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Standard Specification for Self-Supported Spray Applied Cellulosic Thermal Insulation[1]

This standard is issued under the fixed designation C 1149; 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—Table 2 was editorially corrected in May 2007.

1. Scope

1.1 The specification covers the physical properties of self-supported spray applied cellulosic fibers intended for use as thermal insulation or an acoustical absorbent material, or both.

1.2 This specification covers chemically treated cellulosic materials intended for pneumatic applications where temperatures do not exceed 82.2°C (180°F) and where temperatures will routinely remain below 65.6°C (150°F).

1.2.1 *Type I*—Material applied with liquid adhesive and suitable for either exposed or enclosed applications.

1.2.2 *Type II*—Materials containing a dry adhesive that is activated by water during installation and intended only for enclosed or covered applications.

1.3 This is a material specification only and is not intended to deal with methods of application that are supplied by the manufacturer.

1.4 The values stated in SI units are to be regarded as standard. The inch-pound units given in parentheses are for information only.

1.5 *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 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 518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

C 739 Specification for Cellulosic Fiber Loose-Fill Thermal Insulation

C 1363 Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus

E 84 Test Method for Surface Burning Characteristics of Building Materials

E 605 Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members

E 736 Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members

E 759 Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members

E 859 Test Method for Air Erosion of Sprayed Fire-Resistive Materials (SFRMs) Applied to Structural Members

3. Terminology

3.1 *Definitions*—Definitions in Terminology C 168 shall apply in this specification.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *constant mass*—no change in successive weighings in excess of 0.5 % of specimen mass taken at 4-h intervals unless otherwise specified. Specimen should not be always increasing in weight or decreasing in weight.

3.2.2 *cured*—the state of the finished product after it has achieved constant mass.

3.2.3 *curing*—the process in which the liquid vehicle is removed. Normally achieved in ambient building conditions with forced air convection to hasten the evaporation process.

3.2.4 *prepared sample*—samples prepared in accordance with Section 5 and cured to constant mass prior to conducting the specific tests. The prepared samples, after reaching constant mass, as defined in 3.2.1, shall have a density within ±10 % of the manufacturer's recommended design density.

3.2.5 *self supporting*—a product that can be tested by the criteria imposed by this specification and that will require no support other than itself or the substrate to which it is attached.

[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.

3.2.6 *specimen*—definition of specimen as used in this specification shall be the same as that for *prepared sample* in 3.2.4.

3.2.7 *sprayed fiber*—chemically treated cellulosic materials, that are pneumatically conveyed and mixed with water or adhesive, or both, at the spray nozzle and become self-supporting when cured.

4. Physical Properties

4.1 *Materials and Manufacture*:

4.1.1 The basic material shall consist of virgin or recycled wood based cellulosic fiber.

4.1.2 Suitable chemicals shall be introduced to provide flame resistance, improved processing, adhesive/cohesive properties, and handling and application characteristics.

4.1.3 The basic material shall be processed into a form suitable for installation by pneumatic conveying equipment and the simultaneous mixing with liquid at the spray nozzle.

4.2 *Density*—Type I and Type II samples shall be within ±10 % of the manufacturer's stated values when tested in accordance with 6.1.

4.3 *Thermal Resistance*—Type I and Type II samples shall be within ±10 % of the manufacturer's stated values when tested in accordance with 6.4.

4.4 *Surface Burning Characteristics*—Type I and Type II samples shall have a maximum flame spread rating of 25 and a maximum smoke developed rating of 50 when tested in accordance with 6.2.

4.5 *Adhesive/Cohesive Strength*:

4.5.1 *Type I*—The applied material shall have a minimum adhesive/cohesive bond strength per unit area of five times the weight of the material under the test plate when tested in accordance with Test Method E 736.

4.5.2 *Type II*—The applied product shall have a minimum adhesive/cohesive bond strength per unit area of two times the weight of the material under the test plate when tested in accordance with Test Method E 736.

