Designation: C533 – 17 (Reapproved 2023)

Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation[1]

This standard is issued under the fixed designation C533; 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 U.S. Department of Defense.

1. Scope

1.1 This specification covers calcium silicate block and pipe thermal insulation for use on surfaces with temperatures between 80 and 1700°F (27 to 927°C), unless otherwise agreed upon between the manufacturer and the purchaser.

1.2 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.

1.3 The following safety hazards caveat pertains only to the test method (Section 12) described in this specification: *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C165 Test Method for Measuring Compressive Properties of Thermal Insulations

C168 Terminology Relating to Thermal Insulation

C177 Test Method for Steady-State Heat Flux Measurements 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

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

C356 Test Method for Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat

C390 Practice for Sampling and Acceptance of Thermal Insulation Lots

C411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

C421 Test Method for Tumbling Friability of Preformed Block-Type and Preformed Pipe-Covering-Type Thermal Insulation

C446 Test Method for Breaking Load and Calculated Modulus of Rupture of Preformed Insulation for Pipes (Withdrawn 2002)[3]

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

C795 Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel

C870 Practice for Conditioning of Thermal Insulating Materials

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

C1616 Test Method for Determining the Moisture Content of Organic and Inorganic Insulation Materials by Weight

C1617 Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals

[1] 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.

Current edition approved March 1, 2023. Published March 2023. Originally approved in 1964 to replace C344 and C345. Last previous edition approved in 2017 as C533 – 17. DOI: 10.1520/C0533-17R23.

[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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

E84 Test Method for Surface Burning Characteristics of Building Materials
E136 Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 °C

3. Terminology

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

4. Classification

4.1 Thermal insulation shall be of the following types:

4.1.1 *Type I*—Block for use on surfaces at temperature from 80°F (27°C) to to 1200°F (649°C).

4.1.2 *Type I*—Pipe for use on surfaces at temperature from 80°F (27°C) to 1200°F (649°C).

4.1.3 *Type IA*—Block for use on surfaces at temperatures from 80°F (27°C) to 1200°F (649°C).

4.1.4 *Type II*—Block for use on surfaces at temperatures from 80°F (27°C) to 1700°F (927°C).

5. Description

5.1 *Composition*—Calcium silicate thermal insulation shall consist principally of hydrous calcium silicate usually with the incorporation of fibrous reinforcement. Asbestos shall not be used as a component in the manufacture of the material.

6. Physical Requirements

6.1 The insulation shall conform to the physical requirements of Table 1.

7. Standard Shapes, Sizes, and Dimensions

7.1 Calcium silicate block-type thermal insulation shall be supplied in the form of pipe insulation, flat block or curved blocks as specified. Standard sizes of the block type insulation shall be as follows:

7.1.1 *Flat Block*—Flat block shall be furnished in lengths of 36 in. (458 or 914 mm), widths of 6 to 36 in. (152 to 914 mm), and thicknesses from 1 to 6 in. (25 to 152 mm) in ½-in. (13-mm) increments. Thicknesses greater than 3 in. (76 mm)

TABLE 1 Physical Requirements

NOTE 1—The physical requirements are based on the properties of samples dried or conditioned, or both, as specified in the referenced test methods. Calcium silicate insulation tends to absorb moisture to varying degrees depending on exposure conditions. It can absorb up to 4 times its dry weight if placed in direct contact with water through improper storage or application.

NOTE 2—The user is advised that some applications could require the knowledge of the thermal conductivity of the insulation material at mean temperatures above those shown. Consult the manufacturer for data at mean temperatures exceeding those listed.

