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# Standard Specification for Externally Applied Reflective Insulation Systems on Rigid Duct in Heating, Ventilation, and Air Conditioning (HVAC) Systems[1]

This standard is issued under the fixed designation C1668; 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 specification covers the requirements and physical properties of reflective insulation systems applied externally to Rigid Heating, Ventilation, and Air Conditioning (HVAC) duct systems operating at or below 250ºF (121.1 °C). These insulation systems consist of one or more low-emittance surfaces, such as metallic foil or metallic deposits, mounted on substrates to produce reflective air spaces. Reflective insulation systems derive thermal performance from surfaces with an emittance of no greater than 0.1 facing enclosed air spaces.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *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

C335 Test Method for Steady-State Heat Transfer Properties of Pipe Insulation

C390 Practice for Sampling and Acceptance of Thermal Insulation Lots

C411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

C1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions

C1258 Test Method for Elevated Temperature and Humidity Resistance of Vapor Retarders for Insulation

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

C1371 Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers

E84 Test Method for Surface Burning Characteristics of Building Materials

E96/E96M Test Methods for Water Vapor Transmission of Materials

E2231 Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics

2.2 *Other Test Method:*

TAPPI Standard T-512 sp-02 Creasing of Flexible Packaging Material Paper Specimens for Testing[3]

## 3. Terminology

3.1 *Definitions:*

3.1.1 Unless otherwise noted, the terms used in this specification conform to Terminology C168.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *HVAC ducts*—as pertaining to this standard, ducts having rigid rectangular or circular cross-section used to transfer air from the air handling equipment to the conditioned space and return.

3.2.2 *insulation spacers*—material used to form enclosed air spaces that are interior to the reflective insulation system.

3.2.3 *reflective insulation*—thermal insulation consisting of one or more low emittance surfaces, bounding one or more enclosed air space(s). **C168**

## 4. Classification

4.1 Products covered by this specification are classified according to the substrate material and have the physical properties as listed in Table 1.

[1] This specification is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.21 on Reflective 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] Available from Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, http://www.tappi.org.

**TABLE 1 Classification Criteria**

| Property | Type A | Type B | Type C | Type D | Type E |
|---|---|---|---|---|---|
| Emittance | ≤ 0.10 | ≤ 0.10 | ≤ 0.10 | ≤ 0.10 | ≤ 0.10 |
| Max. Flame Spread Index | 25 | 25 | 25 | 25 | 25 |
| Max. Smoke Developed Index | 50 | 50 | 50 | 50 | 50 |
| Hot Surface Performance | Min. 250ºF | Min. 250ºF | Min. 250ºF | Min. 250ºF | Min. 250ºF |
| Water Vapor Permeance (perms) | 0.02 or less | 0.02 or less | 0.02 or less | 0.02 or less | 0.02 or less |

4.1.1 *Type A*—Product with polyethylene foam substrate.

4.1.2 *Type B*—Product with polyethylene bubble pack substrate.

4.1.3 *Type C*—Product with fiberglass substrate.

4.1.4 *Type D*—Product with polyester fiber substrate.

4.1.5 *Type E*—Product with kraft paper substrate.

## 5. Ordering Information

5.1 Specify the required thermal resistance.

5.2 Specify the number of layers of insulation, width, thickness of the insulation system and the configuration of the duct(s) to be insulated.

5.3 Special markings, when required, shall be specified.

5.4 Special performance requirements, when required.

## 6. Materials and Manufacture

6.1 Reflective insulation shall consist of low-emittance surface(s) with substrates and adhesives required to meet the specified thermal performance and physical properties. Air spaces shall be maintained by use of insulation spacers.

6.2 Multiple layer reflective insulation shall be designed to attain the intended separation of layers. The design separation shall be maintained by the use of proper size, location and method of securing the insulation spacers to the duct system.

6.3 *Dimensions*—Insulation and properly sized insulation spacers shall be furnished in dimensions specifically agreed upon between the producer and the buyer.

## 7. Physical Properties

7.1 *Emittance*—Low-emittance surfaces used for this insulation shall have a surface emittance of 0.1 or less, as determined in accordance with 10.1.

7.2 *Water Vapor Permeance*—The water vapor permeance shall be determined in accordance with 10.2 and shall meet the requirements of Table 1.

7.3 *Surface Burning Characteristics*—Surface Burning Characteristics shall be determined in accordance with 10.3. The maximum flame spread index shall not exceed 25 and the maximum smoke developed index shall not exceed 50.

7.4 *Aging Resistance*—The laminates of the reflective insulation shall be tested for aging resistance in accordance with 10.4. Three specimens shall be tested. The test specimens shall be shielded from condensate that drips from the ceiling of the humidity chamber during the test.

