



Designation: C552 – 07

# Standard Specification for Cellular Glass Thermal Insulation<sup>1</sup>

This standard is issued under the fixed designation C552; 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 ( $\epsilon$ ) 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 composition, sizes, dimensions, and physical properties of cellular glass thermal insulation intended for use on surfaces operating at temperatures between  $-450$  and  $800^{\circ}\text{F}$  ( $-268$  and  $427^{\circ}\text{C}$ ). Special fabrication or techniques for pipe insulation, or both, may be required for application in the temperature range from  $250$  to  $800^{\circ}\text{F}$  ( $121$  to  $427^{\circ}\text{C}$ ). Contact the manufacturer for recommendations regarding fabrication and application procedures for use in this temperature range. For specific applications, the actual temperature limits shall be agreed upon between the manufacturer and the purchaser.

1.2 It is anticipated that single-layer pipe insulation in half sections or the inner layer of a multilayer system may exhibit stress cracks above  $250^{\circ}\text{F}$  ( $122^{\circ}\text{C}$ ).

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

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

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- C165 Test Method for Measuring Compressive Properties of Thermal Insulations
- C168 Terminology Relating to Thermal Insulation
- C177 Test Method for Steady-State Heat Flux Measure-

- ments 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
- C240 Test Methods of Testing Cellular Glass Insulation Block
- C302 Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation
- 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
- C411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation
- C450 Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
- C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
- C585 Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing
- C692 Test Method for Evaluating the Influence of Thermal Insulations on External Stress Corrosion Cracking Tendency of Austenitic Stainless Steel
- C795 Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
- C871 Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions
- 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
- C1639 Specification for Fabrication Of Cellular Glass Pipe And Tubing Insulation

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.20 on Homogeneous Inorganic Thermal Insulations.

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<sup>2</sup> 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.

**D226** Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing

**D312** Specification for Asphalt Used in Roofing

**E84** Test Method for Surface Burning Characteristics of Building Materials

**E96/E96M** Test Methods for Water Vapor Transmission of Materials

2.2 *ISO Document:*

**ISO 3951** Sampling Procedure and Charts for Inspection by Variables for Percent Defective<sup>3</sup>

### 3. Terminology

3.1 For definitions used in this specification, see Terminology **C168**.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *board*—fabricated sections of cellular glass adhered and together covered with a facing such as a laminated kraft paper adhered to both faces.

### 4. Classification<sup>4</sup>

4.1 Cellular glass insulation is furnished in the following types:

4.1.1 *Type I*—Flat block manufactured,

4.1.2 *Type II*—Pipe and tubing insulation fabricated from Type I,

4.1.3 *Type III*—Special shapes fabricated from Type I,

4.1.4 *Type IV*—Board fabricated from Type I,

NOTE 1—Types not listed here may not be commercially available. These would be considered special order items.

### 5. Ordering Information

5.1 Purchase orders for cellular glass insulation furnished to this specification shall include the following information:

5.1.1 Type designation (see 4.1),

5.1.2 Dimensions according to type (see Section 9), and

5.1.3 Jacketing when required.

5.2 Any special requirements, such as, type, fabrication combinations not listed in accordance with Section 4, non-standard dimensions in accordance with Section 9, inspection requirements in accordance with Section 13, or certification requirements in accordance with Section 16 shall be agreed upon between the purchaser and the supplier and stated in the purchase contract.

### 6. Materials and Manufacture

6.1 The block material shall consist of a glass composition that has been foamed or cellulated under molten conditions, annealed, and set to form a rigid noncombustible material with hermetically sealed cells. The material shall be trimmed into blocks of standard dimensions that are rectangular or tapered.

6.2 Special shapes and pipe covering shall be fabricated from blocks in accordance with Practices **C450**, **C585** and Specification **C1639**.

6.3 Board, tapered or flat, shall be fabricated from blocks.

### 7. Physical Properties

7.1 The cellular glass insulation shall conform to the physical requirements in **Table 1**. Contact the manufacturer for specific design recommendations for all material types.

