Designation: E2231 – 21

An American National Standard

Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics[1]

This standard is issued under the fixed designation E2231; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice describes procedures for specimen preparation and mounting when testing pipe and duct insulation materials to assess flame spread and smoke development as surface burning characteristics using Test Method E84.

1.2 If the pipe or duct insulation materials to be tested are reflective insulation materials (see 3.2.10 and 3.2.11), the materials shall be tested using the procedures for specimen preparation and mounting described in Practice E2599 and not the procedures described in 6.1 through 6.6.

1.3 Testing is conducted with Test Method E84.

1.4 This practice does not provide pass/fail criteria that can be used as a regulatory tool.

1.5 Use the values stated in inch-pound units as the standard, in referee decisions. The values in the SI system of units are given in parentheses, for information only; see IEEE/ASTM SI-10 for further details.

1.6 This fire standard cannot be used to provide quantitative measures.

1.7 Fire testing of products and materials is inherently hazardous, and adequate safeguards for personnel and property shall be employed in conducting these tests. Fire testing involves hazardous materials, operations, and equipment. This standard gives instructions on specimen preparation and mounting, but the fire-test-response method is given in Test Method E84. See also Section 8.

1.8 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered requirements of the standard.

1.9 *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.*

1.10 *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

C1186 Specification for Flat Fiber-Cement Sheets

C1224 Specification for Reflective Insulation for Building Applications

C1396/C1396M Specification for Gypsum Board

E84 Test Method for Surface Burning Characteristics of Building Materials

E176 Terminology of Fire Standards

E2599 Practice for Specimen Preparation and Mounting of Reflective Insulation, Radiant Barrier and Vinyl Stretch Ceiling Materials for Building Applications to Assess Surface Burning Characteristics

IEEE/ASTM SI-10 International System of Units (SI) The Modernized Metric System

2.2 *UL Standards:*

UL 181 Standard for Safety for Factory-Made Air Ducts and Connectors[3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice refer to the terminology contained in Terminology E176.

3.2 *Definitions of Terms Specific to This Standard:*

[1] This practice is under the jurisdiction of ASTM Committee E05 on Fire Standards and is the direct responsibility of Subcommittee E05.22 on Surface Burning.

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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] Available from Underwriters Laboratories (UL), Corporate Progress, 333 Pfingsten Rd., Northbrook, IL 60062.

3.2.1 *composite, n—as related to a pipe or duct insulation*, see *duct insulation system* or *pipe insulation system*.

3.2.2 *duct, n—as related to heating ventilating, air conditioning or exhaust systems*, a passageway made of sheet metal or other suitable material used for conveying air or other gases.

3.2.3 *duct insulation system, n—as related to fire testing*, system intended to insulate and cover, continuously for an extended length, the outside surface of a duct; the system shall have an insulation core, with or without a covering or vapor retarder facing which includes longitudinal closure systems (if used) and perhaps other duct insulation supplementary materials such as adhesives, fasteners, or tapes (if used).

3.2.3.1 *Discussion*—Duct system components, including tapes, sealants, and fitting covers, that do not cover the duct continuously for an extended length, but which are associated with the duct insulation system are considered separately (see duct insulation supplementary materials). An extended length is not intended to imply a length of 25 ft, but a length of at least 3 ft.

3.2.4 *duct insulation supplementary materials, n—as related to fire testing*, components, including tapes and sealants used for transverse joints as well as fitting covers that are intermittently spaced, as needed, within the duct insulation system, as well as adhesives used to bond the insulation to the duct substrate and that do not cover the duct continuously for an extended length.

3.2.5 *duct lining, n*—material such as an insulation, coating or film, including adhesive, used to line the inside surface of a duct.

3.2.6 *insulation blanket, n*—a relatively flat and flexible insulation in coherent sheet form furnished in units of substantial area.[4]

3.2.7 *pipe, n—as related to heating, ventilating, or air conditioning systems*, a cylindrical conduit for the conveyance of liquids or semi-solids.

