



Designation: C 591 – 01

Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation¹

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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), the manufacturer and the purchaser must agree on what additional cold temperature performance properties, may be required to determine if the material can function adequately for the particular application.

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

1.5 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 *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.*

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

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2. Referenced Documents

2.1 ASTM Standards:

- C 165 Test Method for Measuring Compressive Properties of Thermal Insulations²
- C 168 Terminology Relating to Thermal Insulating Materials²
- C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus²
- C 203 Test Method for Breaking Load and Flexural Properties of Block-Type Thermal Insulation²
- C 236 Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box²
- C 272 Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions²
- C 303 Test Method for Density of Preformed Block-Type Thermal Insulation²
- C 335 Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe²
- C 390 Criteria for Sampling and Acceptance of Preformed Thermal Insulation Lots²
- C 411 Test Method for Hot Surface Performance of High Temperature Thermal Insulation²
- C 518 Test Method for the Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus²
- C 550 Practice for Measuring Trueness and Squareness of Rigid Block and Board Thermal Insulation²
- C 585 Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)²
- C 871 Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions²
- C 976 Test Method for Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box²
- C 1045 Practice for Calculating Thermal Transmission Properties from Steady-State Heat Flux Measurements²

² Annual Book of ASTM Standards, Vol 04.06.

- C 1058 Practice for Selecting Temperatures for Evaluation and Reporting Thermal Properties of Thermal Insulation²
- C 1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus²
- C 1303 Test Method for Estimating the Long-Term Change in the Thermal Resistance of Unfaced Rigid Closed Cell Plastic Foams by Slicing and Sealing Under Controlled Laboratory Conditions³
- D 883 Terminology Relating to Plastics⁴
- D 1621 Test Method for Compressive Properties of Rigid Cellular Plastics⁴
- D 1622 Test Method for Apparent Density of Rigid Cellular Plastics⁴
- D 1623 Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics⁴
- D 2126 Test Method for Response of Rigid Cellular Plastics to Humid Aging⁴
- D 2856 Test Method for Open Cell Content of Rigid Cellular Plastics by the Air Pycnometer⁵
- E 84 Test Method for Surface Burning Characteristics of Building Materials⁶
- E 96 Test Methods for Water Vapor Transmission of Materials²

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 16 lb/in² (110 kPa), minimum.
- 4.1.2 *Type IV*—Compressive resistance of 21 lb/in² (145 kPa), minimum.
- 4.1.3 *Type II*—Compressive resistance of 36 lb/in² (250 kPa), minimum.
- 4.1.4 *Type III*—Compressive resistance of 45 lb/in² (310 kPa), minimum.
- 4.1.5 *Type V*—Compressive resistance of 70 lb/in² (483 kPa), minimum.
- 4.1.6 *Type VI*—Compressive resistance of 125 lb/in² (862 kPa), minimum.
- 4.2 Unfaced, preformed rigid cellular polyisocyanurate thermal insulation covered by this specification is classified into two grades as follows:

³ Annual Book of ASTM Standards, Vol 15.03.
⁴ Annual Book of ASTM Standards, Vol 08.01.
⁵ Annual Book of ASTM Standards, Vol 08.02.
⁶ Annual Book of ASTM Standards, Vol 04.07.

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)	16 (110)	21 (145)	35 (240)	45 (310)	70 (483)	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)	.18 (.026)	.18 (.026)	.18 (.026)	.19 (.027)	.19 (.027)	.20 (.029)
50°F (10°C)	.17 (.025)	.17 (.025)	.17 (.025)	.18 (.026)	.18 (.026)	.19 (.027)
75°F (24°C)	.18 (.026)	.18 (.026)	.18 (.026)	.19 (.027)	.19 (.027)	.20 (.029)
150°F (86°C)	.22 (.032)	.22 (.032)	.22 (.032)	.23 (.033)	.23 (.033)	.24 (.035)
200°F (93°C)	.24 (.035)	.24 (.035)	.24 (.035)	.26 (.037)	.26 (.037)	.28 (.040)
Water absorption, max, % by volume	0.5	0.5	0.7	0.8	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

^AThis specification does not purport to address all the performance issues associated with its use. It is the responsibility of the user of this standard to establish appropriate performance criteria.

^B Pass/fail criteria found in 12.4.