 If marking is other than specified (see 13.2).

## 6. Materials and Manufacture

6.1 *Cellular Material*—Rigid polyisocyanurate thermal insulation boards shall be based upon the reaction of an isocyanate with a polyol, or the reaction of an isocyanate with itself, or both, using a catalyst and blowing agents to form a rigid closed-cell-structured polyisocyanurate foam. The insulation foam core shall be homogeneous and of uniform density.

6.2 *Facing Materials*— The facing material incorporated into the design of the faced thermal insulation board shall be as follows:

6.2.1 *Aluminum Foil*— Aluminum foil is plain or coated aluminum foil, or foil laminated to a supporting membrane.

6.2.2 *Polymer-Bonded Organic/Inorganic Fibrous Felt*—This organic/inorganic fibrous felt shall consist of an organic fiber felt containing inorganic fibers, internally bonded with organic polymer binders.

6.2.3 *Asphalt-Saturated Organic Fibrous Felt*—The asphalt-saturated organic fibrous felt shall conform to the material and physical properties requirements specified in Specification D 226.

[3] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[4] Available from Underwriter's Laboratories of Canada (ULC), 7 Crouse Road, Toronto, Ontario, M1R 3A9.

TABLE 1 Physical Properties[A]

| Product Type | Type I Class 1 | Type I Class 2 | Type II Class 1 | Type II Class 2 | Type III | Type IV | Type V | Type VI |
|---|---|---|---|---|---|---|---|---|
| Facer covering one surface | aluminum foil | aluminum foil | fibrous felt or glass fiber mat membrane | polymer-bonded glass fiber mat membrane | perlite insulation board | cellulosic fiber insulating board | oriented strand board or wafer-board | perlite insulation board |
| Facer covering opposite surface | aluminum foil | aluminum foil | fibrous felt or glass fiber mat membrane | polymer-bonded glass fiber mat membrane | fibrous felt or glass fiber mat membrane | fibrous felt or glass fiber mat membrane | fibrous felt or glass fiber mat membrane or aluminum foil | perlite insulation board |
| Physical Property | | | | | | | | |
| Compressive strength, psi (kPa), min[B] | 16 (110) | 16 (110) | Grade 1 16 (110) Grade 2 20 (138) Grade 3 25 (172) | 16 (110) | 16 (110) | 16 (110) | 16 (110) | 16 (110) |
| Dimensional stability[B] | | | | | | | | |
| Percent linear change, thickness, max | | | | | | | | |
| −40°F (−40°C) amb, RH | 2.0 | 1.5 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| 158°F (70°C)/ 97 % RH | 2.0 | 1.5 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| 200°F (93°C)/ amb RH | 4.0 | 1.5 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Percent linear change, length and width, max | | | | | | | | |
| −40°F (−40°C) amb, RH | 2.0 | 1.5 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| 158°F (70°C)/ 97 % RH | 2.0 | 1.5 | 2.0 | 2.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| 200°F (93°C) amb, RH | 4.0 | 1.5 | 2.0 | 2.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Flexural strength (modulus of rupture)[B] | | | | | | | | |
| psi (kPa), min | 40 (275) | 40 (275) | 40 (275) | 40 (275) | 40 (275) | 40 (275) | 40 (275) | 50 (345) |
| (Break load) lbf (N), min | 8 (35) | 8 (35) | 17 (75) | 17 (75) | 17 (75) | 17 (75) | 17 (75) | 33 (147) |
| Tensile strength, psf (kPa), min[B] Perpendicular to board surface | 500 (24) | 500 (24) | 500 (24) | 500 (24) | 500 (24) | 500 (24) | 500 (24) | 500 (24) |
| Water absorption 2h percent by volume, max[B] | 1.0 | 1.0 | 1.5 | 1.5 | 1.0 | 2.0 | 1.0 | 1.5 |
| Water vapor transmission, perm (ng/Pa·s·m²), max | 0.3 (17.2)[B] | 0.3 (17.2)[B] | 1.0 (57.2)[B] | 4.0 (228.8)[B] | [C] | [C] | [C] | [C] |

[A] Because core foam thickness and facer type, thickness, and permeability can all influence the magnitude of values measured for these physical properties, a nominal 1 in. foam core product has been described for referee purposes. Consult manufacturers regarding specific foam-facer composite products and other product thicknesses. When appropriate, physical property values as agreed between buyer and seller shall replace those listed in Table 1 as qualification requirements described in 10.3.

