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Standard Specification for
Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation[1]

This standard is issued under the fixed designation C 591; 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.

1. Scope

1.1 This specification covers the types, physical properties, and dimensions of unfaced, preformed rigid cellular polyisocyanurate plastic material intended for use as thermal insulation on surfaces from − 297°F (−183°C) to 300°F (150°C). For specific applications, the actual temperature limits shall be agreed upon by the manufacturer and purchaser.

1.2 This specification only covers "polyurethane modified polyisocyanurate" thermal insulation which is commonly referred to as "polyisocyanurate" thermal insulation. This standard does not encompass all polyurethane modified materials. Polyurethane modified polyisocyanurate and other polyurethane materials are similar, but the materials will perform differently under some service conditions.

1.3 This standard is designed as a material specification, not a design document. Physical property requirements vary by application and temperature. At temperatures below - 70°F (- 51°C) the physical properties of the polyisocyanurate insulation at the service temperature are of particular importance. Below - 70°F (-51°C),(- 51°C) the manufacturer and the purchaser must agree on what additional cold temperature performance ~~properties, may be~~properties are required to determine if the material can function adequately for the particular application.

1.4 Tables in the Annex A1 address requirements of unfaced preformed rigid cellular polyisocyanurate thermal insulation manufactured with HCFC blowing agent.

1.5 The use of thermal insulation material covered by this specification may be regulated by building codes that address fire performance.

1.6 ~~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.~~

1.6 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.

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

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 165 Test Method for Measuring Compressive Properties of Thermal Insulations

C 168 Terminology Relating to Thermal Insulation

C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

C 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 411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

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

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[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.

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

C 585   Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)

C 871   Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions

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 883   Terminology 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 1623   Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics

D 2126   Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging

D 2856   Test Method for Open-Cell Content of Rigid Cellular Plastics by the Air Pycnometer

D 6226   Test Method for Open Cell Content of Rigid Cellular Plastics

E 84   Test Method for Surface Burning Characteristics of Building Materials

E 96/E 96M   Test Methods for Water Vapor Transmission of Materials

3. Terminology

3.1   For descriptions of terms used in this specification, refer to Terminologies C 168 and D 883.

3.2   The term polyisocyanurate does not encompass all polyurethane containing materials (see 1.2).

3.3   The term "core specimen" refers to representative samples cut in accordance with the sampling procedure listed within each property test method.

4. Classification

4.1   Unfaced, preformed rigid cellular polyisocyanurate thermal insulation covered by this specification is classified into six types as follows:

4.1.1   *Type I*—Compressive resistance of 20 lb/in^2 (137 kPa), minimum.

TABLE 1 Physical Property Requirements[A]
Grade 1: Operating Temperature Range -70°F (-51°C) to 300°F (149°C)

Property	Type I	Type IV	Type II	Type III	Type V	Type VI
Density, min lb/ft^3(kg/m^3)	1.8 (29)	2.0 (32)	2.5 (40)	3.0 (48)	4.0 (60)	6.0 (96)
Compressive resistance at 10 % deformation or yield whichever occurs first, parallel to rise, min, lb/in^2(kPa)	20 (137)	22 (150)	35 (240)	45 (310)	80 (550)	125(862)
Apparent thermal conductivity, max Btu-in/h-ft^2°F (W/m-K), at a mean temperature of:						
-100°F (-73°C)	.17 (.025)	.17 (.025)	.17 (.025)	.18 (.026)	.18 (.026)	.19 (.027)
-50°F (-46°C)	.19 (.027)	.19 (.027)	.19 (.027)	.20 (.029)	.20 (.029)	.21 (.030)
0°F (-17°C)	.20 (.029)	.20 (.029)	.20 (.029)	.21 (.030)	.21 (.030)	.22 (.032)
50°F (10°C)	.19 (.027)	.19 (.027)	.19 (.027)	.20 (.029)	.20 (.029)	.21 (.030)
75°F (24°C)	.20 (.029)	.20 (.029)	.20 (.029)	.21 (.030)	.21 (.030)	.22 (.032)
150°F (66°C)	.24 (.035)	.24 (.035)	.24 (.035)	.25 (.036)	.25 (.036)	.26 (.037)
200°F (93°C)	.27 (.039)	.27 (.039)	.27 (.039)	.28 (.040)	.28 (.040)	.30 (.044)
Water absorption, max, % by volume	2.0	2.0	1.0	1.0	0.8	0.8
Water vapor permeability, max, perm-in (ng/Pa-s-m)	4.0 (5.8)	4.0 (5.8)	3.5 (5.1)	3.0 (4.4)	2.5 (3.7)	2.0 (2.9)
Dimensional stability, max % linear change						
158 + 4°F (70 + 2°C), 97 + 3 % relative humidity	4	4	4	4	4	4
−40 + 6°F (−40+ 3°C), ambient relative humidity	1	1	1	1	1	1
212 + 4°F (100 + 2°C), ambient relative humidity	2	2	2	2	2	2
Closed cell content, min	90	90	90	90	90	90
Hot-surface performance, at 300°F (149°C)[B]	Pass	Pass	Pass	Pass	Pass	Pass

[A]This specification does not purport to address all the performance issues associated with it's use. it is the responsibility of the user of this standard to establish appropriate performance criteria.
[B]Pass/fail criteria found in 12.4.

