Designation: C 1393 – 08

Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks[1]

This standard is issued under the fixed designation C 1393; 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.

1. Scope

1.1 This specification covers the composition, dimensions, and physical properties of compression-resistant, perpendicularly oriented mineral fiber (rock, slag, or glass) roll and sheet insulation intended for use on flat, curved, or round surfaces operating at temperatures between 0°F (–18°C) and 1000°F (538°C). This product (pipe and tank insulation) is typically used on nominal 24 in. (610 mm) or greater diameter surfaces. For specific applications, the actual use temperatures and diameters shall be agreed upon between the manufacturer and the purchaser.

1.2 The orientation of the fibers within the roll or sheet insulation is essentially perpendicular to the heated/cooled surface (parallel to heat flow). This specification does not apply to flat block, board, duct wrap, or preformed pipe mineral fiber insulation where the insulation fiber orientation is generally parallel to the heated/cooled surface (across the heat flow).

1.3 For satisfactory performance, properly installed protective vapor retarders must be used in below ambient temperature applications to reduce movement of moisture/water vapor through or around the insulation towards the colder surface. Failure to use a vapor retarder can lead to insulation and system damage. Refer to Practice C 921 to aid material selection. Although vapor retarders properties are not part of this specification, properties required in Specification C 1136 are pertinent to application or performance.

1.4 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.

1.5 When the installation or use of thermal 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 for the products of the company 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.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C 165 Test Method for Measuring Compressive Properties of Thermal Insulations

C 168 Terminology Relating to Thermal Insulation

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

C 303 Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation

C 390 Practice for Sampling and Acceptance of Thermal Insulation Lots

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

C 447 Practice for Estimating the Maximum Use Temperature of Thermal Insulations

C 518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

C 665 Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing

C 680 Practice for Estimate of the Heat Gain or Loss and the Surface Temperatures of Insulated Flat, Cylindrical, and Spherical Systems by Use of Computer Programs

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

C 921 Practice for Determining the Properties of Jacketing Materials for Thermal Insulation

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

[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 Oct. 1, 2008. Published November 2008. Originally approved in 2000. Last previous edition approved in 2006 as C 1393 - 00a(2006)$^{\varepsilon 1}$.

[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.

TABLE 1 Physical Property Requirements[A]

Properties	Type I	Type II	Type IIIA	Type IIIB	Type IVA	Type IVB
Maximum Use Temperature,° F (°C) See Caution in 6.2.1	Up to 450 (232)	650 (343)	850 (454)	850 (454)	1000 (538)	1000 (538)
Apparent thermal conductivity Maximum Btu in./h·ft²°F (W/m·K) Mean temperature,° F (°C)						
25 (-4)	0.26(0.038)	0.26(0.038)	0.26(0.038)	0.26(0.038)	0.26(0.038)	0.27(0.039)
75 (24)	0.27(0.039)	0.27(0.039)	0.27(0.039)	0.27(0.039)	0.27(0.039)	0.28(0.040)
100 (38)	0.29(0.042)	0.29(0.042)	0.29(0.042)	0.29(0.042)	0.29(0.042)	0.30(0.043)
200 (93)	0.38(0.055)	0.38(0.055)	0.38(0.055)	0.36(0.052)	0.36(0.052)	0.36(0.052)
300 (149)	0.48(0.069)	0.48(0.069)	0.48(0.069)	0.45(0.065)	0.45(0.065)	0.43(0.062)
400 (204)	0.61(0.088)	0.61(0.088)	0.61(0.088)	0.54(0.078)	0.54(0.078)	0.50(0.072)
500 (260)		0.81(0.117)	0.81(0.117)	0.66(0.095)	0.66(0.095)	0.58(0.084)
600 (316)					0.82(0.118)	0.67(0.097)
Category 1—Greater compressive resistance, minimum load required to produce a 10 % reduction in thickness, lb/ft²(kPa)	120 (5.7)	120 (5.7)	120 (5.7)	120 (5.7)	120 (5.7)	200 (9.6)
Category 2—Lesser compressive resistance, minimum load required to produce a 10 % reduction in thickness, lb/ft²(kPa)	25 (1.2)	25 (1.2)	25 (1.2)	25 (1.2)	25 (1.2)	25 (1.2)
Water vapor sorption, max % by weight	5.0	5.0	5.0	5.0	5.0	5.0
Density, maximum lb/ft³(kg/m³)[B]	6 (96)	6 (96)	6 (96)	6 (96)	6 (96)	8 (128)
Surface burning characteristics:						
Maximum flame spread index	25	25	25	25	25	25
Maximum smoke developed index	50	50	50	50	50	50

[A] Refer to Section 7 for additional physical property requirements.
[B] The maximum density specified is for weight design purposes only. Additional density requirements may be specified as agreed upon between the purchaser and the manufacturer.