[B] Nominal 1-in. (25.4-mm) product.

[C] Not applicable.

**TABLE 2 Thermal Resistance Properties[A,B]**

| Product Type | Type I Class 1 | Type I Class 2 | Type II Class 1 Grades 1, 2, 3 | Type II Class 2 | Type III | Type IV | Type V | Type VI |
|---|---|---|---|---|---|---|---|---|
| Facer Covering One Surface | Aluminum Foil | Aluminum Foil | Fibrous Felt or Glass Fiber Mat Membrane | polymer-bonded glass fiber mat membrane | Perlite Insulation Board | Cellulosic Fiber Insulating Board | Oriented Strand Board, or Wafer-Board | Perlite Insulation Board |
| Facer Covering Opposite Surface | Aluminum Foil | Aluminum Foil | Fibrous Felt or Glass Fiber Mat Membrane | polymer-bonded glass fiber mat membrane | Fibrous Felt or Glass Fiber Mat Membrane | Fibrous Felt or Glass Fiber Mat Membrane | Fibrous Felt or Glass Fiber Mat Membrane or Aluminum Foil | Perlite Insulation Board |
| Minimum Thermal Resistance @ 40± 2°F (4 ± 1°C) mean temp. °F ft2 h/Btu ($Km^2/W$) | | | | | | | | |
| 1 in. (25.4 mm) product | 7.2 (1.26)[C] | 7.2 (1.26)[C] | 6.2 (1.10)[C] | 5.8 (1.02) | | | | |
| 1.5 in. (38.1 mm) product | 10.8 (1.90)[D] | 10.8 (1.90)[D] | 9.2 (1.62)[D] | 8.7 (1.53) | 8.1 (1.42)[C] | 8.0 (1.40)[C] | 7.1 (1.25)[C] | |
| 2 in. (50.8 mm) product | 14.3 (2.52)[E] | 14.3 (2.52)[E] | 12.3 (2.17)[E] | 11.7 (2.06) | 12.5 (2.20)[D] | 12.4 (2.18)[D] | 11.5 (2.02)[D] | 8.6 (1.52)[D] |
| Minimum Thermal Resistance @ 75± 2°F (24 ± 1°C) mean temp. °F ft2 h/Btu ($Km^2/W$) | | | | | | | | |
| 1 in. (25.4 mm) product | 6.5 (1.14)[C] | 6.5 (1.14)[C] | 5.6 (0.97)[C] | 5.3 (0.93) | | | | |
| 1.5 in. (38.1 mm) product | 9.8 (1.72)[D] | 9.8 (1.72)[D] | 8.4 (1.48)[D] | 8.0 (1.41) | 7.4 (1.30)[C] | 7.3 (1.28)[C] | 6.5 (1.14)[C] | |
| 2 in. (50.8 mm) product | 13.0 (2.29)[E] | 13.0 (2.29)[E] | 11.2 (1.97)[E] | 10.6 (1.87) | 11.4 (2.00)[D] | 11.3 (1.99)[D] | 10.5 (1.85)[D] | 7.5 (1.32)[D] |
| Minimum Thermal Resistance @ 110± 2°F (43 ± 1°C) mean temp. °F ft2 h/Btu ($Km^2/W$) | | | | | | | | |
| 1 in. (25.4 mm) product | 5.9 (1.04)[C] | 5.9 (1.04)[C] | 5.0 (0.88)[C] | 4.8 (0.85) | | | | |
| 1.5 in. (38.1 mm) product | 8.8 (1.55)[D] | 8.8 (1.55)[D] | 7.6 (1.34)[D] | 7.2 (1.26) | 6.7 (1.18)[C] | 6.6 (1.16)[C] | 5.9 (1.04)[C] | |
| 2 in. (50.8 mm) product | 11.7 (2.06)[E] | 11.7 (2.06)[E] | 10.1 (1.78)[E] | 9.5 (1.67) | 10.3 (1.81)[D] | 10.2 (1.80)[D] | 9.5 (1.67)[D] | 6.7 (1.18)[D] |

