Designation: C 1224 – 03

Standard Specification for Reflective Insulation for Building Applications[1]

This standard is issued under the fixed designation C 1224; 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 general requirements and physical properties of reflective insulations for use in building applications. These insulation materials consist of one or more low emittance surfaces, such as metallic foil or metallic deposits, unmounted or mounted on substrates. Reflective insulations derive their thermal performance from surfaces with an emittance of 0.1 or less, facing enclosed air spaces.

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

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]

C 168 Terminology Relating to Thermal Insulation

C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

C 390 Practice for Sampling and Acceptance of Thermal Insulation Lots

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

C 727 Practice for Use of Reflective Insulation in Building Constructions

C 1258 Test Method for Elevated Temperature and Humidity Resistance of Vapor Retarders for Insulation

C 1338 Test Method for Determining Fungi Resistance of Insulation Materials and Facings

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

C 1371 Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers

E 84 Test Method for Surface Burning Characteristics of Building Materials

E 96 Test Methods for Water Vapor Transmission of Materials

2.2 *TAPPI Standard:*

T512 Creasing of Flexible Packaging Material Paper Specimens for Testing[3]

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

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

4. Ordering Information

4.1 Prior to purchase, for sampling and acceptance procedures, Practice C 390 can be agreed upon between the purchaser and the manufacturer.

4.2 Specify the required thermal resistance by the direction of the heat flow.

4.3 Specify the width, depth, and total area to be insulated.

4.4 Specify special markings, if required.

5. Materials and Manufacture

5.1 Reflective insulation materials shall consist of low emittance surface(s) with, or without, substrates and adhesives required to meet the specified thermal performance and physical properties.

5.2 Multiple layer reflective insulations shall be designed to attain the intended separation of layers in normal application. Such multiple layer insulation shall form an attachment flange suitable for stapling, or other means of attachment.

5.3 *Dimensions*—Insulation shall be furnished in dimensions to fit framing members, at spacings standard in the construction industry, or as specifically agreed upon between the producer and the buyer.

[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), P.O. Box 105113, Atlanta, GA 30348; 15 Technology Parkway South, Norcross, GA 30092.

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6. Physical Properties Requirements

6.1 Low emittance materials shall have a surface with an emittance of 0.1 or less, as determined in accordance with 9.1.

6.2 *Permeance*—If the reflective insulation is to serve as a vapor retarder, the permeance of the material shall not exceed one perm, as determined in accordance with 9.2.

6.3 *Surface Burning Characteristics*—Building code requirements specify flame spread and smoke development values determined in accordance with 9.3, except as follows:

(*1*) Maximum surface burning characteristics shall not exceed 25 flame spread index and 50 smoke development index in either marine or inside plenum applications.

(*2*) Maximum surface burning characteristics shall not exceed 25 flame spread index and 450 smoke development index in exposed building applications or other installations that may have specific requirements not covered by the building code.

6.4 *Humidity Resistance*—The laminates of the reflective insulation shall be tested in accordance with 9.4. Three specimens shall be exposed. Shield the test specimens from condensate that may drip from the ceiling of the humidity chamber.

6.4.1 The specimens shall be evaluated for visible corrosion and delamination. For purposes of corrosion evaluation, the outer 0.25 in. (6.4 mm) perimeter may be disregarded. No tested specimen shall exhibit visible crystalline deposits exceeding 2 % of the test area nor exhibit unaided delamination of layers.

6.5 *Adhesive Performance*:

6.5.1 *Bleeding*—Adhesives, when used, shall show no sign of bleeding when tested in accordance with the test procedure in 9.5.1. Bleeding at cut edges may be disregarded. Bleeding or delamination, covering over 2 % of the specimen area, shall be cause for rejection.

6.5.2 *Pliability*—Specimens tested in accordance with the test procedure in 9.5.2 shall not show cracking or delamination.

