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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.

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

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

C739 Specification for Cellulosic Fiber Loose-Fill Thermal Insulation

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.

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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.

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 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 Specification C739, 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 *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 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 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 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.

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

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.

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:

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

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 *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 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 on Analytical

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.

Reagents of the American Chemical Society, where such specifications are available.[3]

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 is to be kept for no more than four months at 6± 4°C 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 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 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 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 is to be prepared fresh each day, or be held at 6 ± 4°C 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 at a relative humidity of no less than 95 % and examine these controls after seven days of such incubation. There shall 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 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 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 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 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 wide by 111 mm deep by 190 mm high. The holder is then placed in an autoclavable 1.2 mil (0.003 cm) thick polypropylene bag measuring 305 by 610 mm. A small amount (approximately 50 mL) of water is placed in the bottom of the bag, and the bag is sealed with clamps or other means and is placed in an incubator or oven at 30 ± 1°C .

6.6.5.9 *Inspection*—At the end of the incubation period, the test and comparative item shall be removed from the test chamber and examined at 40 × magnification.

6.6.6 *Report*—Report the growth observed on each of the three samples as being less than, equal to, or greater than the growth observed on the comparative item.

6.6.7 *Precision and Bias*—No statement is made about the precision and bias of this test method since it is a qualitative method and no numerical value is obtained.

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[3] *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.

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.[3]

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.

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.

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,

6.7.14.3 The absence or presence of perforations through the metal coupons. Notches extending into the coupon 3 mm or less from any edge shall be ignored. The absence or presence of perforation by type of metal coupon will also be reported.

6.7.15 *Precision and Bias*—A precision and bias statement is not applicable to this test method because the test produces pass/fail results, not numerical results.

6.8 *Moisture Vapor Sorption:*

6.8.1 *Scope*—This test method describes a procedure for determining the percent moisture absorbed from the atmosphere by the product under laboratory conditions.

6.8.2 *Significance and Use*—The inherent property of cellulosic fiber to exchange water with the atmosphere, and the possible use of hygroscopic chemicals in fire retardants are factors necessitating testing of production lots of insulation for moisture sorption capability.

6.8.3 *Apparatus:*

6.8.3.1 *Specimen Container,* constructed so as to conform to the specimen holder in 6.5.3.1.

6.8.3.2 *Humidity Chamber,* constructed so as to shield the sample from condensate drip and capable of maintaining the following two sets of conditions: 49 ± 1.7°C and 50 ± 5 % relative humidity, and 49 ± 1.7°C and 90 ± 5 % relative humidity.

6.8.3.3 *Balance,* capable of weighing sample and container to nearest 0.2 g.

6.8.4 The test sample shall be randomly selected from one production lot of insulation.

6.8.5 *Procedure*—Moisture vapor absorption shall be determined on a sample within the ±10 % manufacturer's design density.

6.8.6 *Sample Preparations*—The sample shall be prepared as described in Section 5 and 6.5.7.2. Record weight of sample being tested to within 0.2 g.

6.8.7 *Density*—Calculate the density of the sample as follows:

$$D = W/V \tag{2}$$

where:

D = density, kg/m^3,
W = weight of sample, kg, and
V = volume of sample, m^3.

6.8.8 Insert sample into the specimen holder.

6.8.9 Condition this test material at 49 ± 1.7°C and 50 ± 5 % relative humidity to a constant weight and record the weight (W_1). Constant weight has been achieved when successive weighings vary no more than 1 % in a 24-h period.

6.8.10 Increase the relative humidity to 90 ± 5 %. Retain the test specimen in this condition for a period of 24 h, at the end of which remove the test specimen and weigh immediately. Record the weight as W_2.

6.8.11 *Calculation*—Calculate the moisture absorbed as follows:

$$M = W_2 - W_1/\left(W_1 - W_3\right) \times 100 \tag{3}$$

where:

M = percent moisture absorbed,
W_1 = weight of container and specimen after conditioning at 50 % relative humidity, g,
W_2 = weight of container and specimen after conditioning at 90 % relative humidity, g, and

W_3 = weight of the empty container, g.

