Designation: C1685 – 15 (Reapproved 2021)

Standard Specification for Pneumatically Applied High-Temperature Fiber Thermal Insulation for Industrial Applications[1]

This standard is issued under the fixed designation C1685; 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, thermal performance, sound absorption performance, and physical properties of high-temperature fiber thermal insulation for use at temperatures from ambient to 3000°F (1649°C).

1.2 The dry, loose high-temperature fibers shall be pneumatically conveyed to a chamber where they are mixed with a water-based chemical binder and then conveyed to a nozzle.

1.3 The pneumatically applied, high-temperature fiber insulation is intended for use in industrial applications on flat, or nearly flat, surfaces. It is not intended for use on pipes.

1.4 This specification addresses the use performance of this material in both thermal and acoustical applications.

1.5 This specification does not address the requirements for fire-resistive insulation, but it does not preclude this material's use in that capacity.

1.6 This is a material specification only and is not intended to cover methods of application that are provided by the manufacturer.

1.7 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.

1.8 *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.*

1.9 *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]

C71 Terminology Relating to Refractories

C133 Test Methods for Cold Crushing Strength and Modulus of Rupture of Refractories

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

C201 Test Method for Thermal Conductivity of Refractories

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

C423 Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

C447 Practice for Estimating the Maximum Use Temperature of Thermal Insulations

C665 Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing

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

C1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions

C1104/C1104M Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation

C1113 Test Method for Thermal Conductivity of Refractories by Hot Wire (Platinum Resistance Thermometer Technique)

E84 Test Method for Surface Burning Characteristics of Building Materials

[1] This specification is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.23 on Blanket and Loose Fill Insulation.

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[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 Performance Requirements (Excluding Acoustical)

Maximum Use Temperature, °F (°C)		
Type I 2012 (1100)	Type II 2300 (1260)	Type III 3000 (1649)
Apparent Thermal Conductivity, maximum Btu-in./h · ft^2 · °F (W/m · K) at mean temperature, °F (°C), *for all three types*		
	Grade A	Grade B
75 (24)	0.40 (0.058)	0.18 (0.026)
200 (93)	0.44 (0.063)	0.25 (0.036)
400 (204)	0.54 (0.078)	0.38 (0.055)
600 (316)	0.72 (0.104)	0.53 (0.077)
800 (427)	1.00 (0.144)	0.71 (0.10)
1000 (538)	1.37 (0.197)	0.90 (0.13)
1200 (649)	1.82 (0.262)	1.12 (0.16)
1400 (760)	2.36 (0.340)	1.35 (0.19)
1600 (871)	2.99 (0.431)	1.61 (0.23)
Maximum Compressive Resistance, at 10% deformation, min, lb/ft^2 (kPa), *for all three types Grade A in accordance with Test Method C165*		50 (2.4)
Maximum Cold Crush, min., psi (Pa), for all three Types, Grade B, in accordance with Test Method C133		
Modulus of Rupture		10 (0.48)
Cold Crush		13 (0.62)
Linear Shrinkage, at maximum use temperature, %, *for all three types and both Grades A and B*		5.0
Water Vapor Sorption, maximum, % by weight, *for all three types and both Grades A and B*		5.0
Surface Burning Characteristics, *for all three types and both Grades A and B*:		
	Flame Spread Index, maximum	25
	Smoke Developed Index, maximum	50

E136 Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C

E605 Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members

E2231 Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics

2.2 *Other Standards:*

ISO 8894 Thermal Conductivity by the Hot Wire Method; Part 1 Crossed Wire Method, Part 2 Parallel Wire Method[3]

CAN/ULC–S102–07 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies[4]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, see Terminology C71 and C168.

3.2 *Definitions of Terms Specific to This Standard:*

3.3 *cured, n*—state or condition of the finished product after the liquid vehicle has been evaporated to a constant mass.

3.4 *pneumatically applied, v*—use of air to convey the fibrous insulation to a nozzle and then from a nozzle to the intended surface to be insulated.

4. Materials and Manufacture

4.1 *Composition*—The basic types of materials shall be loose inorganic fibers combined with a liquid, water-based binder. The fibers are made from mineral substances such as silica, alumina, calcium, and magnesium processed from the molten state into fibrous form. The liquid binder is made from inorganic materials: water, colloidal silica, and less than 2% of an organic foaming agent.

4.2 *Types*—The product is separated into types based on the chemistry and temperature use limit:

Type	Chemical Composition	Upper Use Temperature, °F (°C)
I	Calcium Magnesium Silicate	2012 (1100)
II	Magnesium Silicate	2300 (1260)
III	Aluminum Silicate	3000 (1649)

4.3 The liquid binder shall be added in sufficient quantity to provide the fibers with necessary adhesion to the applied surface, cohesion to one another, and the required physical properties of the installed, dry insulation.

4.4 There shall be two different grades of material, Grade A and Grade B, differentiated by different thermal conductivity, different sound absorption coefficients, and different noise reduction coefficients.

5. Physical Properties

5.1 For pneumatically applied, high-temperature thermal insulation, it is possible that the properties of density and apparent thermal conductivity will vary with the manufacturer. Minimum acceptable value of density and maximum acceptable values of thermal conductivity shall be stated by the manufacturer before sale and shall be tested in accordance with 9.1. (See Table 1.)