[A] Because core foam thickness and facer type, thickness, and permeability can all influence product R-values, three faced product thicknesses have been described for referee purposes. Consult manufacturers regarding specific foam-facer composite products and other thicknesses. When appropriate, thermal resistance values as agreed between buyer and seller shall replace those listed in Table 2 as qualification requirements described in 10.3.
[B] Determined in accordance with Section 11.
[C] Nominal 1-in. (25.4-mm) product.
[D] Nominal 1.5-in. (38.1-mm) product.
[E] Nominal 2.0-in. (50.8-mm) product.

6.2.4 *Polymer-Bonded Organic Fibrous Felt*—The polymer-bonded organic fibrous felt shall consist of organic fiber felt bonded with organic polymer binders.

6.2.5 *Asphalt-Coated Glass Fiber Mat*—The asphalt-coated glass fiber mat shall consist of fibrous glass mats coated with asphalt or asphalt emulsion.

6.2.6 *Polymer-Bonded Glass Fiber Mat*—The polymer-bonded glass fiber mat shall consist of fibrous glass mats bonded with organic polymer binders coated or not with organic polymer, clay, or other inorganic substances.

6.2.7 *Perlite Insulation Board*—The perlite insulation board shall conform to the material and physical property requirements specified in Standard Specification C 728, either type 1 or type 2 may be used. The perlite insulation board may be either the ½-in. board listed in Specification C 728, which has a *higher* core density and *modified* formulation (as agreed upon between buyer and seller) than the thicker products, or may be a ½-in. thickness (available only to manufacturers of laminated rigid foam products) of the ¾ to 3 in. formulation perlite board listed in Specification C 728.

6.2.8 *Cellulosic Fiber Insulation Board*—The cellulosic fiber insulating board shall conform to the material and physical properties requirements specified in Specification C 208.

6.2.9 *Oriented Strand Board and Waferboard*—The oriented strand board and waferboard shall conform to the material and physical properties requirements specified in ANSI A208.1.

## 7. Physical Properties

7.1 The thermal insulation board shall conform to the properties stated in Table 1.

7.1.1 The physical properties stated in Table 1 shall not be used as design or engineering values unless this recommendation is made in writing by the product manufacturer. It remains the buyer's responsibility to specify design requirements and obtain supporting physical properties documentation from each product manufacturer and supplier.

7.2 *Thermal Resistance (R-value)*—When ordering, specify the R-value; thickness shall be specified if there is a specific thickness requirement and R-value is not specified. The values specified shall be for the faced insulation product only, and shall not include any additional thermal resistances from reflective facer surfaces and adjacent air spaces or from other components of the building system. The mean thermal resistance of the material tested shall not be less than the minimum relevant value prescribed in Table 2. The thermal resistances of individual specimens tested shall not be less than 90 % of the minimum value identified in Table 2. Values in Table 2 determined in accordance with Section 11.

NOTE 2—Thermal characteristics of cellular plastics may be significantly influenced by installation and service-related variables such as age, encapsulation within gas barrier materials, environmental conditions, mechanical abuse, etc. and may be reduced from measured values after exposure to conditions of use. For specific design recommendations, consult the manufacturer or qualified professionals, such as architects or engineers.

7.2.1 *Long-Term Thermal Resistance (LTTR)*—Determine, and report values, in accordance with practice and details in Annex A1.

7.3 *Fire Characteristics*—Polyisocyanurate thermal insulation boards are organic materials and are combustible. They should not be exposed to open flames or other ignition sources. The fire performance of the material should be addressed through fire test requirements established by the appropriate governing authority, which are specified to the end use and occupancy.

7.3.1 *Surface Burning Characteristics*—Determine, if required, in accordance with Test Method E 84.