6.8.12 *Report*—The report shall contain the following:

6.8.12.1 Percentage by weight of moisture absorbed.

6.8.12.2 Sample identification and date of manufacture.

6.8.12.3 Density at which sample was tested.

6.8.12.4 Test conditions, temperature, relative humidity, and exposure time.

6.8.13 *Precision and Bias*—The precision of this test method is not known because interlaboratory data is not available. Interlaboratory data is being obtained, and a precision statement will be added when the data becomes available.

6.9 *Odor Emission:*

6.9.1 *Scope*—This test method covers the determination of the existence, nature, and degree of odors present in Type I and Type II spray-applied cellulosic based thermal/accoustical insulation.

6.9.2 *Significance and Use*—Thermal insulating materials that produce objectionable odors could cause discomfort to persons occupying a structure insulated with such materials. Therefore, an examination to determine the odor potential of a particular insulation is desirable.

6.9.3 *Apparatus*—Containers shall be either all stainless steel or glass with tight-fitting lids. Containers must produce no discernible odor of their own. Capacity of containers shall be a minimum of 50 g of the material to be tested.

6.9.4 *Sampling*—Unless otherwise specified by the purchaser, one sample of the material to be tested shall be selected at random. Each sample shall be cured and cut to produce a cross section of either the Type I or Type II spray applied insulation containing minimum of 50 g of insulation.

6.9.5 *Procedure:*

6.9.5.1 Condition samples to constant mass, at 23 ± 3°C.

6.9.5.2 Insert the sample into a test container and firmly replace the lid. Subject each closed container to a temperature of 65 ± 1.7°C for a period of 30 min.

6.9.5.3 A panel of five persons having normal odor perception shall open the test container and examine for odor.

6.9.5.4 The panel members shall answer the following questions regarding the sample examined:

Was a perceptible odor present?

Yes ________ No________

If so, was the odor:

objectionable ________ pleasant ________ neutral ________

Odor was:

weak _________ strong _________ neutral _________

6.9.6 *Report*—A test report shall be prepared indicating whether the tested material passed or failed in the majority opinion of the panels selected. The report shall also include the compiled panel opinions as above.

6.9.7 *Precision and Bias*—No statement is made about either the precision or bias of this odor emission test method since the results only determine whether the material emits an objectional odor or not. See Note 1.

NOTE 1—Panel members shall be persons who have demonstrated an ability to detect odors accurately and consistently. A recommended method for selecting panel members is given in the paper. "The Selection of Judges of Odor Emission Panels."[4]

6.9.7.1 No statement is made about the precision of this test method for determining the presence of odor since it is a qualitative method only and no numerical value is obtained.

6.9.7.2 The bias of this test method is being established.[4]

6.10 Air erosion will be determined by Test Method E859.

6.11 Substrate deflection shall be determined in accordance with Test Method E759.

7. Packaging, Delivery, and Storage

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

7.2 Material shall be stored under cover in a dry and clean location. Delivered materials which have been exposed to water before use or are otherwise not suitable for use shall be removed from the job site and replaced with acceptable materials.

8. Installation

8.1 Sprayed thermal insulation material shall be applied in strict conformance with the manufacturer's written instructions, and in conformance with all applicable codes.

8.2 Material shall be applied within the temperature limitations of the manufacturer's written instructions.

9. Inspection

9.1 The testing protocols herein are meant to be qualification requirements solely, this specification is not intended to be used as field inspection; any other inspection shall be as agreed upon the by the purchaser and the seller as part of the purchase contract.

10. Keywords

10.1 cellulose; self-supporting thermal insulation; spray-applied

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[4] Wittes , J., and Turk, A.,*"The Selection of Judges for Odor Discrimination Panels," Correlation of Subjective-Objective Methods in the Study of Odors and Taste*, ASTM STP 440, ASTM, 1968, pp. 49–70.

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