5.2 *Maximum Use Temperature*—When tested in accordance with 9.1, the high-temperature fiber insulation shall not warp, flame, or glow during hot surface exposure. No evidence of melting or fiber degradation shall be evident upon post–test inspection.

5.3 *Maximum Exothermic Temperature Rise*—When tested in accordance with 9.1, the internal temperature shall not at any time exceed the hot surface temperature by more than 200°F

[3] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.

[4] Available from Ottawa Standards and Government Relations Office 440 Laurier Ave. West, Suite 200 Ottawa ON K1R 7X6, http://www.ulc.ca.

TABLE 2 Minimum Values of Sound Absorption Coefficients by Frequency

Frequency, Hz	Sound Absorption Coefficients, Grade A	Sound Absorption Coefficients, Grade B
125	0.21	0.32
250	0.88	0.84
500	1.05	0.86
1000	0.95	0.82
2000	0.95	0.86
4000	0.95	0.83

(111°C). The 200°F criterion applies during heat-up as well as steady-state conditions. Exceeding this limit constitutes non-compliance to this specification and rejection.

5.4 *Surface Burning Characteristics*—The cured insulation shall have a maximum flame spread index of 25 and a maximum smoke developed of 50 when tested in accordance with 9.4.

5.5 *Non-combustibility*—If required for the particular application, the installed, dry insulation shall meet the requirements of non-combustibility when tested in accordance with 9.5.

5.6 *Linear Shrinkage and Temperature of Use*—The pneumatically applied high-temperature insulation shall be demonstrated to be dimensionally stable with a maximum of 5% linear shrinkage when tested in accordance with Test Method C356 to its maximum use temperature.

5.7 *Compressive Resistance*—The compressive resistance shall be as shown in Table 1 when tested in accordance with 9.6.

5.8 *Water Vapor Sorption*—Water vapor sorption shall not exceed 5% by weight when tested in accordance with 9.7.

5.9 *Corrosiveness to Steel*—When tested and evaluated in accordance with 9.8, the corrosion resulting from insulation in contact with steel plates shall be judged to be no greater than for comparative plates in contact with sterile cotton in accordance with 9.8.

5.10 *Stress Corrosion to Austenitic Stainless Steel*—When specified, the stress corrosion shall be tested and evaluated in accordance with 9.9.

5.11 Sound Absorption Coefficient and Noise Reduction Coefficient – When required, sound absorption shall not be less than the values given in Table 2, by indicated frequency when tested at a 2 in. (51 mm) thickness. The Noise Reduction Coefficient (NRC) shall not be less than 0.95 for Grad A and 0.90 for Grade B.

6. Workmanship, Finish, and Appearance

6.1 The pneumatically applied high-temperature insulation shall be free of all extraneous foreign material, such as metal and paper, that would adversely affect the performance of the insulation.

6.2 The thickness and appearance of the insulation shall be as agreed upon between the purchaser and the supplier. Surface finish shall be done only in accordance with the manufacturer's instructions.

6.3 The substrate shall be prepared in accordance with the manufacturer's instructions. This has the potential to include, but is not limited to, the addition of mechanical anchors and refractory mortar.

7. Sampling

7.1 Sampling of the insulation shall be in accordance with Practice C390.

8. Specimen Preparation

8.1 *Test Specimens*—All specimens shall be prepared using the manufacturer's recommended application apparatus and application techniques. All specimens shall be dry and cured to constant mass before testing. All specimens shall be tested at the maximum design thickness or the applied thickness unless otherwise specified by the specific test method in Section 9.

9. Test Methods

9.1 *Maximum Use Temperature and Exothermic Rise Temperatures*—Test in accordance with Test Method C411 and the hot surface performance of Practice C447 at the insulation's maximum use temperature. All types shall be tested without jacketing at the manufacturer's maximum recommended thickness for the particular temperature. Tests shall be conducted on a flat hot plate.

9.2 *Density and Thickness*—Density and thickness shall be tested in accordance with Test Method E605.

9.3 *Apparent Thermal Conductivity*—The thermal conductivity shall be determined in accordance with any one of the following test methods: C177, C201, C1113, or ISO 8894, using at least four mean temperatures spanning the expected mean use temperature of the installation if required for the installation. As specified in Practice C1045, the range of test 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 somewhere evenly over the rest of the temperature range

9.4 *Surface Burning Characteristics*—Test in accordance with Test Method E84 using the specimen preparation and mounting method of Practice E2231. For Canada, test in accordance with Test Method CAN/ULC–S102–07.

9.5 *Non-combustibility*—If required for the particular application, test in accordance with Test Method E136.

9.6 *Compressive Resistance*—Test in accordance with Test Method C165 for Grade A, or Test Methods C1113 for Grade B.

9.7 *Water Vapor Sorption*—Test in accordance with Test Method C1104/C1104M.

9.8 *Corrosiveness to Steel*—Test in accordance with Specification C665, Subsection 13.8 on Corrosiveness.

9.9 *Stress Corrosion Performance for Use on Austenitic Stainless Steel*—When requested, test in accordance with Specification C795.