## 8. Dimensions

8.1 *Dimensional Tolerances*—The length and width tolerances shall not exceed ±¼ in. (6.4 mm), the thickness tolerance shall not exceed ⅛ in. (3.2 mm), and the thickness of any two boards shall not differ more than ⅛ in. (3.2 mm) when measured in accordance with Test Method C 303.

8.2 *Board Squareness*—The thermal insulation boards shall not be out of square more than 1⁄16 in./ft (5.2 mm/m) of width or length, when examined in accordance with Practice C 550.

8.3 *Straight Edges*—Unless otherwise specified, the thermal insulation board shall be furnished with straight edges and edges shall not deviate more than 1⁄32 in./ft (2.6 mm/m) when examined in accordance with Practice C 550.

8.4 *Shiplap Edges*—When specified, the insulation board shall be fabricated with shiplap edges along its longest dimensions.

8.4.1 The nominal depth of each shiplap shall be the sum of its thickest facer dimension plus one half the thickness of its core foam dimension.

8.4.2 For boards 2 in. (50.8 mm) or greater in nominal thickness, the width of the shiplap shall be 1 in. (25.4 mm). For boards less than 2 in. (50.8 mm) in thickness, the nominal width of the shiplap shall be one half the thickness of the faced board product.

8.4.3 All fabrication tolerances shall provide for a dimensionally stable, smooth, and uniform shiplap joint in installation and in service.

8.5 *Flatness*—The thermal insulation boards shall not depart from absolute flatness more than ⅛ in./ft (10 mm/m) of length or width when examined in accordance with Practice C 550.

8.6 *Available Sizes*—The thermal insulation boards are normally supplied in sizes of 2 by 8 ft (0.61 by 2.44 m), 3 by 4 ft (0.91 by 1.22 m), 4 by 4 ft (1.22 by 1.22 m), and 4 by 8 ft (1.22 by 2.44 m). Additional sizes may be available from the manufacturer or may be specified by the purchaser.

8.7 *Crushings and Depressions*—The thermal insulation boards shall have no crushed or depressed areas on any surface exceeding ⅛ in. (3.2 mm) in depth on more than 10 % of the total surface area.

## 9. Workmanship

9.1 The thermal insulation boards shall have no defects that will adversely affect their service qualities. The boards shall be of uniform texture and facer integrity, free from the accumulation of unexpanded materials, foreign materials, broken edges and corners, slits, delaminations, and objectionable odors.

## 10. Sampling

10.1 Unless otherwise specified, the product shall be sampled and inspected for acceptance of material in accordance with Criteria C 390.

10.2 The following physical requirements are defined as inspection requirements in accordance with Criteria C 390:

10.2.1 All dimension requirements as described in Section 8.

10.2.2 All workmanship, finish, and appearance requirements as described in Section 9.

10.3 The following physical properties are defined as qualification requirements in accordance with Criteria C 390.

10.3.1 Thermal resistance as described in Section 11.2 and Table 2.

10.3.2 Compressive strength as described in Section 11.3 and Table 1. Five equally spaced specimens are to be taken for testing along a cross-machine board traverse (perpendicular to the machine direction.

10.3.3 Dimensional stability as described in Section 11.4 and Table 1.

10.3.4 Flexural strength as described in Section 11.5 and Table 1.

10.3.5 Tensile strength perpendicular to board surface as described in Section 11.6 and Table 1.

10.3.6 Water absorption as described in Section 11.7 and Table 1.

10.3.7 Water vapor transmission as described in Section 11.8 and Table 1.

10.4 For lots of 150 units or less not subject to tightened inspection, the supplier's certificate of compliance or third-party's certificate of compliance shall be sufficient basis for acceptance of the lot. The certificate shall state that compliance to inspection requirements has been verified by actual inspection of material of the same type, class, size, and thickness manufactured within the same production period as the material offered.

## 11. Test Methods

11.1 *Conditioning*:

11.1.1 Sample boards shall be conditioned at 73 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity for a minimum of 24 h prior to the start of tests or as specified in the applicable test procedure.