### 8. Qualification Requirements

8.1 The following requirements are generally employed for the purpose of initial material or product qualification for Type I, Block Material:

8.1.1 Compressive strength.

8.1.2 Flexural strength.

8.1.3 Water absorption.

8.1.4 Water vapor permeability.

8.1.5 Thermal conductivity.

8.1.6 Hot-surface performance.

8.1.7 Surface burning characteristics.

8.2 The following requirements are generally employed for qualification of Type II, pipe and tubing insulation:

8.2.1 Thermal Conductivity.

8.2.2 Type II, pipe and tubing insulation shall be fabricated from material having met the qualification requirements of Type I.

8.3 Type III and Type IV material shall be fabricated from material having met the qualification requirements of Type I.

### 9. Dimensions, Mass, and Permissible Variations

9.1 *Type I, Flat Block*—Blocks shall be nominal rectangular sections. Block size is 18 in. (457 mm) in width, 24 in. (610 mm) in length, and 1.5 to 6 in. (38 to 152 mm) in thickness. Tapered block has the same dimensions, is tapered on the 24-in. (610-mm) side, with tapers of 1/8, 1/4, or 1/2 in./ft (3, 6, or 13 mm per 0.3 m). (Other block dimensions and thickness must be agreed upon between the purchaser and the supplier.)

9.2 *Type II, Pipe and Tubing Insulation*—See Specification **C1639**.

9.3 *Type III, Special Shapes*—Dimensions of special shapes shall be as agreed upon between the supplier and the purchaser.

9.4 *Type IV, Board*—Dimensions of board shall be agreed upon between the purchaser and the supplier. Boards are available typically as 24 in. (610 mm) wide by 48 in. (1219 mm) long by 1.5 in. (38 mm), or 3 in. (76 mm) thick.

9.5 *Dimensional Tolerances:*

9.5.1 For Types I and IV, the average measured length, width, and thickness tolerances shall be in accordance with those listed in **Table 2**.

9.5.2 For Type II, the dimensional tolerances are given in **Table 3**.

9.5.3 For Type III, dimensional tolerances shall be agreed upon between the purchaser and the supplier.

9.5.4 For Types I, II, and IV, special dimensional tolerances shall be agreed upon between the purchaser and the supplier as stated in the purchase contract.

### 10. Workmanship, Finish and Appearance

10.1 Since some requirements for this material are not easily specified by numerical value, the insulation shall have no visible defects that will adversely affect its service qualities.

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

<sup>4</sup> Type and grade designations are in accordance with *Form and Style for ASTM Standards*, Part B, 10th ed., Section B8., January 1996.

**TABLE 1 Physical Requirements<sup>A</sup>**

TYPE I BLOCK	
Properties	
Density, lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	
Minimum	6.12 (98)
Maximum	8.62 (138)
Compressive strength, capped, <sup>B</sup> min, psi (kPa) (Capped material in accordance with Test Methods C240)	60 (415)
Compressive resistance, uncapped, min, psi (kPa) (Uncapped at 0.2-in. deformation)	35 (242)
Flexural strength, min, psi (kPa)	41 (283)
Water absorption, max, volume %	0.5
Water vapor permeability, max, per-in. or grains-in. of thickness/h-ft <sup>2</sup> -in. Hg (ng-Pa <sup>-1</sup> -s <sup>-1</sup> -m <sup>-1</sup> )	0.005 (0.007)
Hot-surface performance warpage, in. (mm), max Cracking	0.125 (3) see 12.8.1
Behavior of materials in a vertical tube furnace	passed
Surface burning characteristics <sup>C</sup>	
Flame spread index, max	5
Smoke developed index, max	0
Apparent Thermal Conductivity <sup>D,E</sup> : flat block, max (Btu-in./h-ft <sup>2</sup> -°F) (W/m-K) mean temperature, °F (°C)	
400 (204)	0.58 (0.084)
300 (149)	0.48 (0.069)
200 (93)	0.40 (0.058)
100 (38)	0.33 (0.048)
75 (24)	0.31 (0.045)
50 (10)	0.30 (0.043)
0 (-18)	0.27 (0.039)
-50 (-46)	0.24 (0.035)
-100 (-73)	0.22 (0.032)
-150 (-101)	0.20 (0.029)

**TYPE II PIPE AND TUBING**

Apparent thermal conductivity <sup>D,F,G,H</sup> Pipe insulation, max, (Btu-in./h-ft <sup>2</sup> -°F) (W/m-K) at mean temperature <sup>°</sup> F (°C)	
400 (205)	0.69 (0.099)
300 (149)	0.56 (0.081)
200 (93)	0.46 (0.066)
100 (38)	0.37 (0.053)
Hot-surface performance warpage, in. (mm), max Cracking	0.125 (3) see 12.8.1

<sup>A</sup> Physical property requirements shown are for the materials in the as-manufactured condition. They may or may not represent the values of these properties under certain in-service conditions, depending on the type of installation and the ultimate temperature exposure.