4.6 *Smoldering Combustion*—Type I and Type II products, when tested in accordance with 6.5, shall have a weight loss no greater than 15 % of the specimen weight and shall exhibit no evidence of flaming.

4.7 *Fungi Resistance*—Type I and Type II products, when tested in accordance with 6.6, shall not promote more fungal growth than the control in at least two of the three replicate specimens. (See Specification C 739, 1986 edition, paragraph 5.4.)

4.8 *Corrosion*—Type I and Type II products, when tested in accordance with 6.7, shall demonstrate no perforations in the 3-mil metal coupons when observed in close proximity to a 40-W appliance light bulb. Notches extending less than 3 mm into the coupon edge can be ignored.

4.9 *Moisture Vapor Absorption*—Moisture absorption of Type I and Type II products shall be no more than 15 % when tested in accordance with 6.8.

4.10 *Odor*—Type I and Type II, applied products shall have no strong, objectionable odor when tested in accordance with 6.9.

4.11 *Flame Resistance Permanency:*[3]

4.11.1 The importance of an insulation's product to maintain its fire retardant characteristics is recognized. A task group is currently studying methods to ascertain if there is a long term deterioration of fire performance characteristics of cellulose insulation. Should the need for a permanency test method be determined by this task group and a test method developed and finalized, it will become a part of this specification.

4.12 *Additional Characteristics for Type I Product*:

4.12.1 *Substrate Deflection*—Type I applied product shall not spall, crack, or delaminate when tested in accordance with 6.11 of this specification.

4.12.2 *Air Erosion*—Report the results of the air erosion test described in 6.10 of this specification for Type 1 applied product.

5. Specimen Preparation

5.1 Prepare specimens using manufacturer's recommended equipment and procedures and at manufacturer's maximum recommended thickness. Cure specimens to constant mass at 23 ± 3°C (73.4 ± 5.4°F) and 50 ± 5 % relative humidity unless otherwise specified in a specific test procedure. All specimens shall be within ±10 % of the manufacturer's recommended installation density.

6. Test Methods

6.1 *Density*—Density of each sample shall be determined in accordance with Test Methods E 605.

6.2 *Surface Burning Characteristics*—The surface burning characteristics of Type I and Type II products shall be determined in accordance with Test Method E 84.

6.3 *Adhesive/Cohesive Strength*—The adhesive/cohesive strength of the spray applied fiber insulation shall be determined in accordance with Test Method E 736.

6.4 *Thermal Resistance*—Samples shall be prepared as in Section 5. The thermal resistance of the spray applied cellulosic fiber insulation shall be as determined by the average of four specimens tested in accordance with Test Methods C 177, C 518, or C 1363. The referee method shall be Test Method C 177. When Test Method C 518 or C 177 is used, the surface irregularities will be trimmed to provide uniform thickness. When the hot box method is used, the test will be on the insulation component only or alternatively; if tested as a system, the results reported shall include all components of system evaluated.

6.5 *Smoldering Combustion*:

6.5.1 *Scope*—This test method determines the resistance of the insulation to smolder, under specific laboratory conditions.

6.5.2 *Significance and Use*—Insulation materials that rreadily smolder could have an adverse effect on the surrounding structure in the event of exposure to fire or heat sources.

6.5.3 *Apparatus for Smoldering Combustion Test*:

6.5.3.1 *Specimen Holder*—The specimen holder shall be an open-top 203 ± 2 mm (8 ± 0.08 in.) square box, 100 ± 2 mm (4 ± 0.08 in.) in height, fabricated from 18 United States standard gage stainless steel sheet with the vertical edges of the

[3] This statement on flame resistant permanency was added in March 1987.

box overlapped, not to exceed 7 mm (0.27 in.) in seam width, and joined to be watertight.