6.6 *Fungi Resistance*—Specimens shall not have growth greater than comparative item when tested in accordance with 9.6. Use Interpretation of Results (Paragraph 7.2) of Test Method C 1338.

6.7 *Thermal Resistance*—Determine the thermal resistance in accordance with procedures in 9.7. The results of the procedures shall indicate the R-value of the product, in the assembly tested.

7. Workmanship, Finish, and Appearance

7.1 The insulation shall be manufactured, packaged, and shipped in such a manner that, when received by the customer, it shall be suitable for installation in accordance with Practice C 727.

8. Sampling

8.1 Sampling shall be performed in accordance with Practice C 390.

9. Test Methods

9.1 *Emittance*—The emittance of the product shall be tested in accordance with Test Method C 1371.

9.2 *Permeance*—The permeance of the product shall be tested in accordance with Test Method E 96, Desiccant Method.

9.3 *Surface Burning*—Surface burning characteristics shall be tested in accordance with Test Method E 84.

9.4 *Humidity Resistance*—The humidity resistance of the product shall be tested in accordance with Test Method C 1258.

9.5 *Adhesive Performance*:

9.5.1 *Bleeding and Delamination*:

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

9.5.1.2 *Significance and Use*—It is necessary that reflective insulation not show adhesive bleeding or delamination since this could cause a loss of structural integrity and a change in water permeability.

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

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

9.5.1.5 *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 nonquantitative.

9.5.2 *Pliability*:

9.5.2.1 *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.

9.5.2.2 *Significance and Use*—It is necessary that reflective insulation not crack or delaminate since this could cause a loss of structural integrity and change in water permeability.

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

9.5.2.4 *Procedure*—Immediately prior to testing: (*1*) The specimens shall be conditioned at a temperature of 70°F (±2°F) and a relative humidity of 50 % (±5 %) for a period of no less than 24 h for the first test. The second test shall be at 32°F (±2°F) for a period of no less than 24 h. (*2*) The foil laminate shall be folded in accordance with TAPPI Standard T512, and the folded edge smoothed, using light finger pressure. The finished laminate shall not crack or delaminate when folded to a 180° bend.

9.5.2.5 *Precision and Bias*—No information is presented about either precision or bias of TAPPI Standard T512 for determining cracking or delamination, due to folding or bending, since the test result is nonquantitative.

9.6 *Fungi Resistance*—The fungi resistance of the product shall be determined in accordance with Test Method C 1338.

9.7 *Thermal Performance*—The thermal performance of reflective insulation shall be determined in accordance with Test Method C 1363 using the following criteria:

9.7.1 In order to determine the thermal performance of the reflective insulation materials used in a test panel, a uniform method of adjustment of the test panel results is needed.

9.7.2 The test panel shall consist of wood framing members sheathed with a homogenous material with a thermal resistance of no more than R-2, such as 0.25 to 0.75 in. (6.35 mm to 19.05 mm) plywood, OSB board, drywall or chipboard. The exposed surface shall not have an emittance less than 0.8. The width and depth of the cavities shall be representative of the installation for which the insulation product is intended. The reflective insulation shall be installed in the test panel according to the manufacturer's installation instructions.

9.7.3 The testing of the reflective insulation shall be performed at a cavity mean temperature of 75 ± 4°F (24 ± 2°C) with a temperature difference across the insulated cavity of 30 ± 2°F (16.7 ± 1°C).

9.7.3.1 To determine the cavity mean temperature and temperature difference, sufficient temperature instrumentation shall be applied to the interior surfaces of the sheathing to measure the average temperature of these surfaces. Recommended temperature sensor layouts for 16 and 24 in. (40.64 mm and 60.96 mm) on center guarded or calibrated hot boxes are shown in Figs. 1 and 2, respectively.

9.7.4 To determine the heatflow in the cavity area, the net heat flow shall be adjusted to account for the heat flow through the framing members. To perform this adjustment, the thermal resistance of the framing material must be known to within ±10 % and the average temperature difference across the framing members shall be measured.

