



Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation¹

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1. Scope

1.1 This specification applies to faced or unfaced, rigid cellular phenolic thermal insulation in either board or tubular form.

1.2 Materials covered by this specification are used as roof insulation; sheathing or rigid board for non-load bearing, building material applications; and pipe insulation for use between -40 and 257°F (-40 and 125°C). Type II Grade 1 and Type III Grade 1 materials with an appropriate vapor retarder covering on the warm surface can be used to a lower temperature limit of -290°F (-180°C). (See 7.2.)

1.3 The values stated in inch-pound units are to be regarded as standard. International Standard Units (SI) are given in parentheses.

1.4 *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.* For specific precautionary statements, see Section 16.

2. Referenced Documents

2.1 ASTM Standards:

- C 168 Terminology Relating to Thermal Insulating Materials²
- C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus²
- C 209 Test Methods for Cellulosic Fiber Insulating Board²
- C 236 Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box²
- C 335 Test Method for Steady-State Heat Transfer Property of Horizontal Pipe Insulations²
- C 390 Criteria for Sampling and Acceptance of Preformed Thermal Insulation Lots²
- C 518 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus²

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² Annual Book of ASTM Standards, Vol 04.06.

C 550 Practice for Measuring Trueness and Squareness of Rigid Block Thermal Insulation²

C 585 Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)²

C 976 Test Method for Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box²

C 1045 Practice for Calculating Thermal Transmission Properties from Steady-State Heat Flux Measurements²

C 1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation²

C 1303 Test Method for Estimating Long-Term Change in the Thermal Resistance of Unfaced Rigid Closed Cell Plastic Foams by Slicing and Scaling Under Controlled Laboratory Conditions.²

D 1621 Test Method for Compressive Properties of Rigid Cellular Plastics.³

D 1622 Test Method for Apparent Density of Rigid Cellular Plastics.³

D 1623 Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics³

D 2126 Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging³

E 84 Test Method for Surface Burning Characteristics of Building Materials⁴

E 96 Test Methods for Water Vapor Transmission of Materials²

3. Terminology

3.1 The definitions and terms in Terminology C 168 shall apply to this specification.

4. Classification

4.1 The thermal insulation shall be of the following types and grades:

4.1.1 *Type I*—For use as roof insulation board.

4.1.2 *Type II*—For use as sheathing or rigid panel for non-load bearing applications.

4.1.3 *Type III*—For use as pipe insulation.

4.1.4 *Grade 1*—Foam for Type I of this grade will have an average apparent thermal conductivity of $0.16 \text{ Btu}\cdot\text{in.}/\text{h}\cdot\text{ft}^2\cdot^{\circ}\text{F}$

³ Annual Book of ASTM Standards, Vol 08.01.

⁴ Annual Book of ASTM Standards, Vol 04.07.

(0.023 W/mK) or less and foam for Types II and III of this grade will have an average apparent thermal conductivity of 0.13 Btu-in./h-ft²·°F (0.019 W/mK) or less at a mean temperature of 75°F (24°C) when aged in accordance with 13.6.1.

4.1.5 *Grade 2*—Foam of this grade will have an average apparent thermal conductivity of 0.23 Btu-in./h-ft²·°F (0.033 W/mK) or less at a mean temperature of 75°F (24°C).

NOTE 1—The average thermal conductivities shown in this section are for classification only, not for qualification purposes as indicated by Section 10.1.

5. Ordering Information

5.1 Orders for materials purchased under this specification shall include the following information:

- 5.1.1 Designation of this specification.
- 5.1.2 Product name, type, and/or grade.
- 5.1.3 Size and dimensions.
- 5.1.4 Quantity of material.
- 5.1.5 Special requirements for inspection and/or testing.
- 5.1.6 Pipe insulation jacketing (optional).

6. Materials and Manufacture

6.1 *Foam Core Chemical Composition*—The foam shall be produced by a chemical reaction of a phenolic resin, surfactant, blowing agent, and other additives as needed.

6.2 *Facings (Jackets)*—Facing or jackets, if required, shall be adhered to the core stock and suitable for the service intended. They shall be supplied as agreed upon between manufacturer and purchaser.

7. Physical Properties

7.1 The material shall conform to the requirements as shown in Table 1.

7.2 Not all physical properties at temperatures below −40°F (−40°C) have been fully tested, and the user should consult the manufacturer for properties and performance at these lower temperatures.

