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Designation: ~~C1149 – 17~~ C1149 – 23

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

This standard is issued under the fixed designation C1149; 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 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 and where temperatures will routinely remain below 65.6°C.

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.

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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. No other units of measurement are included in this standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *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]

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

C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

C1338 Test Method for Determining Fungi Resistance of Insulation Materials and Facings

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[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.

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C1363 Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
E84 Test Method for Surface Burning Characteristics of Building Materials
E605 Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
E736 Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
E759 Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members
E859 Test Method for Air Erosion of Sprayed Fire-Resistive Materials (SFRMs) Applied to Structural Members

3. Terminology

3.1 *Definitions*—Definitions in Terminology C168 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.

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.

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

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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 E736.

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 E736.

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 Test Method C1338.)

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 *Additional Characteristics for Type I Product:*

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

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

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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 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.

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6. Test Methods

6.1 *Density*—Density of each sample shall be determined in accordance with Test Methods E605.

6.2 *Surface Burning Characteristics*—The surface burning characteristics of Type I and Type II products shall be determined in accordance with Test Method E84.

6.3 *Adhesive/Cohesive Strength*—The adhesive/cohesive strength of the spray applied fiber insulation shall be determined in accordance with Test Method E736.

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 C177, C518, or C1363. The referee method shall be Test Method C177. When Test Method C518 or C177 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 readily 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 square box, 100 ± 2 mm in height, fabricated from 18 United States standard gage stainless steel sheet with the vertical edges of the box overlapped, not to exceed 7 mm 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 thick, with a density of 40 ± 4 kg/m.

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

6.5.3.4 *Drill Press,* with vertical movement capabilities in excess of 114 mm and fitted with an 8 mm diameter drill bit with a minimum usable length of 102 mm 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 long with a tobacco packing density of 0.27 ± 0.0020 g/cm and a total weight of 1.1 ± 0.2 g.~~the Current Supply of National Institute of Standards and Technology (NIST) Standard Reference Material (SRM) 1196 Standard Cigarette for Ignition Resistance Testing.[3]

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 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 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 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 8.01 kg/m^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 1.6 kg/m^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, 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, 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:

[3] The Current Supply of SRM 1196 Series Cigarettes are available from National Institute of Standards and Technology, 100 Bureau Drive, Stop 2322, Gaithersburg, MD 20899-2322.

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

where:

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

6.5.9 *Retest*—If all three specimens pass, the insulation passes. If more than one fail, the insulation is rejected. If any one of the three specimens fails, conduct a retest consisting of three additional specimens. If one of the three retest specimens fails, 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 The fungi resistance of the insulation shall be determined in accordance with Test Method C1338.

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

6.6.3 *Conditioning*—Condition the specimens per 6.5.5.

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6.6.4 *Preparation of Test Samples*—For Type I materials, determine the amount of liquid adhesive concentrate that would be mixed with 10 g 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 material, add 37.5 mL of water to a 10 g sample of the dry material and thoroughly mix. 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.

6.6.5 A section of untreated southern yellow pine is the comparative item.

ASTM C1149-23
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6.6.6 Perform inoculation of test specimen and comparative item per Test Method C1338.

6.6.7 Complete test per Test Method C1338.

6.6.8 Report results as specified in Section 8, Test Method C1338.

6.7 *Corrosion:*

6.7.1 *Scope*—This test method provides a basis for estimating the corrosiveness of spray-applied cellulosic insulation.

6.7.2 *Significance and Use*—This test method provides a basis for estimating the corrosiveness of spray-applied cellulosic insulation in contact with steel, copper, and aluminum test materials. The test method represents one set of exposure conditions designed to accelerate possible corrosive effects, and is not intended to simulate exposure conditions experienced in actual field applications.

6.7.3 *Apparatus and Materials:*

6.7.3.1 *Humidity Chamber (Test Method A),* air-circulating, capable of maintaining a temperature of 48.9 ± 1.7°C and 95 ± 3 % relative humidity throughout the active portion of the chamber.

6.7.3.2 *Oven (Test Method B),* air circulating, capable of maintaining a temperature of 48.9 ± 1.7°C throughout the active portion of the chamber.