3.2.8 *pipe insulation system, n—as related to fire testing*, system intended to insulate and cover, continuously for an extended length, the outside surface of a pipe; the system shall have an insulation core, with or without a covering or vapor retarder facing which includes longitudinal closure systems (if used) and perhaps other pipe insulation supplementary materials such as adhesives, fasteners, or tapes (if used).

3.2.8.1 *Discussion*—Pipe system components, including tapes, sealants, and fitting covers, that do not cover the pipe continuously for an extended length, but which are associated with the pipe insulation system are considered separately (see pipe insulation supplementary materials). An extended length is not intended to imply a length of 25 ft, but a length of at least 3 ft.

3.2.9 *pipe insulation supplementary materials, n—as related to fire testing*, components, including tapes and sealants used for transverse joints as well as fitting covers that are intermittently spaced, as needed, within the pipe insulation system, as well as adhesives used to bond the insulation to the pipe substrate and that do not cover the pipe continuously for an extended length.

3.2.10 *reflective insulation, n*—thermal insulation consisting of one or more low emittance surfaces bounding one or more enclosed air spaces.

3.2.10.1 *Discussion*—Reflective insulation materials are defined in Specification C1224.

3.2.11 *reflective plastic core insulation, n*—an insulation material packaged in rolls, that is less than 0.5 in. (12.7 mm) thick, with at least one exterior low emittance surface (0.1 or less) and a core material containing voids or cells.

3.2.11.1 *Discussion*—Reflective plastic core insulation materials are one specific type of reflective insulation materials.

3.2.12 *self-supporting specimen, n*—a specimen that remains in place by its own structural characteristics both before and during the fire test.

4. Summary of Practice

4.1 This practice describes procedures for specimen preparation and mounting when testing pipe and duct insulation materials to assess flame spread and smoke development as surface burning characteristics using Test Method E84.

4.2 Pipe or duct insulation systems (or composites related to pipe or duct insulation) consist of an insulation core, with or without a jacket, and with or without an adhesive. Pipe or duct insulation systems shall be tested in accordance with the specimen preparation and mounting procedures described in this practice, using Test Method E84.

4.3 Supplementary materials for pipe or duct insulation systems, including tapes, joint sealants, and fitting covers, that are intermittently spaced, shall be tested for flame spread and smoke development as single-component systems, using Test Method E84.

5. Significance and Use

5.1 Pipe and duct insulation systems are often evaluated with Test Method E84 to comply with building or mechanical code requirements. This practice describes, in detail, specimen preparation and mounting procedures for single-component pipe or duct insulation systems and for multi-component pipe or duct insulation systems.

5.2 The material, system, composite, or assembly tested shall be representative of the completed insulation system used in actual field installations, in terms of the components, including their respective thicknesses.

5.3 Pipe and duct insulation systems consist of a variety of materials and constructions.

5.4 Some testing laboratories have developed a number of protocols for testing pipe or duct insulation systems which utilize one generic type of materials, all of them with an insulation core and a jacket. Those protocols are the origin of this practice, which makes them generic, to reduce material bias in the standard; they have resulted in the procedures presented in 6.1. The procedures presented in 6.2 – 6.5 address other types of pipe or duct insulation systems.

[4] This definition is similar to the definition of "blanket insulation" in Terminology C168 from committee C16 on Thermal Insulation.