C 1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation
C 1104/C 1104M Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation
C 1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus
C 1136 Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
C 1335 Test Method for Measuring Non-Fibrous Content of Man-Made Rock and Slag Mineral Fiber Insulation
C 1338 Test Method for Determining Fungi Resistance of Insulation Materials and Facings
E 84 Test Method for Surface Burning Characteristics of Building Materials

2.2 *Other Referenced Documents:*

CAN/ULC-S102 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies[3]

3. Terminology

3.1 *Definitions*—Definitions pertaining to insulation are in accordance with Terminology C 168.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *delivered density*—the actual density, calculated by shipped weight divided by volume, of the product transported by the manufacturer or the seller and received by the purchaser.

3.2.2 *facing*—a layer or foundation of thin material which is adhered to the insulation to form a continuous roll or sheet of insulation.

3.2.3 *mean temperature*—the sum of the cold surface temperature and the hot surface temperature divided by two.

4. Classification

4.1 Mineral fiber roll or sheet insulation covered by this specification is classified into the six types and two categories shown in Table 1. This classification is based upon the maximum use temperature, maximum apparent thermal conductivity, and compressive resistance properties.

4.1.1 *Types*:

4.1.1.1 *Type I*—Maximum use temperature up to 450°F (232°C).

4.1.1.2 *Type II*—Maximum use temperature up to 650°F (343°C).

4.1.1.3 *Type IIIA*—Maximum use temperature up to 850°F (454°C).

4.1.1.4 *Type IIIB*—Maximum use temperature up to 850°F (454°C).

4.1.1.5 *Type IVA*—Maximum use temperature up to 1000°F (538°C).

4.1.1.6 *Type IVB*—Maximum use temperature up to 1000°F (538°C).

4.1.2 *Categories*:

4.1.2.1 *Category 1*—Greater minimum compressive resistance properties are required.

4.1.2.2 *Category 2*—Lesser minimum compressive resistance properties are required.

[3] Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, http://www.ul.com.

5. Ordering Information

5.1 The type, category, dimensions, and facing shall be specified by the purchaser. Shot content and delivered density certification only if specified by the purchaser.

6. Materials and Manufacture

6.1 *Composition*—Mineral fiber roll or sheet shall be composed of rock, slag, or glass processed from the molten state into fibrous form, bonded with an organic binder, and the orientation of the fibers within the roll or sheet insulation is essentially perpendicular to the heated or cooled surface (parallel to heat flow).

6.2 *Facings*:

6.2.1 The purchaser must specify the insulation facing and type required.

NOTE 1—The user is advised that the maximum use temperature of the facings and adhesives may be lower than the maximum use temperature of the insulation. The specifier shall ensure that sufficient insulation thickness is installed so none of the accessory items (facing and adhesive) are exposed to temperatures above their maximum use temperature. Practice C 680 can be used to predict surface temperatures.

6.2.2 *Typical Facings*:

6.2.2.1 Fiber glass nonreinforced mat.

6.2.2.2 Laminated aluminum foil, reinforced fiber glass scrim, and natural Kraft paper generally known as FRK or FSK.

6.2.2.3 Laminated white Kraft paper, reinforced fiber glass scrim, and aluminum foil generally known as ASJ (All Service Jacket).

6.2.2.4 All vapor retarder facings shall comply with Specification C 1136.

6.2.2.5 It is acceptable to specify other kinds of compositions or facings..

6.3 *Manufacturing/Fabrication*—Mineral (rock, slag, or glass) fiberboard is normally manufactured with the fiber essentially oriented parallel with the face or a facing. Fiber direction described in this specification is substantially perpendicular to a facing. This construction aligns mineral fiberboard in a way that one end of the cut fiber is adhered to a facing. The finished product is wound into rolls or cut into sheets.

7. Physical Properties

7.1 The perpendicularly oriented mineral fiber roll and sheet thermal insulation shall conform to the following requirements in Table 1: maximum use temperature, maximum apparent thermal conductivity, minimum compressive resistance, water vapor sorption, maximum design density, and maximum indices for surface burning characteristics.

7.2 *Corrosiveness to Steel*—When tested in accordance with 11.6, the corrosion resulting from the insulation in contact with steel plates shall be judged to be no greater than for comparative plates in contact with sterile cotton.

NOTE 2—There are facing adhesives that can cause corrosion to steel when they are in contact with water or water vapor and the steel. Currently, there is no test method available to satisfy every potential corrosion application.

7.3 *Stress Corrosion to Austenitic Stainless Steel*—When specified, shall be tested and evaluated in accordance with 11.9.