9.7.4.1 A sufficient number of temperature sensors shall be installed to determine the average temperature difference across the framing members. Recommended framing member temperature sensor layouts for 16 and 24 in. (40.64 mm and 60.96 mm) on center guarded and calibrated hot boxes are shown in Figs. 1 and 2, respectively.

NOTE 1—When cavity depths of less than 1 in. (25 mm) are being tested, special care must be taken to install the thermocouples to accurately measure the temperature gradient across the test cavity. Significant uncertainties can be introduced if large diameter temperature sensors (or thermocouples) are used and if the sensors are not installed to measure the temperature gradient accurately. Consult *Temperature Measurement* in Test Method C 1363.

9.7.5 The steady-state heat flow through the reflective insulation in the cavity shall be determined from (Eq 1).

$$Q_{INS} = Q_{TOTAL} - (A_{FRAME} \cdot \Delta T_{FRAME} / R_{FRAME}) \quad (1)$$

where:

Q_{TOTAL} = the total heat flow rate across the test panel (BTU/h),

A_{FRAME} = the cross-sectional area of the framing (ft^2),

ΔT_{FRAME} = the average temperature difference across the framing (°F),

R_{FRAME} = the thermal resistance of the framing ($ft^2 \cdot h \cdot °F/BTU$), and

Q_{INS} = the total heat flow rate across the insulated cavity (BTU/h).

9.7.6 The thermal resistance of the reflective insulation, R_{INS}, shall be determined from (Eq 2).

$$R_{INS} = A_{INS} \cdot \Delta T_{INS} / Q_{INS} \quad (2)$$

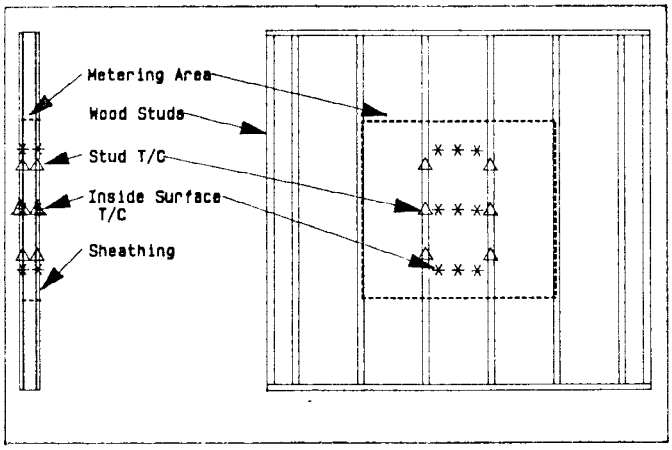
where:

A_{INS} = the total cross-sectional area of the insulated cavity (ft^2), and

ΔT_{INS} = the average ΔT across the insulated cavity measured from the inside surface of the warm-side sheathing to the inside surface of the cool-side sheathing.

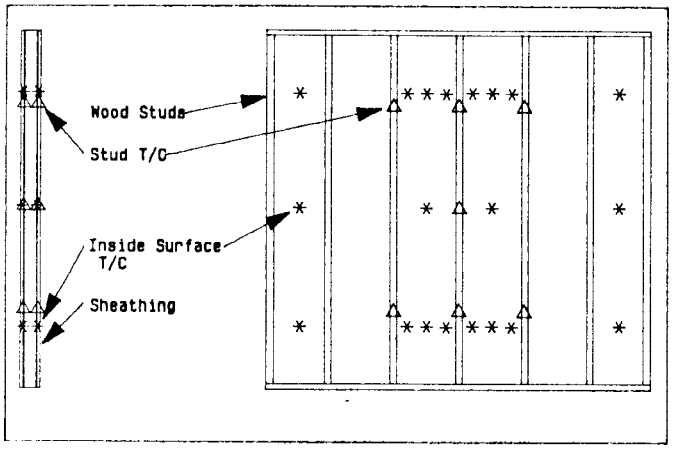
9.7.7 The heat flow correction due to the presence of the framing members resulting from Eq 1 shall be verified by repeating the hot box measurement with a mass insulation material with thermal resistance measured in accordance with test methods C 177 or C 518.