11.1.2 *Thermal Resistance Conditioning*:

11.1.2.1 *Time Conditioning Option*—Thermal insulation boards to be tested for thermal resistance shall be conditioned for 180± 5 days at 73 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity prior to testing.

11.1.2.2 *Thermal Conditioning Option*—Thermal insulation boards to be tested for thermal resistance may alternatively be conditioned for at least 90 days at 140 ± 2°F (60 ± 1°C) dry heat prior to testing.

11.1.3 *Waiver for Thermal Resistance Conditioning*—The requirements for thermal resistance conditioning may be waived provided that the following conditions are met:

11.1.3.1 The same type board offered must have been conditioned as specified within the past 2-year period, and there shall have been no changes in the manufacturing technique or the materials that would affect the physical properties of the board during or since the conditioning was performed.

11.1.3.2 Records that verify and support that the conditioning was performed as specified must be maintained and must be made available for review by the purchaser's representative.

11.1.3.3 Unless otherwise specified, a written statement from the supplier that the conditions for the waiver have been met will be acceptable evidence of compliance of the conditioning requirements.

11.2 *Thermal Resistance*—After conditioning in accordance with 11.1.2, insulation boards will be further conditioned in accordance with Test Method C 518 and shall be tested in accordance with Test Methods C 177, C 518, C 1114, or C 1363 and Practices C 1045 and C 1058. The mean reference testing temperature shall be 75 ± 2°F (24 ± 1°C). In addition, thermal resistance values shall be provided at 40 ± 2°F (4 ± 1°C), or 110 ± 2°F (43 ± 1°C), or both, at the buyer's request; but shall not be required to establish compliance with this specification. All thermal resistance testing shall be conducted with a minimum temperature differential of 40°F (22°C). Cut samples for testing after the conditioning period.

NOTE 3—When an estimate of the long-term change in thermal resistance is desired by the buyer for engineering or design requirements, or both, and agreed upon between the buyer and the seller, Test Method C 1303 provides an alternative technique for estimating long-term changes in thermal resistance. This alternative technique only applies when the material meets the homogeneous material definition in accordance with 3.2.4 of Test Method C 1303 This test method is not applicable to Specification C 1289 Type I products.

The thermal transmission properties of closed-cell insulation products vary with temperature, temperature gradient, moisture content, thickness, age, and shape. Apparent thermal transmission properties contained herein are based upon specimens tested under laboratory conditions specified herein. These thermal transmission properties are comparative values for establishing specification compliance. These thermal transmission properties may not represent the installed performance of the insulation under use conditions differing substantially from test conditions.

11.3 *Compressive Strength*—All material covered by this specification shall be conditioned and tested in accordance with the Cross-Head Motion procedure in Test Method D 1621 to 10 % thickness deformation or yield, whichever occurs first on a full-thickness faced specimen. Faced product compressive strength shall be determined across the thickness dimension of the board product.

11.4 *Dimensional Stability*—The thermal insulation boards shall be tested in accordance with Test Method D 2126 except that each specimen shall be 12 by 12 in. (300 by 300 mm) by the full-faced thickness.

11.4.1 The standard environmental schedule shall be as follows:

| Temperature °F | Temperature °C | Relative Humidity | Exposure Time, days |
|---|---|---|---|
| +200 ± 4 | (93 ± 2) | ambient | 7 |
| −40 ± 6 | (−40 ± 3) | ambient | 7 |
| +158 ± 4 | (70 ± 2) | 97 ± 3 % | 7 |

11.5 *Flexural Strength*—Insulation boards shall be tested in accordance with Test Method C 203, Method 1, Procedure B, at a moving head speed of 0.1 in./min/in. (2.5 mm/min/25.4 mm) of thickness with facings intact, on 3 by 12 in. (76.2 by 304.8 mm) by full thickness replicate specimens conditioned in accordance with 11.1.1.