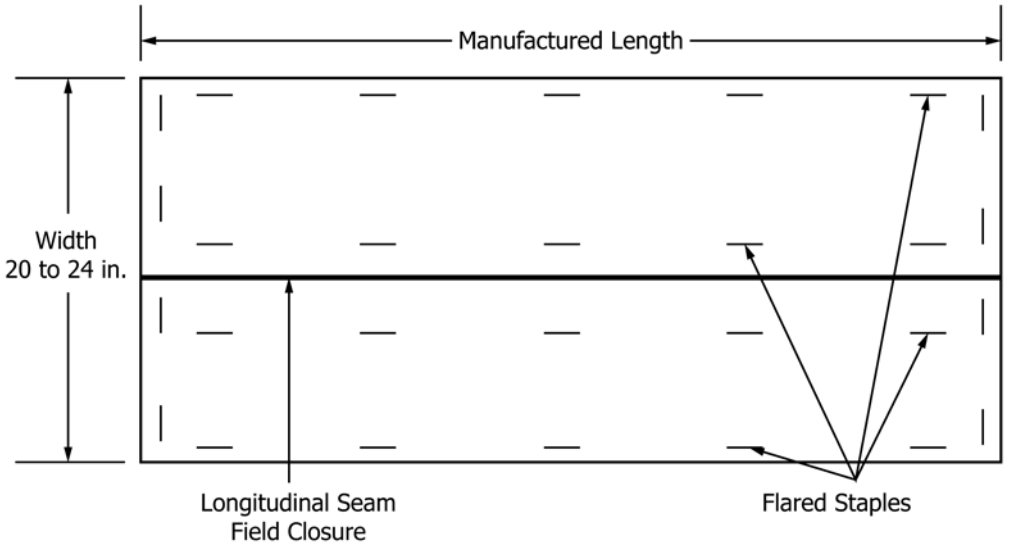

FIG. 1 Insulation and Jacket with No Adhesive (see 6.1.1.1)

5.5 This practice addresses specimen preparation and mounting of systems of the types described in 5.5.1 – 5.5.3 and testing of supplementary materials as described in 5.6.

5.5.1 Multi-component systems containing an insulation core and a jacket, with or without adhesive between insulation core and jacket, not intended to be bonded to a pipe or duct substrate. Specimen preparation and mounting for such systems is described in 6.1 if they are self-supporting and in 6.2 if they are not self-supporting.

5.5.2 Single component systems, not intended to be bonded to a pipe or duct substrate. Specimen preparation and mounting for such systems is described in 6.3 if they are self-supporting and in 6.4 if they are not self-supporting.

5.5.3 Systems intended to be bonded to a pipe or duct substrate. Specimen preparation and mounting for such systems is described in 6.5.

5.5.4 Reflective insulation materials (see 3.2.10 and 3.2.11) intended to be used as pipe or duct insulation materials and installed with an air gap shall be tested using the procedures for specimen preparation and mounting procedures described in Practice E2599. Reflective insulation materials intended to be used as pipe or duct insulation materials and installed without an air gap shall be tested using the specimen preparation and mounting procedures described in Section 6 of this practice.

5.5.5 Specimen preparation and mounting procedures for systems not described in this practice shall be added as the information becomes available.

5.6 *Supplementary Materials:*

5.6.1 It is recognized that supplementary materials for pipe or duct insulation systems are normally able to generate heat, flame or smoke. Thus, the fire safety of the entire system depends, at least to some extent, on the fire performance of supplementary materials. Consequently, the fire-test-response characteristics of all supplementary materials shall be assessed to obtain a full assessment of the fire-test-response of the pipe or duct insulation system. See Appendix X1.

5.6.2 Supplementary materials are often present intermittently spaced, and not for an extended length, in a pipe or duct insulation system. Thus, it is not always possible to suitably test them in conjunction with a pipe or duct insulation system.

5.6.3 *Testing of Supplementary Materials*—Supplementary materials that have not been fully tested in conjunction with the pipe or duct insulation system, in accordance with Section 6, shall be tested for flame spread and smoke development as single-component systems, in accordance with Test Method E84.

5.7 The limitations for this procedure are those associated with Test Method E84.

6. Specimen Preparation and Mounting

6.1 Self-supporting multi-component systems, not intended to be bonded to a pipe or duct substrate:[5]

6.1.1 Hollow cylindrical insulation core inside a jacket, with a longitudinal joint system, to be used without adhesive between jacket and insulation core:

6.1.1.1 In this construction, the insulation board specimens, 20 in. to 24 in. (510 mm to 610 mm) by the appropriate length, shall be produced in a flat cross-section with the jacket (facing) with a seam created at the approximate longitudinal centerline using the same method of closure used in actual field installations. The jacket (facing) shall be mechanically attached to the insulation core using 0.5 in. (13 mm) divergent point steel flared staples. The staples shall be applied, around the perimeter of the board, at 6 in. ± 3 in. (152 mm ± 76 mm) on center spacing, as well as adjacent to and along both sides of the longitudinal seam, at approximately 1 in. from the seam (see Fig. 1).