8. Dimensions and Tolerances

8.1 *Dimensions*—The dimensions shall be as agreed upon

TABLE 1 Physical Properties

Property	Unit	Type I	Type II	Type III ^A
Density, min 16/ft ³ (kg/m ³)		N/A ^B	2 (32)	2 (32)
Compressive resistance, min (faced or unfaced)	psi (kPa)	16 (108)	18 (124)	18 (124)
Tensile strength, min (faced)	psf (Pa)	150 (7180)	N/A ^B	N/A ^B
Apparent Thermal Conductivity, max ^C (foam core):	Btu-in./h-ft ² ·°F (W/mK)			
Grade 1				
−250°F (−157°C) mean temp.		N/A ^B	0.10 (0.015)	0.10 (0.015)
−200°F (−129°C) mean temp.		N/A ^B	0.11 (0.016)	0.11 (0.016)
−150°F (−101°C) mean temp.		N/A ^B	0.12 (0.017)	0.12 (0.017)
−100°F (−73°C) mean temp.		N/A ^B	0.13 (0.019)	0.13 (0.019)
−50°F (−46°C) mean temp.		N/A ^B	0.13 (0.019)	0.13 (0.019)
−0°F (−17°C) mean temp.		N/A ^B	0.13 (0.019)	0.13 (0.019)
40°F (4°C) mean temp.		0.14 (0.020)	0.13 (0.019)	0.13 (0.019)
75°F (24°C) mean temp.		0.16 (0.023)	0.13 (0.019)	0.13 (0.019)
110°F (43°C) mean temp.		0.18 (0.026)	0.15 (0.022)	0.15 (0.022)
150°F (65°C) mean temp.		N/A ^B	N/A ^B	0.18 (0.026)
Grade 2				
40°F (4°C) mean temp.		0.21 (0.030)	0.21 (0.030)	0.21 (0.030)
75°F (24°C) mean temp.		0.23 (0.033)	0.23 (0.033)	0.23 (0.033)
110°F (43°C) mean temp.		0.25 (0.036)	0.25 (0.036)	0.28 (0.036)
150°F (65°C) mean temp.		N/A ^B	N/A ^B	0.28 (0.040)
Dimensional stability, 1 week ^D	% lin chg, max			
Exposure (foam core):				
257 ± 4°F (125 ± 2°C), ambient RH		N/A ^B	N/A ^B	2
−40 ± 6°F (−40 ± 3°C), ambient RH		2	2	2
158 ± 4°F (70 ± 2°C), 97 ± 3% RH		2	2	2
Water absorption, max, (foam core):	% by volume			
Grade 1		3.0	3.0	3.0
Grade 2		8.0	8.0	8.0
Water vapor permeance, perms, (faced)	grains/h-ft ² ·in.-Hg (ng/s·m ² ·Pa)			
Grade 1		^E	≤1.0 (57) ^F	<0.02 (1.15)
Grade 2		^E	>3.0 (170)	<0.02 (1.15)
Flame spread index, max ^{G,H} (foam core)		25	25	25
Smoke developed index, max ^{G,H} (foam core)		50	50	50

^A Type III test samples shall be obtained from a free-rise block of foam, except where otherwise specified.

^B N/A = not applicable.

^C Thermal Conductivity tests shall be used for classification purposes only.

^D Dimensional stability data at lower temperature will be added when testing problem is complete.

^E No minimum or maximum values are required for Type I material. It is expected roof design will reflect actual building and environmental conditions. Under certain circumstances a vapor retarder may be required.

^F Consult manufacturer for application in cold climates where larger permeance values may be desirable.

^G This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk under actual fire conditions.

^H Facings used on composite products may cause the flame and smoke ratings of the composite to be significantly different than the foam core rating.

between the purchaser and the supplier, but commonly shall be as follows:

8.1.1 *Type I*—Width, 24 in., 36 in., or 48 in. (610 mm, 915 mm, or 1220 mm). Length, 48 in. or larger (1220 mm or larger).

8.1.2 *Type II*—Width, 48 in. (1220 mm). Length, 96 in. or larger (2440 mm or larger).

8.1.3 *Type III*—Pipe insulation with dimensions that are in accordance with Practice C 585.

8.2 *Tolerances*—Unless otherwise agreed upon between the purchaser and the supplier, the tolerances shall be as follows:

8.2.1 *Types I and II*—When measured at $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) and $50 \pm 5\%$ relative humidity, these types shall conform to the following:

8.2.1.1 *Length*—Not to exceed $\pm 1/4$ in. (± 6.4 mm).

8.2.1.2 *Width*—Not to exceed $\pm 1/4$ in. (± 6.4 mm).

