



Standard Specification for Pneumatically Applied High-Temperature Fiber Thermal Insulation for Industrial Applications¹

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1. Scope

1.1 This specification covers the composition, thermal 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 nozzle where they are mixed with a water-based chemical binder.

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

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

1.6 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.

1.7 *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 71 Terminology Relating to Refractories

- 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 201** Test Method for Thermal Conductivity of Refractories
- C 356** Test Method for Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat
- 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 665** Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
- C 795** Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
- C 1045** Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions
- C 1104/C 1104M** Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation
- C 1113** Test Method for Thermal Conductivity of Refractories by Hot Wire (Platinum Resistance Thermometer Technique)
- E 84** Test Method for Surface Burning Characteristics of Building Materials
- E 136** Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C
- E 605** Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
- E 2231** Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics

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 Physical Property Requirements

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		
75 (24)	0.40 (0.058)	
200 (93)	0.44 (0.063)	
400 (204)	0.54 (0.078)	
600 (316)	0.72 (0.104)	
800 (427)	1.00 (0.144)	
1000 (538)	1.37 (0.197)	
1200 (649)	1.82 (0.262)	
1400 (760)	2.36 (0.340)	
1600 (871)	2.99 (0.431)	
Maximum Compressive Resistance, at 10% deformation, min, lb/ft ² (kPa), for all three types		50 (2.4)
Linear Shrinkage, at maximum use temperature, %, for all three types		5.0
Water Vapor Sorption, maximum, % by weight, for all three types		5.0
Surface Burning Characteristics, for all three types:		
Flame Spread Index, maximum		25
Smoke Developed Index, maximum		50

2.2 Other Standards:

ISO 8894 Thermal Conductivity by the Hot Wire Method; Part 1 Crossed Wire Method, Part 2 Parallel Wire Method³
CAN/ULC-S102-07 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies⁴

3. Terminology

3.1 *Definitions*— For definitions of terms used in this specification, see Terminology **C 71** and **C 168**.

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)

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>.

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.

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 (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 **C 356** to its maximum use temperature.

5.7 *Compressive Resistance*—The compressive resistance shall be at least 50 psi (2.4 kPa) at 10% deformation, 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.

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 C 390.

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 C 411 and the hot surface performance of Practice C 447 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 E 605.

9.3 *Apparent Thermal Conductivity*—The thermal conductivity shall be determined in accordance with any one of the following test methods: C 177, C 201, C 1113, 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 C 1045, 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 E 84 using the specimen preparation and mounting method of Practice E 2231. 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 E 136.

9.6 *Compressive Resistance*—Test in accordance with Test Method C 165.

9.7 *Water Vapor Sorption*—Test in accordance with Test Method C 1104/C 1104M.

9.8 *Corrosiveness to Steel*—Test in accordance with Specification C 665, Subsection 13.8 on Corrosiveness.

9.9 *Stress Corrosion Performance for Use on Austenitic Stainless Steel*—When requested, test in accordance with Specification C 795.

10. Qualification Requirements

10.1 Unless otherwise specified, the following requirements shall be employed for the purpose of initial material or product qualification after application on a particular job.

10.1.1 Maximum use temperature.

10.1.2 Thickness.

10.1.3 Apparent thermal conductivity at four or more mean temperatures over the range of expected temperature use.

10.1.4 Linear shrinkage.

10.1.5 Surface burning characteristics.

10.1.6 Compressive resistance.

10.1.7 Water vapor sorption.

10.1.8 Corrosiveness.

10.1.9 Non-combustibility (if required for the particular application).

11. Inspection and Acceptance of Installed Insulation

11.1 Unless otherwise specified, the following requirements shall be employed for the purposes of acceptance sampling of an application:

11.1.1 *Density*, 8 lb/ft³ (128 kg/m³) ± 10%.

11.1.2 *Thickness*, within ± 10% of specified.

11.1.3 *Workmanship, Finish, and Appearance*.

12. Acceptance or Rejection

12.1 If inspection of the samples prepared at the site of the application shows failure to conform to the requirements of the specification, a second sampling from the same lot shall be tested and the results of this retest averaged with the results of the original test.

12.1.1 Upon retest as described in 12.1, failure to conform to this specification shall constitute grounds for rejection.

12.1.2 In case of rejection, the manufacturer, supplier, or contractor shall have the right to reinspect the rejected shipment and resubmit the lot after removal of that portion of the shipment not conforming to the specified requirements.

13. Packaging and Package Marking

13.1 Material shall be delivered to the site in the approved manufacturer's original and unopened packaging, bearing labels showing the type of material, brand name, labels as required, lot numbers, and the manufacturer's name and address.

14. Delivery and Storage

14.1 Material shall be stored under cover in a dry and clean location. Delivered materials that have been exposed to water before use or are otherwise not suitable for insulation shall be removed from the job site and replaced with acceptable materials. The inorganic liquid binder shall be stored in a freeze-protected environment.

15. Installation

15.1 Pneumatically applied high-temperature insulation material shall be applied in conformance with the manufacturer's written instructions and all applicable codes and standards.

15.2 Material shall be applied within the acceptable installation temperature limitation in accordance with the manufacturer's written instructions.

16. Keywords

16.1 cured; high-temperature fiber insulation; industrial applications; pneumatically applied; refractory fibers

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