[5] The specimen preparation and mounting procedures in 6.1, including potentially slitting the facing or jacket, mirror those used by Underwriters Laboratories, and described in their documents "BRER GuideInfo—Pipe and Equipment Coverings—[Building Materials] (Surface Burning Characteristics)" and "BIYR GuideInfo—Acoustical Materials—[Building Materials] (Surface Burning Characteristics)." Similar concepts are also used in the testing of Factory-made Air Ducts and Air Connectors by Test Method E84 in UL 181.

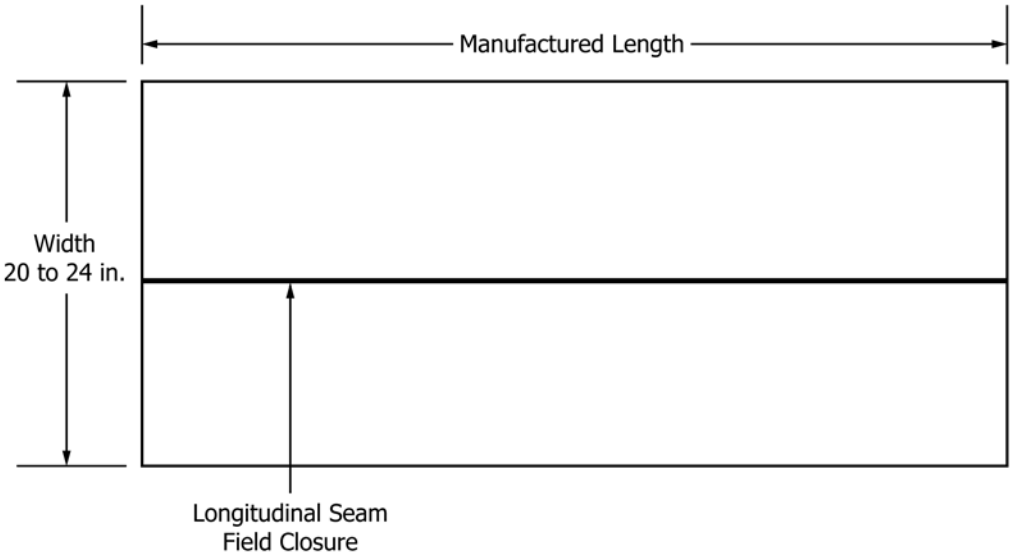

FIG. 2 Insulation and Jacket with Full Coat Adhesive (see 6.1.2.1 and 6.1.4.1)

6.1.1.2 Mount the specimens on the ledges of the Test Method E84 furnace without using an auxiliary support mechanism.

6.1.2 Hollow cylindrical insulation core inside a jacket, with a full coat adhesive attaching the jacket to the insulation core:

6.1.2.1 In this construction, the insulation board specimens, 20 in. to 24 in. (510 mm to 610 mm) by the appropriate length, shall be produced in a flat cross-section with the jacket (facing) adhered to one side of the insulation core (see Fig. 2).

6.1.2.2 Each test shall be conducted using a factory or field joint along the longitudinal centerline of the test specimen, with a longitudinal seam created in the approximate centerline using the same method of closure used in actual field installations.

6.1.2.3 It shall be permitted to represent the field joint by introducing a longitudinal slit cut along the longitudinal centerline of the specimen jacket and applying the manufacturer's recommended field closure system (if applicable).[6]

6.1.2.4 For each test, mount the specimens on the ledges of the Test Method E84 furnace without using an auxiliary support mechanism.

6.1.3 Hollow cylindrical insulation core inside a jacket, with longitudinal adhesive beads or stripes in a stitch pattern attaching the jacket to the insulation core:

6.1.3.1 In this construction, the insulation board specimens, 20 in. to 24 in. (510 mm to 610 mm) by the appropriate length, shall be produced in a flat cross-section with the jacket (facing) laminated to one side of the insulation core. The adhesive bead or stripe spacing shall be the same as used in the actual field installation. Divergent point steel flared staples, 0.5 in. (13 mm) in size, shall be applied, around the perimeter of the board, at 6 in. ± 3 in. (152 mm ± 76 mm) on center spacing, as well as adjacent to and along both sides of the longitudinal seam, at approximately 1 in. from the seam (see Fig. 3).