	Type I	Type IA	Type II
	Block and Pipe	Block	Block
Use temperature, max, °F (°C)	1200 (649)	1200 (649)	1700 (927)
Density (dry), max, lb/ft^3 (kg/m^3)	15 (240)	22 (352)	22 (352)
Flexural strength, min, psi (kPa)	50 (344)	50 (344)	50 (344)
Compressive strength, min, at 5 % deformation, psi (kPa)	100 (688)	100 (688)	100 (688)
Mass loss by tumbling, max, %			
after first 10 minutes	20	20	20
after second 10 minutes	40	40	40
Soaking heat linear shrinkage, max,%	2	2	2
Hot surface performance:			
warpage, max, in. (mm)	¼ (6)	¼ (6)	¼ (6)
cracking	No cracks completely through the insulation thickness. Surface cracks on hot face are acceptable		
Apparent thermal conductivity[A] (see Note 2)			
Btu-in./h-ft^2-°F (W/m-K)max at mean temperature of:			
100°F (38°C)	0.41 (0.059)	0.50 (0.072)	0.50 (0.072)
200°F (93°C)	0.45 (0.065)	0.54 (0.078)	0.54 (0.078)
300°F (149°C)	0.50 (0.072)	0.58 (0.084)	0.58 (0.084)
400°F (204°C)	0.55 (0.079)	0.61 (0.088)	0.61 (0.088)
500°F (260°C)	0.60 (0.087)	0.64 (0.092)	0.64 (0.092)
600°F (316°C)	0.66 (0.095)	0.67 (0.097)	0.67 (0.097)
700°F (371°C)	0.71 (0.102)	0.70 (0.101)	0.70 (0.101)
800°F (427°C)	...		0.73 (0.105)
900°F (482°C)	...		0.75 (0.108)
1000°F (538°C)	...		0.77 (0.111)
Surface burning characteristics:			
Flame spread index, max	0	0	0
Smoke density index, max	0	0	0
Non-Combustibilty	Pass	Pass	Pass
Mass Loss Corrosion Rate	≤ DI Water		
Stress Corrosion Performance	Pass		
Moisture content, by weight, max %	20	20	20

[A] The thermal transmission properties of calcium silicate block and pipe insulation vary with temperature, temperature gradient, moisture content, thickness, and shape. Note that the apparent thermal conductivity requirements in the table are based on samples tested under the conditions specified in 12.1.2. These are comparative values for establishing specification compliance. They do not represent the installed performance of the insulation under use conditions differing substantially from the test conditions.

shall be furnished in one or more layers as agreed upon by purchaser and manufacturer.

7.1.2 *Curved Block*—Curved block shall be furnished in lengths of 36 in. (914 mm), widths of approximately 6 to 12 in. (152 or 305 mm), thicknesses of 1½ to 4 in. (38 to 101 mm) in ½-in. (13-mm) increments, and curved to inside radii of over 16½ in. (419 mm). Individual dimensions shall conform to those specified by the manufacturer.

7.1.3 *Grooved Block*—Grooved block shall be furnished in lengths of 36 in. (914 mm), widths of 12 or 18 in. (305 or 458 mm), and thicknesses from 1 to 6 in. (25 to 152 mm) in ½-in. (13-mm) increments. Size and spacing of grooves shall be as specified by the manufacturer.

7.2 *Calcium Silicate Pipe Insulation*—Calcium silicate pipe insulation shall be supplied either as hollow cylindrical shapes split in half lengthwise (in a plane including the cylindrical axis) or as curved segments. The pipe insulation shall be furnished in sections or segments in a length of 36 in. (914 mm) , unless otherwise agreed upon by the Purchaser, to fit standard sizes of pipe and tubing, and in nominal wall thicknesses from 1 to 6 in. (25 to 152 mm), in ½ in. (13 mm) increments. Thicknesses greater than 3 in. (76 mm) shall be furnished in one or more layers as agreed upon by between the purchaser and the manufacturer. Inner and outer diameters shall be in accordance with those standard dimensions specified in Practice C585.