6.7.3.3 *Crystallizing Dishes,* six, glass, 90 mm in diameter by 50 mm in height.

6.7.3.4 *Containers,* six, glass, polyethylene or polypropylene, with screw cap or friction top lid capable of sealing, 127 mm in normal diameter and 76 mm in nominal height. Rubber gloves, clean and in good condition.

6.7.3.5 *Chemicals*—Reagent grade chemicals shall be used in all test. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[4]

6.7.3.6 *Water,* sterilized and either deionized or distilled water.

6.7.3.7 *Test Coupons*—Two, 3003 bare aluminum alloy, zero temper. Two, ASTM B152, Type ETP, Cabra number 110 soft copper. Two, low-carbon, commercial quality, cold-rolled, less than 0.30 % carbon, shim steel. Each coupon shall be 50.8 by 50.8 by 0.076 mm thick, free of tears, punctures, or crimps. Six coupons shall be used for one test of the insulation.

6.7.3.8 *Sampling*—Samples of spray-applied cellulose insulation used for testing shall be blown, combed, or otherwise mixed to reasonably assure homogeneity of the sample.

6.7.4 *Procedure for Precleaning Metal Coupons:*

6.7.4.1 During fabrication, cleaning, or testing never touch the metal coupons with ungloved hands. Handle cleaned coupons with clean forceps.

6.7.4.2 In order to avoid exposing laboratory personnel to toxic fumes perform all cleaning in a fume hood.

6.7.4.3 Clean the coupons by vapor degreasing with 1-1-1 trichlorethane for 10 min. Following vapor degreasing subject the coupons to caustic or detergent washing, or both, as appropriate. Following caustic or detergent washing, rinse the coupons in flowing water to remove residues. Inspect each coupon for a water-break free surface. (A water-break is a separation, beading, or retraction of the water film as the coupon is held vertically after wetting.) As the coupons are cleaned, the water film will become gradually thinner at the top and heavier at the bottom. Hot-air dry the coupons at 105°C.

6.7.5 *Preparation of Test Samples:*

6.7.5.1 For each metal coupon, subdivide a 20 g sample of insulation into two 10 g portions. For Type I materials: determine the amount of liquid adhesive concentrate that would be mixed with 10 g of dry material. To this adhesive, add sufficient water to make 75 mL of solution for each 10 g sample. For Type II materials: since the dry adhesive is already present, no special preparation is required. Presaturate each 10 g portion with 75 mL of water for Type II materials (or 75 mL of adhesive/water solution for Type I materials). Place one presaturated 10 g portion into a crystallizing dish on the metal coupon and tamp the composite specimen (metal coupon and saturated insulation in the crystallizing dish), tamp level using the bottom of a clean suitably sized glass beaker. Place a metal coupon onto the presaturated insulation portion and center it in a horizontal plane. Place the other presaturated 10 g portion into the crystallizing dish to ensure an even distribution of this material and to ensure good contact of the insulation with metal. Exercise care in preparing the composite specimens to eliminate air pockets from forming next to the metal coupons.

6.7.5.2 Do not cover the crystallizing dish. Care shall be taken to avoid evaporation from the composite during preparation and until it is placed in the testing chamber. Prior to placing in the test chamber, the composite specimen shall be weighed to the nearest 0.1 g.

6.7.6 *Sample Test Cycle*—Use either a humidity chamber (Test Method A) or an oven (Test Method B) to provide for the required temperature and relative humidity exposure.

6.7.7 *Test Method A*—Test Method A is provided for compliance with federal standards when required.

6.7.7.1 Precondition the humidity chamber to 48.9 ± 1.7°C and 95 ± 3 % relative humidity.

6.7.7.2 Place all six composite samples in the humidity chamber. Keep the samples in the humidity chamber 336 ± 4 h. During the test cycle, periodically monitor the temperature and humidity.

[4] *ACS Reagent Chemicals, Specifications and Procedures for Reagents and Standard-Grade Reference Materials*, 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. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

6.7.7.3 If dripping of condensate occurs within the humidity chamber, position guards over the samples to prevent the condensate from falling onto the samples.

