Designation: C 552 – 00$^{\epsilon 1}$

Standard Specification for Cellular Glass Thermal Insulation[1]

This standard is issued under the fixed designation C 552; 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.

ε[1] NOTE—Fig. A3.1 was editorially reinstated in July 2002.

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°F (−268 and 427°C). Special fabrication or techniques for pipe insulation, or both, may be required for application in the temperature range from 250 to 800°F (121 to 427°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°F (122°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:*

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 203 Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation[2]

C 240 Test Methods for Testing Cellular Glass Insulating Block[2]

C 302 Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation[2]

C 303 Test Method for Density of Preformed Block-Type Thermal Insulation[2]

C 335 Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation[2]

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

C 411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation[2]

C 450 Practice for Prefabrication and Field Fabrication of Thermal Insulating Fitting Covers for NPS Piping, Vessel Lagging, and Dished Head Segments[2]

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

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

C 692 Test Method for Evaluating the Influence of Thermal Insulations on the External Stress Corrosion Cracking Tendency of Austenitic Steel[2]

C 795 Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel[2]

C 871 Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions[2]

C 1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions[2]

C 1058 Practice for Selecting Temperatures for Evaluating 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]

[1] This specification is under the jurisdiction of ASTM Committee C-16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.20 on Homogeneous Inorganic Thermal Insulations.

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

D 226 Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing[3]
D 312 Specification for Asphalt Used in Roofing[3]
E 84 Test Method for Surface Burning Characteristics of Building Materials[4]
E 96 Test Methods for Water Vapor Transmission of Materials[2]

2.2 *ISO Document:*

ISO 3951 Sampling Procedure and Charts for Inspection by Variables for Percent Defective[5]

3. Terminology

3.1 For definitions used in this specification, see Terminology C 168.

3.2 *Definitions of Terms Specific to This Standard:*

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

4. Classification [6]

4.1 Cellular glass insulation covered by this specification shall be classified in the two grades shown in Table 1. Grades vary in density, thermal conductivity, compressive strength, and flexural strength. Cellular glass insulation may be furnished in the following types:

4.1.1 *Type I*—Flat block, generally manufactured in Grades 1 and 2.

4.1.2 *Type II*—Pipe and tubing insulation, generally fabricated in Grades 1 and 2.

4.1.3 *Type III*—Special shapes, generally fabricated in Grades 1 and 2.

4.1.4 *Type IV*—Board, generally fabricated in Grade 2.

NOTE 1—Type and grade combinations not listed here may not be commercially available. These would be considered special order items.

TABLE 1 Physical Requirements[A] Grades 1 and 2

TYPE I BLOCK		
Properties	Grade 1	Grade 2
Density, lb/ft^3(kg/m^3)		
Minimum	6.12 (98)	6.80 (109)
Maximum	8.62 (138)	9.74 (156)
Compressive strength, capped,[B] min, psi (kPa) (Capped material in accordance with Test Methods C 240)	60 (415)	60 (415)
Compressive resistance, uncapped, min, psi (kPa) (Uncapped at 0.2-in. deformation)	35 (242)	60 (415)
Flexural strength, min, psi (kPa)	41 (283)	60 (414)
Water absorption, max, volume %	0.5	0.5
Water vapor permeability, max, per·in. or grains·in. of thickness/h·ft^2·in. Hg (ng·Pa^{-1}·s^{-1}·m^{-1})	0.005 (0.007)	0.005 (0.007)
Hot-surface performance warpage, in. (mm), max	0.125 (3)	0.125 (3)
Cracking	see 12.8.1	see 12.8.1
Behavior of materials in a vertical tube furnace	passed	passed
Surface burning characteristics[C]		
Flame spread index, max	5	5
Smoke developed index, max	0	0
Apparent Thermal Conductivity[D,E]: flat block, max (Btu-in./h·ft^2°F) (W/m·K) mean temperature, °F (°C)		
400 (204)	0.58 (0.084)	0.63 (0.090)
300 (149)	0.48 (0.069)	0.52 (0.075)
200 (93)	0.40 (0.058)	0.44 (0.063)
100 (38)	0.33 (0.048)	0.37 (0.053)
75 (24)	0.31 (0.045)	0.35 (0.051)
50 (10)	0.30 (0.043)	0.34 (0.049)
0 (–18)	0.27 (0.039)	0.31 (0.045)
–50 (–46)	0.24 (0.035)	0.29 (0.042)
–100 (–73)	0.22 (0.032)	0.27 (0.039)
–150 (–101)	0.20 (0.029)	0.26 (0.037)
Apparent thermal conductivity[D,F,G,H] Pipe insulation, max, (Btu·in./h·ft^2°F) (W/m·K) at mean temperature° F (°C)		
400 (205)	0.69 (0.099)	0.69 (0.099)
300 (149)	0.56 (0.081)	0.58 (0.083)
200 (93)	0.46 (0.066)	0.48 (0.069)
100 (38)	0.37 (0.053)	0.41 (0.059)
Hot-surface performance warpage, in. (mm), max	0.125 (3)	0.125 (3)
Cracking	see 12.8.1	see 12.8.1