6.1.3.2 For each test, mount the specimens on the ledges of the Test Method E84 furnace without using an auxiliary support mechanism.

6.1.4 Insulation core board with a jacket laminated to the insulation:

6.1.4.1 In this system the resulting longitudinal seam shall be closed with either an adhesive tape or a vapor retarder lap adhesive. In this construction, the insulation board specimens, 20 in. to 24 in. (510 mm to 610 mm) by the appropriate length, shall be produced in a flat cross-section with the jacket (facing) laminated to one side of the insulation core (see Fig. 2).

6.1.4.2 Each test shall be conducted using a factory or field joint along the longitudinal centerline of the test specimen, with a longitudinal seam created in the approximate centerline using the same method of closure used in actual field installations.

6.1.4.3 It shall be permitted to represent the field joint by introducing a longitudinal slit cut along the longitudinal centerline of the specimen jacket and applying the manufacturer's recommended field closure system (if applicable).[6]

6.1.4.4 For each test, mount the specimens on the ledges of the Test Method E84 furnace without using an auxiliary support mechanism.

6.1.5 Hollow cylindrical insulation core inside a jacket laminated to the outer circumference of the insulation core, with the jacket (facing) attached to the insulation core by means of a longitudinal adhesive stripe pattern, on opposite sides of the longitudinal seam:

6.1.5.1 In this construction, the insulation board specimens, 20 in. to 24 in. (510 mm to 610 mm) by the appropriate length, shall be produced in a flat cross-section with the jacket (facing) laminated to one side of the insulation core. The adhesive bead or stripe spacing shall be the same as used in the actual field installation. Divergent point steel flared staples, 0.5 in. (13 mm) in size, shall be applied, around the perimeter of the board, at 6 in. ± 3 in. (152 mm ± 76 mm) on center spacing, as well as adjacent to and along both sides of the longitudinal seam, at approximately 1 in. from the seam (see Fig. 3).

[6] This testing is intended to investigate the contribution of all combustibles to the flame spread and smoke developed by the system to be used in the actual field installation.

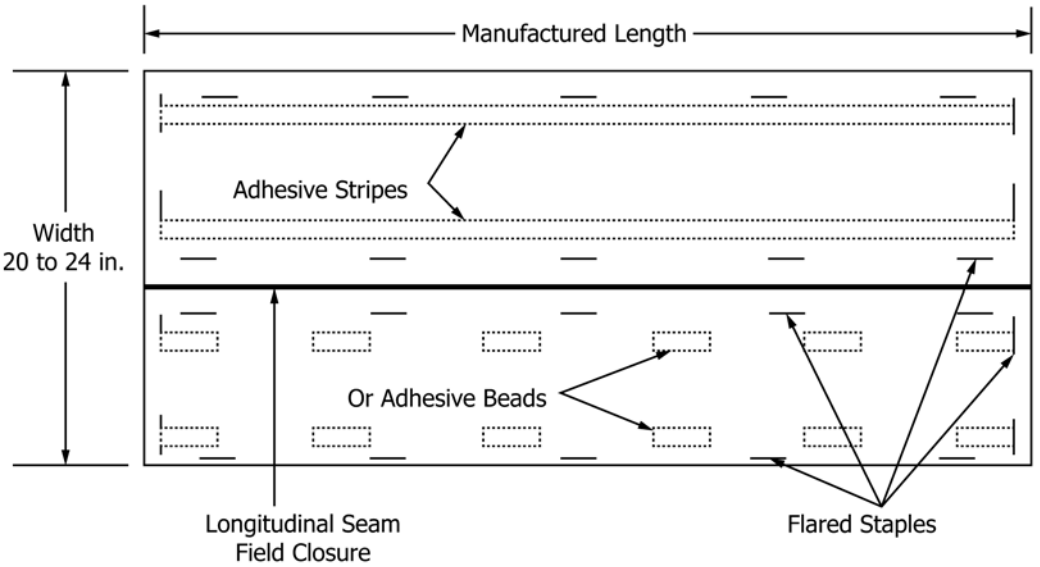

FIG. 3 Insulation and Jacket with Longitudinal Adhesive Stripes or Beads (see 6.1.3.1 and 6.1.5.1)

6.1.5.2 For each test, mount the specimens on the ledges of the Test Method E84 furnace without using an auxiliary support mechanism.