7.4.1 After exposure the specimens shall be evaluated for visible corrosion and delamination. For purposes of corrosion evaluation, disregard the outer 0.25 in. (6 mm) perimeter. No tested specimen shall exhibit visible corrosion or unaided delamination of layers.

7.4.2 After exposure re-measure the emittance of the samples. No test specimen shall have greater than 0.04 deviation from the original emittance measurement and must remain under 0.1.

7.5 *Adhesive Performance*—Adhesives when used shall show no sign of bleeding when tested in accordance with the test procedure in 10.5. Disregard bleeding at cut edges. Bleeding or delamination, shall be cause for rejection.

7.6 *Pliability*—Specimens tested in accordance with the procedure in 10.6 shall not show cracking or delamination.

7.7 *Fungi Resistance*—Specimens shall not have growth greater than the comparative item (southern yellow pine) when tested in accordance with 10.7. Use interpretation of results in 7.2 of Test Method C1338.

7.8 *Thermal Resistance*—Determine the thermal resistance in accordance with procedures in 10.8. The surface-to-surface R-value of a test assembly shall not be less than 95 % of the label value when tested in accordance with 10.8.

7.9 *Hot-Surface Performance*—Determine the Hot-Surface performance in accordance with procedures in 10.9. The minimum temperature requirement is 250ºF (121.1°C).

## 8. Workmanship, Finish, and Appearance

8.1 The insulation system shall be manufactured, packaged and shipped in such a manner that, when received, it shall be suitable for installation.

## 9. Sampling

9.1 Sampling shall be performed in accordance with Practice C390.

## 10. Test Methods

10.1 *Emittance*—The emittance of the product shall be tested in accordance with Test Method C1371.

10.2 *Water Vapor Permeance*—The permeance of the insulation product shall be tested in accordance with Test Method E96/E96M (Desiccant Method).

10.3 *Surface Burning Characteristics*—The surface burning characteristics shall be determined in accordance with Test Method E84 and Practice E2231.

10.4 *Aging Resistance*—The aging resistance of the product shall be determined in accordance with Test Method C1258.

10.5 *Adhesive Performance*

10.5.1 *Bleeding and Delamination:*

10.5.2 *Scope*—This test method covers the determination of bleeding and delamination of the reflective insulation.

10.5.3 *Significance and Use*—It is necessary that reflective insulation not show adhesive bleeding or delamination since there is a potential for loss of structural integrity, a change to the emittance or a change in water permeability, or both.

10.5.4 *Sampling*—A minimum of three specimens of the reflective insulation, with dimensions of approximately 3 by 6 in. (7.62 by 15.24 cm), shall be tested. The specimens shall be cut from separate locations on a roll or panel of the insulation.

10.5.5 *Procedure*—Suspend the specimens vertically in an oven and heat to a temperature of 356 ± 10°F (180 ± 5ºC) for at least 5 hours. Determine, under 5× magnification; has the adhesive bled or exuded through the surface, or has separation of the foil from substrate (delamination) occurred.

10.5.6 *Precision and Bias*—No information is presented about either precision or bias of this test method for determining Bleeding and Delamination, since the test results are non-quantitative.

10.6 *Pliability:*

10.6.1 *Scope*—This test method covers the determination of cracking or delamination of the reflective insulation due to folding and bending. Any reflective insulation product that does not require bending during installation shall be exempt from the requirements of this section.

10.6.2 *Significance and Use*—It is necessary that reflective insulation not crack or delaminate since these are contributing factors to loss of structural integrity and change in water permeability.

10.6.3 *Sampling*—A minimum of three specimens of the reflective insulation shall be subjected to two tests: one specimen shall contain a factory produced edge.

10.6.4 *Procedure*—Immediately prior to testing: *(a)* The specimens shall be conditioned at a temperature of 70 ± 2ºF (21.1 ± 1.1°C) and a relative humidity of 50 ± 5 % for a period of no less than 24 hours, for the first test. The second test shall be at 32 ± 2ºF (0 ± 1.1º C) for a period of no less than 24 hours. *(b)* The foil laminate shall be folded in accordance with TAPPI Standard T-512 sp-02 and the folded edge smoothed, using light finger pressure. The finished laminate shall not crack or delaminate when folded to an 180º bend.

10.6.5 *Precision and Bias*—No information is presented about either precision or bias of TAPPI Standard T-512 sp-02 for determining cracking or delamination, due to folding or bending, since the test is qualitative.

10.7 *Fungi Resistance*—The fungi resistance of the product shall be determined in accordance with Test Method C1338.

