Designation: C 591 – 94

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 operating between − 40°F (−40°C) and + 225°F (107°C). For specific applications, the actual temperature limits shall be agreed upon by the manufacturer and purchaser. This specification does not cover cryogenic applications. Consult the manufacturer for specific recommendations and properties regarding cryogenic applications.

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

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 When the installation or use of thermal insulation materials, accessories, and systems, may pose safety or health problems, the manufacturer shall provide the user appropriate current information regarding any known problems associated with the recommended use of the company's products, and shall also recommend protective measures to be employed in their safe utilization. The user shall establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.

2. Referenced Documents

2.1 *ASTM Standards:*

C 165 Test Method for Measuring Compressive Properties of Thermal Insulations[2]

C 168 Terminology Relating to Thermal Insulating Materials[2]

C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus[2]

C 236 Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box[2]

C 390 Criteria for Sampling and Acceptance of Preformed Thermal Insulation Lots[2]

C 518 Test Method for the Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus[2]

C 550 Practice for Measuring Trueness and Squareness of Rigid Block and Board Thermal Insulation[2]

C 585 Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)[2]

C 976 Test Method for Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box[2]

C 1045 Practice for Calculating Thermal Transmission Properties from Steady-State Heat Flux Measurements[2]

C 1058 Practice for Selecting Temperatures for Evaluation and Reporting Thermal Properties of Thermal Insulation[2]

C 1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus[2]

D 883 Terminology Relating to Plastics[3]

D 1621 Test Method for Compressive Properties of Rigid Cellular Plastics[3]

D 2126 Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging[3]

D 2842 Test Method for Water Absorption of Rigid Cellular Plastics[4]

D 2856 Test Method for Open Cell Content of Rigid Cellular Plastics by the Air Pycnometer[4]

E 84 Test Method for Surface Burning Characteristics of Building Materials[5]

E 96 Test Methods for Water Vapor Transmission of Materials[2]

2.2 *Society of the Plastics Industry Standards:*

SPI Bulletin 108 An Assessment of the Thermal Performance of Rigid Polyurethane and Polyisocyanurate Foam Insulation for Use in Building Construction[6]

3. Terminology

3.1 *General*—Terms used in this specification are defined in

[1] This specification is under the jurisdiction of ASTM Committee C-16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.22 on Organic and Nonhomogeneous Inorganic Thermal Insulations.

Current edition approved Oct. 15, 1994. Published December 1994. Originally published as C 591 – 66 T. Last previous edition C 591 – 85.

[2] *Annual Book of ASTM Standards*, Vol 04.06.

[3] *Annual Book of ASTM Standards*, Vol 08.01.

[4] *Annual Book of ASTM Standards*, Vol 08.02.

[5] *Annual Book of ASTM Standards*, Vol 04.07.

[6] Available from the Society of the Plastics Industry, 355 Lexington Ave., New York, NY 10017.

Terminologies C 168 and D 883.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *polyisocyanurate*—encompasses both polyurethane and polyisocyanurate.

4. Classification

4.1 The unfaced, preformed rigid cellular polyisocyanurate thermal insulation covered by this specification are classified into four types as follows:

4.1.1 Type I—Compressive strength 16 psi (110 kPa) minimum.

4.1.2 Type IV—Compressive resistance 25 psi (172 kPa) minimum.

4.1.3 Type II—Compressive strength 35 psi (240 kPa) minimum.

4.1.4 Type III—Compressive strength 50 psi (345 kPa) minimum.

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 R-value or 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.

7. Physical Requirements

7.1 The material shall conform to the requirements as shown in Table 1.

8. Dimensions and Tolerances

8.1 The dimensions shall be as agreed upon by the purchaser and the seller. Polyisocyanurate thermal insulation is commonly available in lengths up to 144 in. (3.66 m), widths up to 48 in. (1.22 m), and thicknesses from 0.5 in. (1.2 cm) to 24 in. (0.6 m).

8.2 Dimensional tolerances for boards shall be as follows:

Dimension	Tolerance, in. (mm)
Length	±⅛ (3)
Width	±1/16 (1.5)
Thickness	±1/32 (1)

8.3 *Other Board Parameters*:

8.3.1 The trueness and squareness shall be determined in accordance with Practice C 550, except that a straightedge of length longer than the dimension being determined shall be used.

8.3.2 *Edge Trueness*—The thermal insulation boards shall be furnished with true edges. Edges shall not deviate more than 1/32 in./ft (2.6 mm/m) of width or length.

8.3.3 *Face Trueness*—The boards shall not deviate from absolute trueness more than 1/16 in./ft (5.2 mm/m) of width or length.

8.3.4 *Squareness*—The boards shall not deviate from squareness by more than 1/16 in./ft (5.2 mm/m) of width or length.

8.4 *Pipe Insulation*—Material supplied for pipe insulation shall have dimensions that are in accordance with Practice C 585.

9. Workmanship and Appearance

9.1 The insulation shall have no defects that adversely affect its service qualities.

10. Sampling

10.1 Unless otherwise specified in the purchase order or contract, sampling shall be in accordance with Criteria C 390.

11. Qualification Requirements

11.1 For the purpose of initial material qualification, each type of thermal insulation shall meet the test results of Table 1.