6.1.6 Insulation core inside an overlapping jacket laminated to the outer circumference of the insulation core with transverse adhesive stripes. The jacket (facing) shall be attached to the insulation core by means of a transverse adhesive stripe pattern, with the resulting longitudinal seam closed with either an adhesive tape or a vapor retarder lap adhesive.

6.1.6.1 In this construction, the insulation board specimens, 20 in. to 24 in. (510 mm to 610 mm) by the appropriate length, shall be produced in a flat cross-section with the jacket (facing) laminated to one side of the insulation core using the same transverse adhesive stripe spacing as used in the actual insulation system. A longitudinal seam shall be created in the approximate center of the specimen, using the same method of closure as used in the actual insulation system. If necessary, 0.5 in. (13 mm) divergent point steel flared staples shall be applied around the perimeter of the board, at 6 in. ± 3 in. (152 mm ± 76 mm) on center longitudinal spacing (See Fig. 4).

6.1.6.2 For each test, mount the specimens on the ledges of the Test Method E84 furnace without using an auxiliary support mechanism.

6.2 Non self-supporting, multi-component systems not intended to be bonded to a pipe or duct substrate:

6.2.1 In all of these constructions, the test specimens shall be prepared as described in 6.1.1 – 6.1.6 (as appropriate).

6.2.2 If the physical characteristics of the core material (or blanket) permit, and the core material (or blanket) is at least 1 in. (25 mm) thick[7], for each test, insert steel rods, 0.25 in. (6 mm) in diameter by 20 in. to 24 in., (510 mm to 610 mm) in length, through the material, so that the bottom of the rod is approximately 0.25 in. (6 mm) from the surface to be exposed to the flame. The steel rods shall be placed at approximately 2 ft (0.6 m) intervals starting with the fire end of the panel, approximately 2 in. (51 mm) from the end of the test specimen.[8]

6.2.3 If the physical characteristics of the core material are such that they do not permit insertion of steel rods through it, and the material has a jacket, mount the test specimens on sheet metal, held in place with stick pins or speed-clips. The stick pins or speed-clips shall be placed in two longitudinal rows, centered across the width of the test specimen.

6.2.3.1 If the test specimen sections are 4 ft (1.2 m) or longer, the spacing of the stick pins or speed-clips shall be at approximately 2 ft. (0.6 m) intervals starting with the fire end of the panel.

6.2.3.2 If the test specimen sections are less than 4 ft (1.2 m) in length, the spacing of the stick pins or speed-clips shall be at approximately 18 in. (0.45 m) intervals starting with the fire end of the panel.

6.2.4 For materials without a jacket, if the physical characteristics of the core material are such that they do not permit insertion of steel rods through it, or if the core material is less than 1 in. (25 mm) thick, for each test, mount the test specimens on the ledges of the Test Method E84 furnace by supporting the specimens on steel rods, 0.25 in. (6.3 mm) in diameter by 20 in. to 24 in. (510 mm to 610 mm) in length that span the width of the tunnel furnace. The steel rods shall be placed at approximately 2 ft (0.6 m) intervals starting with the fire end of the panel, approximately 2 in. (51 mm) from the end of the test specimen.[8]

6.2.5 For materials without a jacket, if visual observation indicates that the test specimen will not be adequately supported by steel rods as indicated in 6.2.2 or 6.2.4, mount the test specimens as described in 6.2.3 through 6.2.3.2.

[7] This mounting method, described in Annex A7 of Test Method E84, is intended for single-component batt or blanket materials that do not have sufficient rigidity or strength to support themselves and is inappropriate for materials less than 1 in. (25 mm) thick.

[8] The placement of steel rods within the tunnel is described in Annex A4 of Test Method E84.