6.7.8 *Test Method B:*

6.7.8.1 Precondition the oven to 48.9 ± 1.7°C.

6.7.8.2 Place the crystallizing dishes containing the composite sample in separate 127 mm diameter containers.

6.7.8.3 Add 70 mil of distilled water solution plus 25 g of potassium sulfate to the annular space between the crystallizing dish and the container. If any of the solution is inadvertently added to the composite sample, prepare a new composite.

6.7.8.4 Loosely place the covers on the containers and preheat the containers 1 h in the oven at 48.9 ± 1.7°C. After preheating, seal the containers in the oven 336 ± 4 h. During the test cycle, periodically monitor the temperature.

6.7.8.5 *Post-Test Cleaning of the Metal Coupons*—After completing the test cycle, the composite specimens shall be weighed to the nearest 0.1 g. Disassemble the composite specimens and thoroughly wash the metal coupons under running water and lightly brush them using a soft nylon bristle brush or equivalent to remove loose corrosion products. Remove the remaining corrosion products from the metal coupons by cleaning them as follows in a fume hood:

6.7.9 *Technique Number 1–Electrolytic Cleaning*—(For copper, steel, and aluminum coupons.) Electrolyze the coupons by making a solution containing 28 mL of sulfuric acid (sp gr 1.34), 2 mL of organic inhibitor, for example, about 0.5 g of such inhibitors as diorthotolyl thiourea, quinoline ethiodide, or betanaphthol quinoline, and 970 mL of water. Maintain the solution at 75 ± 2°C. Use carbon or lead for the anode and one metal coupon for carbon or lead. Electrolyze for 3 minutes at a current density of 20 A/cm^2. **Warning—**If using lead anodes, lead may deposit on the coupon. If the coupon is resistant to nitric acid, remove the lead by a flash dip in a solution of equal parts nitric acid and water.**Warning—** To avoid injury when mixing acid and water, for electrolytic cleaning gradually pour the acid into the water with continuous stirring, and provide cooling if necessary.

6.7.10 *Technique Number 2–Copper*—(This technique or Technique Number 1 shall be used for postcleaning only the tested copper coupons.) Make a solution containing 500 mL of hydrochloric acid (sp gr 1.19), 100 mL of sulfuric acid (sp gr 1.84), and 400 mL of water. **Warning—**To avoid injury, prepare the solution by slowly adding the sulfuric acid to the water with continuous stirring. Cool, then add the hydrochloric acid slowly with continuous stirring. The solution shall be at room temperature. Dip the coupons in the solution for 1 to 3 min.

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6.7.11 *Technique Number 3–Steel*—(This technique or Technique Number 1 shall be used for postcleaning only the tested steel coupons.) Use one of the following two solutions:

6.7.11.1 *Solution Number 1*—Add 100 mL of sulfuric acid (sp gr 1.84), 1.5 mL of organic inhibitor, and water to make a 1-L solution. Maintain the solution at 50 ± 2°C. Dip the coupons in this solution.

6.7.11.2 *Solution Number 2 (Clarke's solution)*—Add 20 g of antimony trioxide and 50 g of stannous chloride to 1 L of hydrochloric acid (sp gr 1.19). Stir the solution and use it at room temperature. Dip the coupons for up to 25 min in this solution, stirring the solution at a rate so that deformation of the coupons does not occur.

6.7.12 *Technique Number 4–Aluminum*—(This technique or Technique Number 1 can be used for postcleaning only the tested aluminum coupons.) Make a 1-L solution by adding 20 g of chromic acid and 50 mL of phosphoric acid (sp gr 1.69) to water. Maintain the solution at 80 ± 2°C. Dip the coupons in this for 5 to 10 min. If a film remains, dip the coupons in nitric acid (sp gr 1.42) for 1 min. Repeat the chromic acid dip. If there are no deposits, use nitric acid alone.

6.7.13 *Inspection*—After cleaning the metal coupons, examine the coupons over a 40 W appliance light bulb for perforations. Ignore notches that extend into the coupon 3 mm or less from any edge.

6.7.14 *Report*—The report shall include the following:

6.7.14.1 Description of the insulation tested,

6.7.14.2 ASTM test method used,