11.6 *Tensile Strength Perpendicular to Board Surface*—Tensile strength perpendicular to the major board surfaces of the faced board product shall be tested in accordance with Test Method C 209, Tensile Strength Perpendicular to Surface, utilizing a 250°F (121°C) hot melt adhesive system for sample preparation. Molten adhesive[5] shall be uniformly applied over each faced sample surface and allowed to cool in 73°F (23°C) laboratory air for 24 h before testing.

11.7 *Water Absorption*— Insulation boards shall be tested in accordance with Test Method C 209, Water Absorption.

11.8 *Water Vapor Transmission*—Insulation boards shall be tested in accordance with Test Method E 96, desiccant method at 73 ± 2°F (23 ± 1°C), with facings intact.

## 12. Rejection and Resubmittal

12.1 Failure to conform to the requirements in this specification shall constitute cause for rejection. Rejection shall be promptly reported to the manufacturer.

12.2 The manufacturer shall have the option to reinspect rejected shipments and resubmit the entire lot for inspection and resampling after the removal and replacement of nonconforming portions.

[5] Cascomelt™ hot melt adhesive manufactured by the Borden Chemical Co. and Bostik Glue Stix #6363-15™ hot melt adhesive manufactured by the Bostik Co., Middleton, MA have been found suitable for use in this procedure.

## 13. Packaging and Marking

13.1 *Packaging*—Unless otherwise specified, the insulation shall be supplied in the manufacturer's standard commercial packages.

13.2 *Marking*—Unless otherwise specified, each package or board shall be marked with the insulation specification number; type; manufacturer's name or trademark, address, and telephone number; lot number; and thermal resistance (R-value).

## 14. Keywords

14.1 cellular plastic insulation; cellulosic fiber insulating board; composite foam insulation board; faced foam board; foam plastic insulation; oriented strand board; perlite board; polyiso board; polyisocyanurate; polyisocyanurate foam; polyurethane; polyurethane foam; thermal insulation; waferboard

# ANNEX

**(Mandatory Information)**

## A1. LONG-TERM THERMAL RESISTANCE

### A1.1 Background

A1.1.1 Rigid closed cell plastic foams, including polyisocyanurate foam insulation, experience a reduction in thermal resistance with time. The theory behind this change is well understood but until the introduction of slicing and scaling technology, developed for estimating and predicting standardized time-aged values, long term values were unobtainable or imprecise at best. A recently developed standard, Test Method C 1303 provides a procedure for rapidly estimating for selected time frames the long-term thermal resistance of closed cell plastic foams without facings. A derivative procedure, CAN/ULC-S770, has subsequently been developed in Canada as a standard that allows slicing and scaling technology to be applied to permeably faced polyisocyanurate closed-cell foam insulation. It is simple to use and very prescriptive as it defines what is long term and from where to cut the slices, their thickness, and how to prepare and measure them. Neither of these methods is applicable to impermeable faced products.

### A1.2 Scope

A1.2.1 This practice is based on CAN/ULC-S770. It defines the Long-Term Thermal Resistance (LTTR) of polyisocyanurate foam product as the value measured after 5-year storage in standard laboratory conditions (73 ± 4°F (23 ± 2°C) and 50 ± 10 % RH). It has been demonstrated[6] that the thermal resistance value measured after 5 years is approximately equivalent to a 15-year time weighted average age value.

A1.2.2 The user of this practice shall determine if the rate of aging of the surface layers compared to the core layers of the product tested limits the use of this practice for the specific application.

A1.2.3 This practice is applicable to products with permeable facers only (Type II to VI). A 2.0 ± 0.2 in. (50 ± 5 mm) product shall be selected and used to determine the LTTR of 1.0 in. (25.4 mm), 2.0 in. (50.8 mm) and 3.0 in. (76.2 mm). The proponent shall be able to select and test a specific thickness of product in order to predict the LTTR of that specific product.

### A1.3 Sampling

A1.3.1 A 2.0 ± 0.2 in. (50 ± 5 mm) product shall be used. Select a minimum of three samples, at least two hours apart, from the production run. Deliver these samples to the laboratory such that the lab receives them in 14 days or less from the date of manufacture. The actual size of the sample shall be agreed between the testing laboratory and the proponent. However, the minimum dimension of each sample shall be 3 by 4 ft (0.91 by 1.22 m).