6.5.3.2 *Specimen Holder Pad*—During the test the specimen holder shall rest upon a pad of unfaced glass fiberboard having dimensions equal to the bottom of the specimen holder. The glass fiberboard shall be approximately 25 mm (0.98 in.) thick, with a density of 40 ± 4 kg/m (2.5 ± 0.25 lb/ft).

6.5.3.3 *Laboratory Scales*, capable of weighing the specimen holder and sample with an accuracy of ± 0.2 g (0.007 oz).

6.5.3.4 *Drill Press*, with vertical movement capabilities in excess of 114 mm (4.5 in.) and fitted with an 8 mm (0.315 in.) diameter drill bit with a minimum usable length of 102 mm (4.0 in.) when chucked.

6.5.3.5 *Ignition Source*—The ignition source shall be a cigarette without filter tip made from natural tobacco, 85 ± 2 mm (3.35 ± 0.08 in.) long with a tobacco packing density of 0.27 ± 0.0020 g/cm and a total weight of 1.1 ± 0.2 g (0.04 oz).

6.5.4 *Sampling*—Three specimens per sample shall be tested.

6.5.5 *Conditioning*—Sample shall be allowed to dry at 23 ± 3°C (73.4 ± 5.4°F) and 50 ± 5 % relative humidity until constant mass is achieved.

6.5.6 *Test Chamber*—A draft-protected chamber or hood with a suitable exhaust system to remove products of combustion. Air velocities shall not exceed 0.5 m/s (1.64 ft/s) in the vicinity of the specimen surface when measured by a hot wire anemometer.

6.5.7 *Procedure*:

6.5.7.1 Determine tare weight of specimen holder and fiberglass shim (after drilling) to nearest 0.2 g and record weight (see 6.5.7.4).

6.5.7.2 After conditioning in accordance with 6.5.5, cut specimens 203 by 203 ± 2 mm (8 by 8 ± 0.08 in.) square to fit snugly inside the specimen holder.

6.5.7.3 After cutting specimen to the correct size, drill a hole through the thickness of the specimen at the center. Use a drill press and steel drill bit described in 6.5.3.4.

6.5.7.4 Insert drilled specimen level with top edge of specimen holder. If required, provide a shim of unfaced fiberglass (approximate 0.5 lb/ft^3) under the specimen that is cut to fit holder and center drilled to align with specimen. Carefully cut excess material extending above the top edge of the specimen holder. A reciprocating electric knife or saw has been found suitable. Take care that the center drilled hole is free of debris and if the shim pad is used, that the hole is aligned through specimen and pad.

6.5.7.5 Weigh specimen and specimen holder, subtract weight of empty specimen holder and fiberglass shim if used. Record this as the starting weight of the specimen, (W_1). Calculate the density of the specimen to the nearest 0.1 lb/ft^3; density shall be within ± 10 % of the manufacturer's design density.

6.5.7.6 With the specimen in the specimen holder and placed on the insulation pad, insert well-lighted cigarette, burned no more than 8 mm (0.32 in.), into the formed cavity, with the lighted end upward and flush with the specimen surface. Place the specimen in the test chamber and allow burning of the cigarette to proceed undisturbed for at least 1 h, after which, allow specimen to remain until there is no evidence of heat or smoke and the bottom of the specimen holder is cool to the touch.

6.5.7.7 After the specimen has cooled to less than 25°C (77°F), weigh to the nearest 0.2 g and subtract the tare weight determined in 6.5.7.1 to arrive at the final net weight, (W_2).

6.5.8 *Calculation*—Calculate percent weight loss as follows:

$$WL = (\{W_1 - W_2\}/W_1) \times 100 \quad (1)$$

where:

WL = weight loss, %,
W_1 = weight of specimen before test, g (oz), and
W_2 = final weight of specimen at completion of test, g (oz).

6.5.9 *Retest*—If all three specimens pass, the insulation passes. If more than one fails, the insulation is rejected. If any one of the three specimens should fail, conduct a retest consisting of three additional specimens. Should one of the three retest specimens fail, the insulation is rejected.