<sup>B</sup> For information on higher density and compressive strength material, contact the manufacturers.

<sup>C</sup> For Types II and III, smoke index and flame spread will remain constant with some fabrication techniques and will change with other fabrication techniques. For applications requiring a flame spread index of 25 and a smoke developed index of 50, contact fabricator or manufacturer.

<sup>D</sup> Thermal transmission properties of insulation will vary with temperature, temperature gradient, thickness, and shape. Note the apparent thermal conductivity values in the table are based on samples tested under conditions specified in 12.3. These are comparative values for establishing specification compliance. They may not represent the installed performance for the insulation under use conditions differing substantially from the test conditions.

<sup>E</sup> Evaluated at a small temperature difference in accordance with Practice C1058.

<sup>F</sup> Evaluated at a large temperature difference in accordance with Practice C1058.

<sup>G</sup> Single layer or inner layer on a multilayer system piping insulation fabricated in half sections may exhibit stress cracks above 250°F (122°C). The thermal performance in this range is characterized with cracks present.

<sup>H</sup> At this time, pipe insulation cannot be tested below ambient temperatures. See 12.3, Note 2.

**TABLE 2 Manufacturers Dimensional Tolerances**

Dimensions, in. (mm)	Block (Type I) and Board (Type IV)
Length	± 1/16 (1.6)
Width	± 1/16 (1.6)
Thickness	± 1/16 (1.6)

**TABLE 3 Fabrication Tolerances**

Dimensions, in. (mm)	Board (Type III, IV)	Pipe (Type II)
Length	± 1/8 (3.2)	In accordance with Practice C1639
Width	± 1/8 (3.2)	In accordance with Practice C1639
Thickness	± 1/8 (3.2)	In accordance with Practice C1639
Inner diameter	...	In accordance with Practice C1639
Outer diameter	...	In accordance with Practice C1639

## 11. Sampling

11.1 The insulation shall be sampled for the purpose of testing in accordance with Practice C390. Any specific provisions for sampling shall be agreed upon between the purchaser and the supplier.

## 12. Test Methods

12.1 All cellular glass is produced initially in block form. When special shapes are required, cellular glass is fabricated into pipe, curved or segmental insulation, precision V-grooved (material specifically cut to fit around the exterior surface of piping or equipment with no gaps), or board. All initial qualification testing shall be made on block specimens. All tests shall be conducted on specimens with no surface moisture. The properties referenced in this specification shall be determined in accordance with the following test methods:

### 12.2 Density:

12.2.1 *Type I*—Block insulation: Test Method C303.

12.2.2 *Type II*—Pipe insulation: Test Method C302.

12.3 *Thermal Conductivity*—Make determinations at four mean temperatures in accordance with Practice C1058. Use the results of these tests to calculate thermal transmission properties in accordance with Practice C1045.

NOTE 2—At this time, tested values cannot be achieved for below ambient temperatures for Type II pipe insulation due to the lack of a test apparatus measuring radial heat flow in accordance with Test Method C335.

12.3.1 *Type I: Block Insulation*—Use either Test Method C177, C518, or C1114 in conjunction with Practice C1045, using the following specimen preparation. Test Method C518 shall not be used at temperatures or thermal resistances other than those in the range of calibration. Test Method C1114 shall not be used at temperatures or thermal resistance ranges other than those with comparable/verifiable results to Test Method C177. In case of dispute, Test Method C177 is recognized as the final authority. Specimen preparation is as follows:

12.3.2 To achieve flatness and parallelism of the surface as required by the preceding test methods, the following method is suggested: By sawing from the original block, prepare a