### A1.4 Thermal Testing

A1.4.1 The standard test conditions shall be in accordance with Test Method C 518 using 75 ± 2°F (24 ± 2°C) and a temperature differential of 40 ± 2°F (22 ± 2°C).

### A1.5 Initial Thermal Resistance

A1.5.1 After delivery of the samples to the testing laboratory, cut three specimens, 24 by 24 in. (600 by 600 mm) (or five specimens, 12 by 12 in. (300 by 300 mm), depending on the size of the heat flow meter apparatus used), at least one from each board. If the major surfaces of the test specimens are not parallel, a maximum thickness of 0.2 in. (5 mm) shall be removed from each surface to make them parallel. In no case shall the total thickness removed exceed 15 % of the product thickness.

A1.5.2 The initial thermal resistance measurements on the above three (or five if using 12 by 12 in. (300 by 300 mm) specimens) specimens shall be completed within 7 to 14 days after the production date. Calculate the initial thermal resistivity of the samples given for testing as an average of these three (or five) specimens.

### A1.6 Slicing

A1.6.1 On the same day, denoted as Day 1 for subsequent calculation of the testing periods, select one of the three 24 by 24 in. (600 by 600 mm) specimen and cut into four 12 by 12 in. (300 by 300 mm) (or select two of the five 12 by 12 in. (300 by 300 mm) specimens as already prepared above). From each of these, slice two layers adjacent to the surfaces (called "surface layers") with thickness between 0.25 in. (6 mm) and 0.50 in. (12 mm), and two layers with the same thickness as the surface layers from the middle part (called "core layers"). Thus

[6] Kumaran, M. K. and Bomberg, M. T., "Thermal Performance of Sprayed Polyurethane Foam Insulation with Alternative Blowing Agents," *Journal of Thermal Insulation*, Vol 14, July 1990, p. 43.

TABLE A1.1 Interlaboratory Imprecision—Permeably Faced Polyisocyanurate

| Equivalent Thickness | Number of Laboratories | Interlaboratory Imprecision at the Two Standard Deviation Level (%) | | |
|---|---|---|---|---|
| | | Initial Resistivity[A] | Aging Factor | LTTR |
| 75 mm (3.0 in.) | 7 | 5.5 | 8.7 | 5.3 |
| 50 mm (2.0 in.) | 9 | 7.5 | 9.4 | 6.5 |
| 25 mm (1.0 in.) | 8 | 8.0 | 10.4 | 8.5 |

[A] The Precision Statement in Test Method C 518 quotes results from several round robins on thermal resistance measurements made on Fibreglass and loose fill. At the two standard deviation level they are 2 to 3.7 % for fibreglass and from 5 to 10 % for different loose fills. No results for foamboard.

there will be four surface layers and four core layers available for further testing. If the required number of core layers cannot be sliced from two specimens (as restricted by the total thickness of the 12 by 12 in. (300 by 300 mm) specimens), a third specimen shall be used for completing the total 8 thin layers for subsequent testing.

### A1.7 Testing the Thin Layers

A1.7.1 Measure and record the thicknesses of each of the eight thin layers using a minimum of 5 uniformly spaced points, one center point and four other uniformly spaced points. Separate thickness measurements shall be within 5 % of the mean of the five thicknesses. If the thicknesses of the layers are not within 5 % of their mean value, they shall be tested separately.

A1.7.2 Measure the initial thermal resistance and calculate resistivity of the layers. The layers may be tested in stacks. Surface layers can be stacked to get an average thickness for the surface layers. The same can be done for the core layers. The surface layers and the core layers shall not be mixed to form a stack. It is essential that this be done within 2 h of cutting because the thin layers will age very rapidly.

A1.7.3 From the thickness of the layers (which can be the average thickness if they are stacked), calculate the testing periods when the layers must be retested to correspond to the five year aging of the product at the various thicknesses (see A1.2.3). The scaling equation $[(t_1/ t_2) = (L_1/ L_2)^2]$ shall be used for this purpose.