6.5.10 Results of test: Pass/Fail.

6.5.11 *Precision and Bias* The precision and bias of this test method has not been determined.

6.6 *Fungi Resistance*:

6.6.1 *Scope*—This test method covers the determination of the amount of resistance to the growth of fungi present in self-supported spray applied cellulosic thermal/acoustical insulation.

6.6.2 *Significance and Use*—It is necessary to ensure that spray applied cellulosic insulation materials support no greater growth of fungi than the surrounding materials of the structure being insulated. Normally the structural materials in question will be wood. Excessive growth of fungi on the insulation could result in loss of efficiency of the insulation, damage to the structure, and possible health hazards to the occupants of the insulated structure. The purpose of this test method is to provide an evaluation of the potential for fungi growth present in the insulation material relative to common wood used for framing.

6.6.3 *Apparatus*—The apparatus required to conduct this test method consists of chambers or cabinets together with auxiliary instrumentation capable of maintaining the specified conditions of temperature and humidity. The apparatus shall be constructed to keep light from entering the chamber during the test period.

6.6.4 *Sampling*—Unless specified by the purchaser, one specimen shall be selected from each of three different bags or other packages of insulation, as applicable.

6.6.5 *Procedure*—Prepare mineral salts agar in accordance with Table 1.

6.6.5.1 Sterilize the mineral salts agar by autoclaving at 121 ± 2°C (250 ± 3.6°F) for 20 min. Adjust the pH of the solution with 0.01 normal NaOH solution so that after sterilization the pH is from 6.0 to 6.5. Reagent grade chemicals shall be used in all tests. Unless otherwise specified, it is intended that all reagents shall conform to the specifications of the Committee

TABLE 1 Preparation of Mineral Salts Agar

Chemical	Amount
Sodium nitrate ($NaNO_3$)	2.0 g
Magnesium sulfate ($MgSO_4$)	0.5 g
Potassium chloride (KCl)	0.5 g
Ferric sulfate ($Fe_2(SO_4)_3 \cdot 9H_2O$)	0.01g
Potassium dihydrogen orthophosphate (KH_2PO_2)	0.14g
Potassium monohydrogen orthophosphate (K_2HPO_4)	1.2 g
Agar	15.0 g
Distilled water	1.0 L
Yeast extract	0.02g

TABLE 2 Test Fungi for Preparation of Mixed Spore Suspension

Fungi	ATCC[A]
Aspergillus niger	9642
Aspergillus flavus	9643†
Aspergillus versicolor	11730
Penicillium funiculosum	11797
Chaetomium globosum	6205

[A] Available from American Type Culture Collection, 12301 Parklawn Dr., Rockville, MD 20852.

† Editorially corrected in May 2007.

on Analytical Reagents of the American Chemical Society, where such specifications are available.[4]

6.6.5.2 Unless otherwise specified, reference to water shall be understood to mean sterilized and either deionized or distilled water.