11.2 Acceptance qualification for lots and shipments of qualified product should be agreed upon by purchaser and the supplier.

12. Specimen Preparation

12.1 A period of at least 72 h shall elapse from the time of manufacture of the rigid cellular polyisocyanurate until the cutting of any test specimens.

12.2 Unless otherwise specified, the test specimens shall be conditioned at 73 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity for at least 12 h prior to testing.

13. Test Methods

13.1 *Compressive Resistance*—Determine by using Test Method D 1621, Procedure A at a crosshead speed of 0.1 in./min/in. of thickness, or by Test Method C 165.

NOTE 1—Insulation foams can be anisotropic and, therefore, strength properties can vary with direction. The manufacturer should be consulted if additional information is required.

13.2 *Thermal Resistance*—Determine the thermal resistance on 1 ± ⅛ in. (25 ± 3 mm) thick core specimens by using either Test Methods C 177, C 236, C 518, C 976, or C 1114 in conjunction with Practice C 1045 and using temperature differences as indicated in Practice C 1058. These core specimens shall be conditioned at 73 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity for 180 ± 5 days from time of manufacture. In case of dispute, Test Method C 177 shall be the referee method. The mean thermal resistance of the material tested shall not be less than the minimum value identified in Table 1. The thermal resistance of individual specimens tested shall not be less than 90 % of the minimum value identified in Table 1.

NOTE 2—Thermal characteristics of rigid cellular plastics may be significantly influenced by installation and service-related variables such as age, encapsulation within gas-barrier materials, environmental conditions, and mechanical abuse and may be reduced from measured values

TABLE 1 Physical Properties

Property	Unit	Type I	Type IV	Type II	Type III
Compressive resistance at yield or 10 % deformation, whichever occurs first, min	psi (kPa)	16 (110)	25 (172)	35 (240)	50 (345)
Thermal resistance of 1.0-in. (25-mm) thickness, min, at mean temperature:	°F ft^2 h/Btu (k·m^2/W)				
40°F (4°C) mean temperature		6.2 (1.1)	6.2 (1.1)	6.2 (1.1)	6.2 (1.1)
75°F (24°C) mean temperature		5.6 (1.0)	5.6 (1.0)	5.6 (1.0)	5.6 (1.0)
110°F (43°C) mean temperature		5.1 (0.9)	5.1 (0.9)	5.1 (0.9)	5.1 (0.9)
Dimensional Stability	% linear change, max				
158 ± 4°F (70 ± 2°C), 97 ± 3 % relative humidity		4	4	4	4
−40 ± 6°F (−40± 3°C), ambient relative humidity		1	1	1	1
212 ± 4°F (100 ± 2°C), ambient relative humidity		2	2	2	2
Water vapor permeance, max	perm-inch (ng/Pa s m)	4.0 (5.8)	3.5 (5.1)	3.0 (4.4)	2.5 (3.7)
Closed cell content, min	%	90	90	90	90
Water absorption, max	%	3	3	3	3

after exposure to conditions of use. For specific design recommendations using a particular product, consult the manufacturer.

13.3 *Dimensional Stability*—Determine by using Test Method D 2126 with test specimens being exposed to the following conditions for 168 ± 2 h:

Temperature,° F (°C)	Relative Humidity, %
158 ± 4 (70± 2)	97 ± 3
−40 ± 6 (−40 ± 3)	ambient
212 ± 4 (100± 2)	ambient

Measure and report after 24 ± ½ h and 168 ± 2 h.

13.3.1 These requirements are for qualification of foams. Consult the manufacturer for in-service performance data.

13.4 *Water Vapor Permeance*—Determine in accordance with Test Methods E 96 using the dessicant procedure at 73 ± 2°F (23 ± 1°C).

NOTE 3—The application of a vapor retarder may be required in conjunction with the application of this insulation.

13.5 *Closed Cell Content*—Determine the closed cell content in accordance with Test Method D 2856.

13.6 *Surface Burning Characteristics*—Determine in accordance with Test Method E 84 at end-use thickness and report the results. See Section 1 of Test Method E 84 for information regarding the applicability of this specification for testing rigid cellular plastics.

NOTE 4—Polyisocyanurate thermal insulation is an organic material and is, therefore, combustible. It should not be exposed to flames or other ignition sources.

13.7 *Water Absorption*—Determine in accordance with Test Method D 2842.

14. Inspection

14.1 Inspection of this material shall be agreed upon by the purchaser and the supplier as part of the purchase agreement.

15. Rejection and Rehearing

15.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection shall be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the tests, the producer or supplier may request a rehearing. Retesting may be necessary.

15.2 At the agreement of the buyer and seller, the seller shall have the right to reinspect a rejected shipment and resubmit same after removal of the nonconforming portion.

16. Packaging and Marking

16.1 Unless otherwise agreed upon between the purchaser and the supplier, materials under this specification shall be packaged by the manufacturer's standard commercial practice.

16.2 Unless otherwise specified, shipping containers shall be marked with the name and designation of the manufacturer, type, lot number, size thickness, product thermal resistance, and quantity of material in the container.

17. Keywords

17.1 cellular plastic; polyisocyanurate; polyurethane; thermal insulation