10.8 *Thermal Resistance*—The thermal performance of the reflective insulation system shall be determined for a representative specimen for a duct with a minimum dimension of 6-in. (15.24 cm) diameter or 6-in. (15.24 cm) square.

10.8.1 The thermal resistance of reflective insulation systems for duct application shall be determined in an apparatus meeting Test Method C335 and calculated using Equation 9 of Test Method C335. Thermal data shall be determined for a test specimen installed in accordance with the manufacturer's instructions. End-cap corrections, when utilized, shall meet the requirements of Test Method C335. The area used for the calculation of R-value shall be the exterior surface of the heated test apparatus.

10.8.2 The thermal resistance of a reflective duct insulation system depends on the mean temperature, emittance of the reflective surface(s), the size of the air space between the insulation and the duct surface, and any thermal value from the substrate. The R-value shall be determined over a range of mean temperatures that includes the labeling temperature of 75°F (23.9°C), and a ΔT of 30°F (13.1°C) or larger.

10.8.3 The measured surface-to-surface R-values and the corresponding mean temperatures of the reflective insulation assembly shall be used to obtain an equation relating the R-value to the mean assembly temperature using the Method of Least Squares as outlined in Practice C1045. The equation obtained in this manner shall be used to calculate the R-value evenly spaced 5ºF increments over a range that extends from a temperature that is no less than 25 % of the total measurement range below the lowest measured mean assembly temperature to no greater that 25 % of the total measurement range above the highest measured mean temperature. When a single R-value measurement is made at 75°F (23.9°C) mean and ΔT of 30°F (13.1°C) or greater that value shall be reported for the reflective insulation system.

10.8.4 The results to be reported as a result of applying 10.8.3 shall include all measured R-values and corresponding mean assembly temperatures. R-values shall be reported for the reflective insulation system for the region from the duct surface to the insulation outer surface.

10.8.5 The R-value used for labeling shall be the value at 75ºF (23.9°C) mean. Additional R-values at other mean temperatures are included as required for codes or design calculations.

10.9 *Hot-Surface Performance*—The Hot-Surface Performance shall be determined in accordance with Test Method C411. When multiple layers are required to obtain a given thermal value the first layer must sit on the test apparatus and all other layers including spacers shall be installed as manufacture's instructions.

## 11. Inspection

11.1 Inspection of the material shall be agreed upon between the purchaser and supplier as part of the purchase contract.

## 12. Rejection and Rehearing

12.1 *Requirements Determined by Visual Inspection*—Samples shall be inspected visually for mechanical damage as follows:

12.1.1 *Surface Punctures* shall not exceed one non-repairable puncture per 500 $ft^2$ (152.4 $m^2$).

12.1.2 *Damage* (bleeding, corrosion) to reflective properties of surface coatings shall not exceed 2 % of the insulated area.

12.1.3 *Improper Assembly* (when referenced to manufacturer's specifications) shall not exceed 1 % of area.

12.2 When inspection of reflective insulation specimens show failure to conform to the requirements of the purchase specification, a second specimen from the same lot shall be tested and the results of this retest averaged with the results of the original test.

12.3 Upon retest, as described in 12.2, material that fails to conform to the requirements of this specification shall be subject to rejection. Rejection shall be reported to the producer or supplier in writing. The producer or supplier has the right for a rehearing.

## 13. Packaging and Package Marking

13.1 All insulation products shall be packaged in a manner which will protect the reflective surfaces from physical damage during storage and transportation.

13.2 *Packaging Marking:*

13.2.1 All packages shall be marked to identify the manufactures name, address, and the products name and designation.

13.2.2 All packages shall be marked with a lot number.

13.2.3 A table of thermal resistance values, shall be included for the reflective insulation's intended temperature range of use.

13.2.4 All package marking shall indicate insulation width and length.

13.2.5 All package marking shall indicate the total area, square feet covered by the package contents, when installed according to the installation instructions per the manufacturer.

13.2.6 *Surface Burning Properties*—Flame spread and smoke developed indices.

## 14. Insulation Marking

14.1 Insulation shall be imprinted with the manufacturers or distributors name or trademark, or both.

14.2 Insulation shall be imprinted with the name of the manufacturer, R-values and the Flame Spread and Smoke Density index.

14.3 Insulation markings shall not exceed 1 % of the total surface area. Insulation markings shall be repeated at intervals not exceeding 36 in. (0.914 m).

## 15. Keywords

15.1 duct insulation; emittance; HVAC (heating, ventilation, air-conditioning); reflective air spaces; reflective insulation; reflective insulation spacers; reflective insulation system; R-value; thermal resistance