For example,

$$\frac{t}{1826\ \text{days}} = \left\{\frac{10\ \text{mm}}{25\ \text{mm}}\right\}^2 \tag{A1.1}$$

As an example, for a 2.0 in. (50.8 mm) insulating product and for a 0.3937 in. (10 mm) thin layer, the testing periods for various product thickness shall be as follows:

Slice sample test period as it relates to 5-year product aging period

| Product Thickness, in. (mm) $L_1$ | Testing Period, day $t_2$ |
|---|---|
| 1.0 (25.4) | 283.0 |
| 2.0 (50.8) | 70.8 |
| 3.0 (76.2) | 31.4 |

Between testing periods, the slices shall be stored in a laboratory environment such that both major surfaces of all slices are exposed to the ambient air (73 ± 5°F (23 ± 5°C) and 50 ± 20 % RH).

### A1.8 Calculating LTTR

A1.8.1 Within 24 h of the prescribed testing periods (that is, the calculated scaled aging time), remeasure the thermal resistivity of each surface layer and of each core layer or the stacks of surface and core layers. If the layers were remeasured individually, calculate the average aging factors for the surface layers and for the core layers. If the measurements are done using a stack of four, the aging factor will be derived from the thermal resistivity of the whole stack. The aging factor is derived by dividing the thermal resistivity of the layers at the testing point by the initial thermal resistivity, as obtained from A1.7.2.

A1.8.2 If the difference between the average aging factor of the surface layers and that of the cores layers does not exceed 12 % of their mean value, use the higher of these two values as the effective aging factor. If the difference is more than 12 %, the test is considered invalid, and cannot be used for determining LTTR.

A1.8.3 Establish LTTR as a product of the average initial thermal resistivity of the product (see A1.5.2), the thickness under consideration and the effective aging factor as defined above.

### A1.9 Reporting

A1.9.1 The LTTR shall be determined and reported for 1.0 in. (25.4 mm), 2.0 in. (50.8 mm) and 3.0 in. (76.2 mm). For other product thickness, from 0.5 in. (12 mm) to 4.5 in. (115 mm), the LTTR value can be calculated from these three points, using a best curve fitting equation. Report age in days of the product tested when initial thermal resistivity is measured.

### A1.10 Precision and Bias

A1.10.1 This procedure is applicable to permeably faced polyisocyanurate closed-cell foam insulation. Previous precision information on another slicing and scaling technique for unfaced polyisocyanurate insulation has been reported in Test Method C 1303, Section 11, Precision and Bias.

A1.10.2 The precision of the procedure in this Annex has been determined in a round-robin study for CAN/ULC-S770, the method used as the basis for this Annex. Table A1.1 has been prepared from Table 2 in Technical Report, CAN/ULC-S770-XX Round Robin Test Programme.[7] Other references[8,9] pertaining to precision and bias of the LTTR method are available.

[7] Martin Hofton & Associates Inc., *Technical Report, CAN/ULC-S770-XX Round Robin Test Programme*, Canadian Plastics Industry Association, April 2001.

[8] Singh, S. N., Ntiru, M., and Dedecker, K., "Long Term Thermal Resistance of Pentane Blown Polyisocyanurate Laminate Boards," *Polyurethanes Conference 2002*, October , 2002.

[9] Stovall, T. K., Fabian, B. A., Nelson, G. E., and Beatty, D. R., "A Comparison of Accelerated Aging Test Protocols for Cellular Foam Insulation," *Insulation Materials Testing and Applications, Fourth Volume, ASTM STP 1426*, 2002.

A1.10.3 As stated in Section A21.3.1, Form of ASTM Test Methods, "Bias is a systemic error that contributes to the difference between the mean of a large number of test results and an accepted reference value." Since niether a large number of test results nor an accepted reference value are available no information on the bias of this procedure can be presented. Preliminary data from industry sources indicates there could be a bias. A study to determine bias is being conducted by the manufacturers of polyisocyanurate foam insulation utilizing permeably faced product only.