7.4 *Non-fibrous Content (Shot)*—The average maximum shot content of rock and slag mineral fiber products shall not exceed 30 % by weight in accordance with 11.3.1. Non-fibrous content is not applicable to glass mineral fiber products.

7.5 *Maximum Use Temperature*—When tested in accordance with 11.1, the insulation with facing shall not warp, flame, or glow during hot surface exposure. No evidence of melting or fiber degradation shall be evident upon posttest inspection.

7.6 *Maximum Exothermic Temperature Rise*—When tested in accordance with 11.1, the midpoint temperature shall not at any point in time exceed the hot surface temperature by more than 200°F (111°C). The 200°F criterion applies during heat up as well as steady state conditions. Exceeding this limit shall constitute noncompliance to this specification and rejection.

NOTE 3—Organic binders, adhesives, and some facings may thermally decompose at high temperatures causing an exothermic temperature rise to occur. A double-layered installation of perpendicularly oriented mineral fiber insulation and facing on surfaces hotter than 450°F (232°C) may increase the possibility of internal exothermic temperature rise and may destroy the fiber.

7.7 *Compressive Resistance*—Shall be tested in accordance with 11.8.

NOTE 4—At conditions above 450°F (232°C) hot surface temperatures, the compressive resistance of the installed insulation material may decrease. Contact the manufacturer for reduced compression resistances at maximum temperature conditions.

7.8 *Fungi Resistance*—Shall be tested in accordance with 11.10; growth no greater than that on a comparative item (white birch wood) shall be considered to have passed the test method criteria.

8. Dimensions and Permissible Variations

8.1 *Dimensions*—Standard sizes of roll and sheet insulation are as follows:

8.1.1 *Rolls*:

8.1.1.1 *Length*—Will vary depending on thickness, up to 50 ft (15.2 m).

8.1.1.2 *Width*—24 in. (610 mm) and 36 in. (914 mm).

8.1.1.3 *Thickness*—½ to 6 in. (12.7 to 152 mm) in ½-in. (12.7-mm) increments.

8.1.2 *Sheets*:

8.1.2.1 *Length*—48 in. (1.2 m) and 96 in. (2.4 m).

8.1.2.2 *Width*—24 in. (610 mm) and 36 in. (914 mm).

8.1.2.3 *Thickness*—½ to 6 in. (12.7 to 152 mm) in ½-in. (12.7-mm) increments.

8.2 *Dimensional Tolerances*—The average measured length, width, and thickness shall differ from the manufacturer's standard dimensions by not more than the following:

	Roll	Sheet
Length	= – 0 in. (0 mm) Excess permitted	± ⅛ in. (3 mm)
Width	= ± ¼ in. (6 mm)	± ⅛ in. (3 mm)
Thickness	= ± 1/16 in. (2 mm)	± 1/16 in. (2 mm)

9. Workmanship, Finish and Appearance

9.1 The insulation shall have good workmanship and shall not have defects which adversely affect its installation and performance qualities.

10. Sampling

10.1 Inspection and qualification of the insulation shall be in accordance with Practice C 390, or as otherwise specified in the purchase order or contract, as agreed upon between the purchaser and the supplier.

11. Test Methods

11.1 *Maximum Use and Exothermic Rise Temperature*—Test in accordance with Test Method C 411 and the hot surface performance section of Practice C 447 at the manufacturer's maximum recommended thickness for each temperature. The test surface shall be at the intended surface temperature when the test begins.

11.1.1 No special requirements for heat-up shall be specified by the manufacturer to comply with either maximum use or maximum exothermic temperature claims at the manufacturer's maximum recommended thickness.

11.1.2 Test samples with facing as a flat surface at the maximum use temperature and the manufacturer's maximum thickness for each temperature.

11.2 *Density*:

11.2.1 Test all rolls and sheets in accordance with Test Method C 303.

11.2.2 The maximum density of a rock-, slag-, or glass-type insulation shall not exceed that shown in Table 1.

11.3 *Non-Fibrous (Shot) Content*:

11.3.1 Determine the non-fibrous (shot) content that would be retained on all screens (sieves) up to and including 100 mesh (150 μm) in accordance with the test method and calculation procedure in Test Method C 1335.

11.3.2 A minimum of three specimens per lot (shipment) shall determine the averaged non-fibrous (shot) content. The manufacturer shall furnish certification of the shot content of the delivered product if so specified at time of purchase.

11.4 *Apparent Thermal Conductivity*:

11.4.1 Determine the thermal conductivity as a function of temperature for the representative specimens with data obtained from a series of thermal tests utilizing Test Methods C 177, C 518, or C 1114 as appropriate for the material under study. Test the specimen with the facing attached and at a maximum thickness of 2 in. (51 mm).