8.2.1.3 *Thickness*—Not to exceed $\pm 1/8$ in. (± 3.1 mm).

8.2.2 *Type III*—Thicknesses available for various pipe and tube sizes should be in accordance with Practice C 585. The average measured length shall not differ from the manufacturer's standard dimension by more than $\pm 1/4$ in. (6.4 mm).

8.3 *Other Parameters for Types I and II*:

8.3.1 *Squareness*—Board squareness shall be within required tolerance if the two diagonal measurements of the board differ by no more than $1/4$ in. (6.4 mm).

8.3.2 *Straightness*—Unless otherwise specified, the boards shall be furnished with straight edges which shall not deviate by more than $1/32$ in./ft (2.6 mm/m).

8.3.3 *Flatness*—The boards shall not depart from absolute flatness by more than $1/16$ in./ft of width or length (5.2 mm/m).

8.3.4 The straightness and flatness shall be determined in accordance with Practice C 550, except that a straight edge longer than the dimension being determined shall be used.

9. Workmanship, Finish, and Appearance

9.1 The insulation shall have no defects that adversely affect its service qualities.

10. Qualification Requirements

10.1 For the purpose of initial material or product qualification, each type and grade of insulation shall meet the test results of Table 1.

10.2 Acceptance qualification for lots and shipments of qualified product should be agreed upon by purchaser and supplier.

10.3 When it is anticipated that phenolic foam will be in direct contact with metal, the foam supplier shall provide the proper installation procedure. Type 1 phenolic foams may contain some compounds which may promote corrosion in the presence of liquid water. As far as can be ascertained, there are currently no directly applicable ASTM corrosion tests for phenolic foams. An attempt will be made to develop a meaningful corrosion test and will be incorporated into the standard when it becomes available.

11. Sampling

11.1 Unless otherwise specified in the purchase order or contract, sampling shall be in accordance with Criteria C390.

12. Specimen Preparation

12.1 Unless otherwise specified in the test procedure, all tests shall be made on specimens conditioned at least 24 h at $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) and $50 \pm 5\%$ relative humidity.

12.2 All test specimens are foam core samples except where otherwise indicated.

12.3 All cut edges shall be smooth and free of any mechanical damage which would affect test results.

12.4 Where foam is tested with facings, care should be taken to avoid delamination of the specimen during sample preparation.

13. Test Methods

13.1 Properties of the insulation shall be determined in accordance with the following methods.

13.2 *Test Conditions*—Tests shall be conducted at standard laboratory conditions of $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) and $50 \pm 5\%$ relative humidity unless otherwise specified.

13.3 *Density*—Determine by using Test Method D 1622.

13.4 *Compressive Resistance*—Determine by using Test Method D 1621, Procedure A, on faced or unfaced sample in the direction normal to its application, except for Type III. Type III will be tested in the direction normal to rise. If the thickness is less than 1 in., it should be tested at the product thickness. See Note 2 and Footnote A of Table 1.

NOTE 2—Insulation foams can be anisotropic and, therefore, strength properties can vary with direction. The manufacturer should be consulted if additional information is required.

13.5 *Tensile Strength*—Determine by using Test Method D 1623, Type C specimen, faced, in the direction normal to its application.

13.6 *Thermal Performance*:

13.6.1 *Foam Thermal Conductivity*:

13.6.1.1 Determine the apparent thermal conductivity on core foam by Test Method C 177 or Test Method C 518 in conjunction with Practice C 1045 using temperature differences as indicated in Practice C 1058. Precondition the samples at $73 \pm 2^\circ\text{F}$ ($23 \pm 1^\circ\text{C}$), $50 \pm 5\%$ relative humidity for 72 h. Grade 2 foam core specimens shall require no further preconditioning before testing. Grade 1 foam core specimens require a minimum of 180 days at $73 \pm 2^\circ\text{F}$ ($23 \pm 1^\circ\text{C}$), $50 \pm 5\%$ relative humidity prior to testing. Time to reach steady state before readings are taken should be a minimum of 24 h. In the event of dispute, Test Method C 177 shall be used.

13.6.1.2 Apparent thermal conductivity shall be reported at mean temperatures of 40°F (4°C), 75°F (24°C), and 110°F (43°C). For Type III product, report also at 150°F (65°C) using a cold-face temperature of $75 \pm 15^\circ\text{F}$ ($24 \pm 8^\circ\text{C}$) and a hot-face temperature of $225 \pm 15^\circ\text{F}$ ($107 \pm 8^\circ\text{C}$). Time to reach steady state before readings are taken should be 24 h minimum. For Type II and Type III, Grade 1 product report also at mean temperatures of -250°F (-157°C), -200°F (-129°C), -150°F (-101°C), -100°F (-73°C), -50°F (-46°F), and 0°F (-17°C). The mean apparent thermal conductivity of the material tested shall not be greater than the manufacturer's stated value. The thermal conductivity of individual specimens tested shall not be more than 110 % of the manufacturer's

stated value. In the event of dispute, Test Method C 177 should be used. See Note 3.