9.7.8 The thermal resistance of the framing, R_{FRAME} in Eq 1, shall be determined from hot box data obtained with the



NOTE—The diagram shows a total of 30 thermocouples. Eighteen of the thermocouples provide panel surface temperatures, twelve or more of the thermocouples provide stud surface temperatures. As few as 3 thermocouples minimum, per side, may be used to measure stud surface temperature.

FIG. 1 Recommended Guarded Hot Box R-Value Test Panel Inside Surface and Stud Thermocouple Layout for 16 in. (406 mm) OC Stud Spacing



NOTE—The diagram shows a total of 54 thermocouples. Forty of the thermocouples provide panel surface temperatures, 14 of the thermocouples provide stud surface temperatures.

FIG. 2 Recommended Guarded Hot Box R-Value Test Panel Inside Surface and Stud Thermocouple Layout for 24 in. (610 mm) OC Stud Spacing

specific framing being used and mass insulation of known thermal resistance using Eq 3.

$$R_{FRAME} = \frac{A_{FRAME} \cdot \Delta T_{FRAME}}{Q_{TOTAL} - \frac{A_{INS}\,\Delta T_{INS}}{R_{INS}}} \quad (3)$$

9.7.9 *Reporting Requirements*—The report shall include all the requirements of Test Methods C 177, C 518 or C 1363 as per the parameters listed in Eq 1 and 2 of Section 9. The date of the last frame verification shall also be reported along with any specific test results affecting the present experiment.

10. Inspection

10.1 Inspection of the material shall be agreed upon between the purchaser and supplier as part of the purchase contract as specified in Practice C 390.

11. Rejection and Rehearing

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

11.1.1 *Surface Punctures*—Shall not exceed one nonrepairable puncture per 500 ft^2.

11.1.2 *Damage (bleeding adhesive, corrosion) to reflective properties of surface coatings*—Shall not exceed 2 % of the insulated area.

11.1.3 *Crinkling (as evidenced by numerous creases and bends resulting in nonparallel surfaces)*—Shall not exceed 5 % of the insulated area.

11.1.4 *Improper Assembly (when referenced to manufacturer's specifications)*—Shall not exceed 1 % of area.

11.1.5 *Improper Expansion (to designed form or size, or both)*—Shall not exceed 1 % of area.

11.2 If inspection of the samples shows failure to conform to the requirements of this specification, a second sample from the same lot shall be tested and the results of this retest averaged with the results of the original test.

11.3 Upon retest, as described in 11.2, material that fails to conform to the requirements of this specification may be rejected. Rejection should promptly be reported to the producer or supplier in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make a claim for a rehearing.

11.4 In case of rejection, the manufacturer or supplier shall have the right to reinspect the rejected shipment or resubmit the lot after removal of that portion of the shipment not conforming to the specified requirements.

12. Packaging and Package Marking

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

12.2 *Package Marking*:

12.2.1 All packages shall be marked to identify product origin.

12.2.2 All packages shall be marked with a lot number.

12.2.3 Thermal resistance values referenced to this specification will be given for heat flow up, heat flow down, or heat flow horizontal, as applicable.

12.2.4 Width and length of material.

12.2.5 Total area, square feet (square meters) covered by the package contents when installed according to the manufacturer's recommendations.

12.3 *Insulation Marking*:

12.3.1 Insulation shall be imprinted with the manufacturer's or distributor's name or trademark, or both.

12.3.2 Insulation markings shall not reduce the stated thermal performance of the product. Insulation markings shall be repeated at intervals not exceeding 8 ft (2.4 m).

13. Keywords

13.1 emittance; R-value; reflective air spaces; reflective insulation; thermal resistance

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