6.6.5.3 *Preparation of Mixed Spore Suspension*—Use the test fungi prescribed in Table 2. Maintain separate cultures of these fungi on an appropriate medium such as potato dextrose agar. However, the culture of *chaetomium globosum* shall be maintained on strips of filter paper on the surface of mineral salts agar. The stock culture may be kept for no more than four months at 6± 4°C (43 ± 7°F) at that time subcultures shall be made, and new stocks shall be selected from the subcultures. If genetic or physiological changes occur, obtain new cultures as specified previously. Subcultures used for preparing new stock cultures or the spore suspension shall be incubated at 30 ± 2°C (86 ± 3.6°F) for nine days or longer. Prepare a spore suspension of each of the five fungi by pouring 10 mL of a sterile solution containing 0.05 g/L of a nontoxic wetting agent such as sodium dioctyl sulfosuccinate or sodium lauryl sulfate on each culture. Use a sterile platinum or nichrome inoculating wire to gently scrape the surface growth from the culture of the test organism. Pour the spore charge into a sterile 125 mL glass stoppered Erlenmeyer flask containing 45 mL of sterile water and 50 to 75 solid glass beads, 5 mm (0.20 in.) in diameter. Shake the flask vigorously to liberate the spores from the fruiting bodies and to break the spore clumps. Filter the dispersed fungal spore suspension through a 6 mm (0.24 in.) layer of glass wool contained in a glass funnel, into a sterile flask. This process is intended to remove large mycelial fragments and clumps of agar that could interfere with the spraying process. Centrifuge the filtered spore suspension aseptically, and discard the supernatant liquid. Re-suspend the residue in 50 mL of sterile water and centrifuge. Wash the spores obtained from each of the fungi in this manner three times. Dilute the final washed residue with sterile water so that the resulting spore suspension shall contain 1 000 000 ± 200 000 spore/mL as determined with a counting chamber. Repeat the operation for each organism used in the test and blend equal volumes of the resultant spore suspensions to obtain the final mixed spore suspension. The spore suspension may be prepared fresh each day, or may be held at 6 ± 4°C (43 ± 7°F) for no more than seven days.

6.6.5.4 *Visibility of Innoculum Control*—With each daily group of tests, place one each of three pieces of sterilized filter paper, 1 in.[2] on hardened mineral salts agar in separate covered petri dishes. Inoculate these with the spore suspension from a sterilized atomizer (an atomizer capable of providing 15 000± 3 000 spores per square centimetre). Incubate these in the test chamber along with samples at 30 ± 2°C (86 ± 3.6°F) at a relative humidity of no less than 95 % and examine these controls after seven days of such incubation. There should be copious growth on all three of the filter paper control specimens. Absence of such growth requires repetitions of the test.

6.6.5.5 *Comparative Items*—A section of untreated southern pine approximately 50.8 by 50.8 by 9.5 mm (2 by 2 by ⅜ in.) thick. The upper surface of the pine shall be planed smooth and shall be employed as a comparative item to determine the relative extent of the growth on samples being tested.

6.6.5.6 *Preparation of Test Samples*—For Type I materials, determine the amount of liquid adhesive concentrate that would be mixed with 10 g (0.35 oz) of dry material. To this adhesive, add sufficient water to make 37.5 mL of solution. Thoroughly mix the 10 g sample and water/adhesive solution. For Type II and Type III material, add 37.5 mL of water to the dry material and thoroughly mix.

6.6.5.7 *Innoculation of Test and Comparative Item*—Precondition the test area at 30 ± 2°C (86 ± 23.6°F) and at least 95 % relative humidity for at least 4 h. Place each piece of wood in a sterile petri dish and moisten with 3 mL of sterile water. Aseptically transfer approximately one-third of the insulation mix to each of three sterile petri dishes and gently tamp down to a relatively smooth surface to facilitate subsequent microscopic examination. Inoculate the test and comparative items with the spore suspension by spraying approximately 0.5 mL onto the contents of each petri dish. The spray shall be in the form of a fine mist from a previously sterilized atomizer or nebulizer. The petri dish shall be covered and incubation shall be started immediately following the inoculation.

6.6.5.8 *Incubation*—Maintain test conditions at 30 ± 2°C (86 ± 3.6°F) and at minimum relative humidity of 95 % for 28 days. The test chamber shall be kept closed during the incubation period, except during inspection. One means of achieving the proper conditions of temperature and humidity is to place the covered petri dishes in a neoprene coated wire petri dish holder (autoclavable) measuring approximately 222 mm (8¾ in.) wide by 111 mm (4⅜ in.) deep by 190 mm (7½ in.) high. The holder is then placed in an autoclavable 1.2 mil

[4] *Reagent Chemicals, American Chemical Society Specifications* , American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmaceutical Convention, Inc. (USPC), Rockville, MD.