NOTE 3—The redistribution of moisture in phenolic foams may be slow enough to increase the time required to reach stable heat flow in the thermal conductivity tests. The equilibrium values measured after 24 h best represent the heat insulating properties expected under stable temperature gradient conditions. If it can be confirmed that the equilibrium value can be obtained in less than 24 h, then it is acceptable to take proper measurements and to report the equilibrium time.

13.6.2 Product Thermal Resistance—The thermal resistance of the product as used shall be agreed upon by purchaser and supplier. Use Test Methods C 177, C 518, C 236, or C 976 in conjunction with Practice C 1045 for Types I and II, with Test Method C 177 being the referee method. Use Test Method C 335 for Type III. The mean thermal resistance of the material tested shall not be less than the manufacturer's stated value. The thermal resistances of individual specimens tested may not be less than 90 % of the manufacturer's stated values. See Note 4.

NOTE 4—The thermal transmission properties of phenolic foams board and pipe insulation may vary with temperature, temperature gradient, moisture content, thickness, and shape. Note that the apparent thermal conductivity requirements in Table 1 are based on samples tested under the conditions specified in 13.4.1. These are comparative values for establishing specification compliances. They may not represent the installed performance of the insulation under use conditions differing substantially from the test conditions. Test Method C 1303 provides an alternative technique for estimating long-term changes in thermal resistance, when the material meets the homogeneous material definition of 3.2.4 of Test Method C 1303.

13.7 Dimensional Stability—Determine by using Test Method D 2126 with test specimens being exposed to the following conditions:

Temperature, °F (°C)	Relative Humidity, %
257 ± 4 (125 ± 2)	Ambient
(Type III only)	
−40 ± 6 (−40 ± 3)	Ambient
158 ± 4 (70 ± 2)	95 ± 3

13.7.1 Each of the test specimens shall be conditioned 48 hours at 73.4 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity prior to testing. See Note 5.

NOTE 5—This standard used the dimensional stability test to indicate maximum surface use temperature for Type III insulation.

13.7.2 These requirements are for qualification of foams. Consult manufacturer for in-service performance data.

13.8 Water Absorption— For the purposes of this specification, determine in accordance with Test Methods C 209. Length of test shall be 2 h. (Facings can affect the determined value.)

13.9 Water Vapor Permeance—Determine in accordance with Test Method E 96, water method on faced specimen.

13.10 Burning Characteristics—For the purpose of this specification, surface burning characteristics shall be determined in accordance with Test Method E 84 on foam core samples. The requirements of Table 1 shall apply where required by applicable regulations or by the purchaser. As with other building materials, phenolic foams may continue to smolder after a fire exposure; therefore, total extinguishment is required. Facings used on composite products may cause the flame and smoke indexes of the composites to be significantly different than the foam core rating. For composites, the flame spread and smoke developed indexes shall be provided by the supplier as required.

14. Inspection

14.1 Inspection of the material shall be agreed upon by the purchaser and the supplier as part of the purchase agreement.

15. Rejection and Rehearing

15.1 Material that fails to conform to the requirements of this specification *may* be rejected. Rejection shall be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the tests, the producer or supplier may request a rehearing. Retesting may be necessary.

15.2 At the agreement of the buyer and seller, the seller shall have the right to reinspect a rejected shipment and resubmit same after removal of the nonconforming portion.

16. Health and Safety Precautions

16.1 When applying Type III product on a hot pipe operating at 140°F (60°C) or higher in closed or confined spaces, adequate ventilation should be provided, and care should be taken to avoid burns. Consult the manufacturer for details.

17. Packaging and Package Marking

17.1 Unless otherwise agreed upon between the purchaser and the supplier, materials under this specification shall be packaged by the manufacturer's standard commercial practice.

17.2 Unless otherwise specified, shipping containers shall be marked with the name and designation of the manufacturer, type, size, thickness, product thermal resistance, and quantity of material in the container.

18. Keywords

18.1 cellular phenolic thermal insulation; faced phenolic foam thermal insulation; phenolic foam thermal insulation; rigid thermal insulation; unfaced phenolic foam thermal insulation

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