11.4.1.1 Test Method C 518 shall not be used at temperatures or resistances other than those in the range of the calibration.

11.4.1.2 Test Method C 1114 shall not be used at temperatures or resistance ranges other than those with comparable results to Test Method C 177.

11.4.1.3 Perpendicularly oriented insulations for pipes are typically used at 24-in. (610-mm) or larger diameter surfaces. Base thermal calculations on a flat surface.

11.4.2 The test method selected shall have proven correlation with Test Method C 177 over the temperature range of conditions used. In cases of dispute, Test Method C 177 shall be considered as the final authority for material having flat geometry.

11.4.3 Practice C 1058 shall be used to obtain recommended test temperature combinations for testing purposes.

11.4.4 As specified in Practice C 1045, the range of tests conditions must include at least one test where the hot surface temperature is greater than, or equal to, the hot limit of the temperature range of desired data and at least one test where the cold surface temperature is less than, or equal to, the cold limit of the temperature range desired. At least two additional tests shall be distributed somewhat evenly over the rest of the temperature range.

11.4.5 Conduct final analysis of the thermal data in accordance with Practice C 1045 to generate a thermal conductivity versus temperature relationship for the specimen.

11.4.6 The final step of Practice C 1045 analysis would be to calculate the thermal conductivity using the equations generated at a set of mean temperatures for comparison to the specification.

NOTE 5—While it is recommended that the specification data be presented as conductivity versus temperature, several existing specifications may contain mean temperature data from tests conducted at specific hot and cold surface temperatures. In these cases, the conductivity as a function of temperature from the Practice C 1045 analysis may provide different results. To ensure that the data is compatible, a Practice C 680 analysis, using the conductivity versus temperature relationship from Practice C 1045 and the specific hot and cold surface temperatures, is required to determine the effective conductivity for comparison to the specification requirements.

11.5 *Surface Burning Characteristics*—Test surface burning characteristics in accordance with Test Method E 84 with facing applied. For Canada, test in accordance with Test Method CAN/ULC-S102with facing applied. When the referenced Canadian document in this specification is referred to in applicable Canadian building codes, the editions, referenced by those building codes, shall govern.

11.6 *Corrosiveness to Steel*—Test in accordance with the corrosiveness test method in Specification C 665.

11.7 *Water Vapor Sorption*—Test in accordance with Test Method C 1104/C 1104M without facing.

11.8 *Compressive Resistance*—Test 2-in. (51-mm) thick specimen in accordance with Test Method C 165. Preload the horizontal loading surface with 2.5-lb/ft^2(0.12-kPa) weight before measuring thickness.

11.9 *Stress Corrosion Performance for Use on Austenitic Stainless Steel*—When requested, test in accordance with Specification C 795. All test specimens must include the facing and adhesive.

11.10 *Fungi Resistant*—Test in accordance with Test Method C 1338.

12. Qualification Requirements

12.1 The following requirements shall be employed for the purpose of initial material or product qualification:

12.1.1 Maximum use temperature.

12.1.2 Apparent thermal conductivity.

12.1.3 Water vapor sorption.

12.1.4 Surface burning characteristics.

12.1.5 Corrosiveness.
12.1.6 Shot content (rock and slag).
12.1.7 Compressive resistance.
12.1.8 Maximum design density.
12.1.9 Fungi Resistance.

13. Inspection

13.1 The following requirements are generally employed for the purpose of acceptance sampling of lots or shipments of qualified insulation.
13.1.1 Density.
13.1.2 Dimensional tolerances.
13.1.3 Compliance with facing specification.
13.1.4 Workmanship including total adhesion of the insulation to the facing.
13.1.5 Rock or slag non-fibrous (shot) content.

14. Rejection

14.1 Failure to conform to the requirements in this specification shall constitute cause for rejection. Rejection shall be reported to the manufacturer or seller promptly and in writing.

15. Certification

15.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

16. Packaging and Package Marking

16.1 *Packaging*—Unless otherwise specified, the insulation shall be packed in the standard commercial containers available from the manufacturer.
16.2 *Marking*—Unless otherwise specified, each container shall be marked as follows:
16.2.1 *Roll and Sheet Insulation*—Name of manufacturer, address, and phone number; product name; type; description of facing; quantity in square feet (metres); number of pieces or rolls or sheets; nominal dimensions; manufacturing lot number or date code for the material in the container.
16.3 When specified in the purchase order or contract, each container shall be marked with the appropriate ASTM specification alphanumeric number, including type and category.

17. Keywords

17.1 apparent thermal conductivity; facing; mineral fiber; perpendicularly oriented fiber; pipe and tank insulation; sheet; shot; shot content