NOTE 1—When multilayer sectional pipe insulation is required, it is necessary to consider the inside and outside diameters of each layer to ensure proper nesting of materials when installed. Necessity of furnishing multilayer pipe insulation nested from the manufacturer shall be based on manufacturer's ability to control outside diameters on inner layers to not greater than inside diameters, at minus tolerances, of nesting outer layer under normal production, as agreed to between purchaser and manufacturer.

8. Dimensional Tolerances

8.1 *General*—The average tolerances for length, width, and thickness shall be as following:

	Block	Pipe
Length	± ⅛ in. (3 mm)	± ⅛ in. (3 mm)
Width	± ⅛ in. (3 mm)	
Thickness	± ⅛ in. (3 mm)	
Inner Diameter		in accordance with Practice C585
Outer Diameter		in accordance with Practice C585

8.2 *Pipe Insulation*—The following additional dimensional tolerances apply only to calcium silicate pipe insulation supplied as half sections.

8.2.1 *Fit and Closure*—When fitted to the appropriate size pipe by banding on 9-in. (229-mm) centers, the longitudinal seams on both sides of the pipe insulation shall close to within 1/16 in. (2 mm) along the entire length of the section.

8.2.2 *Concentricity*—The inner bore of the pipe insulation shall be concentric with the outer cylindrical surface. The deviation from concentricity shall not exceed ⅛ in. (3 mm) or 5 % of the wall thickness, whichever is greater.

8.2.3 *Half-Section Balance*—The plane formed by the slit between half sections shall include the cylindrical axis. Deviation of the slit plane from the cylindrical axis over a 36-in. (914-mm) length shall not exceed ⅛ in. (3 mm).

8.3 *Grooved Block*—The following additional requirements apply only to calcium silicate block insulation containing grooves and intended for installation over curved surfaces, 20 in. (508 mm) in diameter of larger.

8.3.1 *Fit and Closure*—When fitted to the curved surface, the grooves shall close to ⅛ in. (3 mm) or less through the depth of the groove. The exposed surface crack shall not open more than ⅛ in. (3 mm).

9. Workmanship

9.1 Since some requirements for this material are not easily defined by a numerical value, the insulation shall not have visible defects that will adversely affect its service qualities.

10. Sampling

10.1 The insulation shall be sampled in accordance with Practice C390. Specific provision for sampling shall be agreed upon between the purchaser and the supplier as part of the purchase contract.

11. Qualification Requirements

11.1 The following requirements are generally employed for purpose of initial material or product qualification:

11.1.1 Flexural strength.
11.1.2 Compression strength.
11.1.3 Mass loss by tumbling.
11.1.4 Linear shrinkage after soaking heat.
11.1.5 Hot surface performance.
11.1.6 Apparent thermal conductivity.
11.1.7 Surface burning characteristics.
11.1.8 Moisture content.
11.1.9 Non-Combustibility.
11.1.10 Stress Corrosion Performance (Type I only).
11.1.11 Mass Loss Corrosion Rate (Type I only).

12. Test Methods

12.1 The properties enumerated in this specification shall be determined in accordance with the following test methods. Samples shall be preconditioned in accordance with Practice C870.

12.1.1 *Density and Dimensions:*
12.1.1.1 *Block Insulation*—Test Method C303.
12.1.1.2 *Pipe Insulation*—Test Method C302.
12.1.2 *Apparent Thermal Conductivity:*
12.1.2.1 *General*—Apparent thermal conductivity versus mean temperature shall be calculated in accordance with Practice C1045. Determinations shall be made at four or more mean temperatures. Two of the test mean temperatures shall be within 50°F (28°C) of the highest and lowest mean temperature specified in Table 1 for the appropriate material type. The other two determinations shall be made at mean temperatures spaced equally within the specified range. All test temperatures shall be selected in accordance with Practice C1058 and reported in the test results.

12.1.2.2 The results of these tests shall be interpolated through reasonable curve fitting or numerical techniques, to establish the apparent thermal conductivity at the specified mean temperature.