4.1.2 *Type IV*—Compressive resistance of 22 lb/in^2 (150 kPa), minimum.

4.1.3 *Type II*—Compressive resistance of 35 lb/in^2 (240 kPa), minimum.

4.1.4 *Type III*—Compressive resistance of 45 lb/in^2 (310 kPa), minimum.

4.1.5 *Type V*—Compressive resistance of 80 lb/in^2 (550 kPa), minimum.

4.1.6 *Type VI*—Compressive resistance of 125 lb/in^2 (862 kPa), minimum.

4.2 Unfaced, preformed rigid cellular polyisocyanurate thermal insulation covered by this specification is classified into two grades as follows:

4.2.1 Grade 1–Service temperature range of - 70°F (- 51°C) and 300°F (150°C).

4.2.2 Grade 2–Service temperature range of - 297°F (- 183°C) and 300°F (150°C).

5. Ordering Information

5.1 Orders for materials purchased under this specification shall include the following:

5.1.1 Designation of this specification and year of issue,

5.1.2 Product name or type, or both,

5.1.3 Apparent thermal conductivity and specific thickness required,

5.1.4 Product dimensions,

5.1.5 Quantity of material,

5.1.6 Special packaging or marking, if required, and

5.1.7 Special requirements for inspection or testing, or both.

6. Materials and Manufacture

6.1 Unfaced, preformed rigid cellular polyisocyanurate thermal insulation is produced by the polymerization of polymeric polyisocyanates in the presence of polyhydroxyl compounds, catalysts, cell stabilizers, and blowing agents.

6.2 The material covered by this specification may be supplied in "bun" form or finished board stock or special shapes.

6.2 The material covered by this specification shall be supplied in "bun" form or finished board stock or special shapes as agreed upon by the manufacturer and end-user.

7. Physical Properties

7.1 Unfaced, preformed rigid cellular polyisocyanurate thermal insulation shall conform to the requirements shown in Table 1 or Table 2.

7.2 Polyisocyanurate thermal insulation is an organic material and is combustible. It should Do not be exposed expose this insulation to flames or other ignition sources. The fire performance of the material shouldshall be addressed through fire test

TABLE 2 Physical Property Requirements
Grade 2: Operating Temperature Range -297°F (-183°C) to 300°F (149°C)

Property	Type IV	Type II	Type III	Type V	Type VI
Density, min lb/ft^3(kg/m^3)	2.0 (32)	2.5 (40)	3.0 (48)	4.0 (60)	6.0 (96)
Compressive resistance at 10 % deformation or yield whichever occurs first, parallel to rise, min, lb/in^2(kPa)	22 (150)	30 (240)	45 (310)	80 (550)	125 (862)
Apparent thermal conductivity, max Btu-in/h-ft^2°F (W/m-K), at a mean temperature of:					
-200°F (-129°C)	.13 (.019)	.13 (.019)	.14 (.020)	.14 (.020)	.15 (.022)
-150°F (-101°C)	.15 (.022)	.15 (.022)	.16 (.023)	.16 (.023)	.17 (.025)
-100°F (-73°C)	.17 (.025)	.17 (.025)	.18 (.026)	.18 (.026)	.19 (.027)
-50°F (-46°C)	.19 (.027)	.19 (.027)	.20 (.029)	.20 (.029)	.21 (.030)
0°F (-17°C)	.20 (.029)	.20 (.029)	.21 (.030)	.21 (.030)	.22 (.032)
50°F (10°C)	.19 (.027)	.19 (.027)	.20 (.029)	.20 (.029)	.21 (.030)
75°F (24°C)	.20 (.029)	.20 (.029)	.21 (.030)	.21 (.030)	.22 (.032)
150°F (66°C)	.24 (.035)	.24 (.035)	.25 (.036)	.25 (.036)	.26 (.037)
200°F (93°C)	.27 (.039)	.27 (.039)	.28 (.040)	.28 (.040)	.30 (.044)
Water absorption, max, % by volume	2.0	1.0	1.0	1.0	0.8
Water vapor permeability, max, perm-in (ng/Pa-s-m)	4.0 (5.8)	3.5 (5.1)	3.0 (4.4)	2.5 (3.7)	2.0 (2.9)
Dimensional stability, max % linear change					
158 + 4°F (70 + 2°C), 97 + 3 % relative humidity	4	4	4	4	4
−40 + 6°F (−40+ 3°C), ambient relative humidity	1	1	1	1	1
212 + 4°F (100 + 2°C), ambient relative humidity	2	2	2	2	2
Closed cell content, min	90	90	90	90	90
Hot-surface performance, at 300°F (149°C)[A]	Pass	Pass	Pass	Pass	Pass

[A] Pass/fail criteria found in 12.4.