[A] 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.

[B] For information on higher density and compressive strength material, contact the manufacturers.

[C] For Types II and III, smoke index and flame spread may vary with different fabrication methods. For applications requiring a flame spread index of 25 and a smoke developed index of 50, contact fabricator or manufacturer.

[D] Thermal transmission properties of insulation may 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 12.2.2 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.

[E] Evaluated at a small temperature difference in accordance with Practice C 1058.

[F] Evaluated at a large temperature difference in accordance with Practice C 1058.

[G] 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.

[H] At this time, pipe insulation cannot be tested below ambient temperatures. See 12.3, Note 2.

5. Ordering Information

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

5.1.1 Type and grade designation (see 4.1),

5.1.2 Dimensions according to type and grade (see Section 8), and

5.1.3 Jacketing when required.

5.2 Any special requirements, such as, Type and grade fabrication combinations not listed in accordance with Section

[3] *Annual Book of ASTM Standards*, Vol 04.04.
[4] *Annual Book of ASTM Standards*, Vol 04.07.
[5] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.
[6] Type and grade designations are in accordance with *Form and Style for ASTM Standards*, Part B, 10th ed., Section B8., January 1996.

4, nonstandard dimensions in accordance with Section 8, 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 may be rectangular or tapered.

6.2 Special shapes and pipe covering shall be fabricated from blocks in accordance with Practices C 450 and C 585 and Annex A1 of this specification.

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. The manufacturer should be contacted 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 for specific grades, that is, Grade 1 and 2, 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, Grades 1 and 2, 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.

8.2.3 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 ⅛ , ¼ , or ½ 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 Annex A1.

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 and grade 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 may 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.

11. Sampling

11.1 The insulation shall be sampled for the purpose of testing in accordance with Criteria C 390. 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 and may be fabricated into pipe, curved or segmental insulation, precision V-grooved (material 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 C 303.

12.2.2 *Type II*—Pipe insulation: Test Method C 302.

12.3 *Thermal Conductivity*—Make determinations at four mean temperatures in accordance with Practice C 1058. Use the results of these tests to calculate thermal transmission properties in accordance with Practice C 1045.

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 C 335.

12.3.1 *Type I: Block Insulation*—Use either Test Method C 177, C 518, or C 1114 in conjunction with Practice C 1045, using the following specimen preparation. Test Method C 518 shall not be used at temperatures or thermal resistances other than those in the range of calibration. Test Method C 1114 shall not be used at temperatures or thermal resistance ranges other

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	±⅛ (3.2)	±⅛ (3.2)
Width	±⅛ (3.2)	not applicable
Thickness	±⅛ (3.2)	not applicable
Inner diameter	. . .	in accordance with Practice C 585
Outer diameter	. . .	±⅛ (3.2)

than those with comparable/verifiable results to Test Method C 177. In case of dispute, Method C 177 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 specimen with the required dimensions, its thickness being 2 or 3 mm greater than the final thickness should be.

12.3.3 Place the specimen on a flat metal plate slightly larger than the specimen itself and put two machined metal bars on the metal plate near two opposite sides of the specimen. Insert a uniform sheet of paper having about ¼-mm (0.01-in.) thickness between the flat base plate and the metal bars but not under the sample. The metal bars are as thick as the final thickness of the specimen and machined so that their top and bottom surfaces are flat and parallel. Alternatively to machined bars use cold rolled steel bars. These bars are generally sufficiently flat and uniform in thickness.

12.3.4 Using a third straight metal bar long enough to lap metal bars on each side, carefully rub off the upper face of the specimen until the scraping bar just contacts thickness bars. Turn the specimen upside down and place it back on the flat metal plate and put the two metal bars on the metal plate near two opposite sides of the specimen, this time without the sheet of paper under each metal bar. Repeat the rubbing operation.

12.3.5 If the specimens have to be shipped, provide adequate protection.

12.3.6 Due to the rigid nature of the material and its open cell surface, it is preferable to have the thermocouples mounted in the surface of the plates and not adhered to the surface of the specimens.

12.3.7 For maximum accuracy, it is recommended that the temperature difference between the hot and cold surfaces of the specimens is such that the temperature gradient in the specimen equals or exceeds 900 K m^{-1} (40°F/in.). Specimens made from several pieces of cellular glass should be avoided. Joints are prohibited in the central measuring area and their number should be minimized in the guard area.

12.3.8 The number of specimens to be tested and the sampling plan shall be in accordance with Criteria C 390 where applicable. For the purpose of inspection by the user's representative or independent third party, the number of specimens shall conform to ISO 3951 Inspection Level S-3, 10.0 % AQL using the S Method.

12.3.9 *Type II, Pipe Insulation*—Test Method C 335 in conjunction with Practices C 1058 and C 1045.

12.3.10 Samples shall be fabricated into 1½ + ½ , – 0-in. (38 + 13, – 0-mm) thick specimens of pipe insulation.

12.4 *Compressive Properties- (Type I-Block)*—Determine the compressive strength in accordance with Test Method C 165, Procedure A, with the following test parameters and specimen preparation techniques. This process indicates a failure point in compressive loading.

12.4.1 Each of the two parallel bearing surfaces of the specimens shall be plane. If necessary, rub them on a suitable abrasive surface to produce the required flat surface.

12.4.2 The test specimens shall preferably be one half-block 225 by 300-mm (12 by 18-in.) by nominal received thickness. Alternates include a quadrant 225 by 300-mm (9 by 12-in.) or a full block 450 by 600 mm (18 by 24 in.) by nominal received thickness. A quadrant specimen shall be taken from any one of four equal area quadrants of the preformed block. The minimum acceptable specimen size is 200 by 200 mm (8 by 8 in.) The report shall include the specimen size.

12.4.3 Cap both bearing surfaces of the specimens as follows: Coat one surface with molten Type III or Type IV asphalt (preheated to 177, +28, –14°C (350, +50, –25°F)), completely filling the surface cells with a small excess. Such a coating application rate is approximately 1.0 kg/m^2 (0.20 lb/ft^2) ± 25 %. Immediately press the hot-coated block onto a precut piece of felt or paper laying on a flat surface. This is to prevent the asphalt surface from sticking to the compression platen during the test. A lightweight kraft paper is suitable, although traditionally Type 1 roofing felt paper, commonly called No. 15 asphalt felt, in accordance with Specification D 226 has been used. Properly capped surfaces should be approximately plane and parallel. Set the specimens on edge, exposing both capped surfaces to room temperature for a minimum of 15 min to allow the asphalt to harden before testing.

12.4.4 The number of specimens to be tested and the sampling plan shall be in accordance with Criteria C 390 where applicable. For the purpose of inspection by the user's representative or independent third party, the number of specimens shall conform to ISO 3951 Inspection Level S-4, 10.0 % AQL using the S Method.

12.4.5 Compress the specimen until failure. The deformation at failure will vary, depending on the thickness of insulation and the thickness of the capping materials. Record the load at the failure point or definite yield point. The compressive strength is calculated from this load divided by the specimen cross-sectional area in accordance with Test Method C 165.

12.4.6 The rate of loading will depend on the type of equipment used. With a hydraulic test machine, use a constant load rate of 500 lb/s (2200 N/s). With a screw-driven machine use a crosshead speed of 0.01 in. (0.25 mm)/min/1 in. (25.4 mm) of specimen thickness, within a tolerance of ±25 % (on the crosshead speed or loading rate). Using the preferred specimen size in accordance with Test Methods C 240, the preceding load rates correspond to a nominal 2.3 psi/s (16 kPa/s). Another alternate testing procedure is to reach the failure within 30 to 90 s (nominal 16 kPa/s (2.3 psi/s).

12.4.7 Due to the sample preparation, with the inclusion of felts and asphalt, the test method described in Test Method C 165 to determine compressive modulus of elasticity does not apply for cellular glass as a material by itself.

12.4.8 For compressive resistance of uncapped material, use Test Method C 165, Procedure A, preferably test a half block,