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Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation[1]

This standard is issued under the fixed designation C 1126; 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 ~~applies to~~ covers faced or unfaced, rigid cellular phenolic thermal ~~insulation in either board~~ insulation. Boards shall be faced or ~~t~~ unfaced. Tubular forms covered by this standard shall be unfaced. It does not apply to field expanded cellular phenolic materials.

NOTE 1—If a facer or vapor retarder is to be used for the tubular form, then refer to Practice C 921

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:* [2]

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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 C16.22 on Organic and Nonhomogeneous Inorganic Thermal Insulations.

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C 168 Terminology Relating to Thermal ~~Insulating Materials[2]~~ Insulation
C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus
C 209 Test Methods for Cellulosic Fiber Insulating Board
C ~~236~~35 Test Method for Steady-State ~~Thermal Performance~~ Heat Transfer Properties of ~~Building Assemblies by Means of a Guarded Hot Box[2]~~ Horizontal Pipe Insulations
C ~~335 Test Method~~ 390 Practice for ~~Steady-State Heat Transfer Property~~ Sampling and Acceptance of ~~Horizontal Pipe Insulations[2]~~ Preformed Thermal Insulation Lots
C ~~390 Criteria~~ 518 Test Method for ~~Sampling~~ Steady-State Heat Flux Measurements and ~~Acceptance of Preformed~~ Thermal ~~Insulation Lots[2]~~ Transmission Properties by Means of the Heat Flow Meter Apparatus
C ~~518 Test Method~~ 550 Practice for ~~Steady-State Heat Flux Measurements~~ Measuring Trueness and ~~Thermal Transmission Properties by Means~~ Squareness of ~~the Heat Flow Meter Apparatus[2]~~ Rigid Block and Board Thermal Insulation
C 58~~5~~0 Practice for ~~Measuring Trueness~~ Inner and ~~Squareness~~ Outer Diameters of Rigid ~~Block~~ Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)
C 585921 Practice for ~~Inner and Outer Diameters~~ Determining the Properties of ~~Rigid~~ Jacketing Materials for Thermal ~~Insulation for Nominal Sizes of Pipe and Tubing (NPS System)[2]~~ Insulation
C ~~976 Test Method~~ 1045 Practice for Calculating Thermal ~~Performance of Building Assemblies by Means of a Calibrated Hot Box[2]~~ Transmission Properties Under Steady-State Conditions
C 10458 Practice for ~~Ca~~ Selecting Temperatures for Evaluating and Reporting Thermal ~~Transmission~~ Properties ~~from Steady-State Heat Flux Measurements[2]~~ of Thermal Insulation
C ~~1058 Practice~~ 1303 Test Method for ~~Selecting Temperatures for Evaluating and Reporting~~ Estimating Long-Term Change in the Thermal ~~Properties~~ Resistance of ~~Thermal Insulation[2]~~ Unfaced Rigid Closed Cell Plastic Foams by Slicing and Scaling Under Controlled Laboratory Conditions.
C 13~~0~~63 Test Method for ~~Estimating Long-Term Change in~~ the ~~Thermal Resistance~~ Hot Box Performance of ~~Unfaced Rigid Closed Cell Plastic Foams~~ Building Assemblies by ~~Slicing and Scaling Under Controlled Laboratory Conditions.[2]~~ Means of a Hot Box Apparatus
D 1621 Test Method for Compressive Properties of Rigid Cellular Plastics.
D 1622 Test Method for Apparent Density of Rigid Cellular Plastics.
D 1623 Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
D 2126 Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
E 84 Test Method for Surface Burning Characteristics of Building Materials
E 96 Test Methods for Water Vapor Transmission of Materials

3. Terminology

3.1 The definitions and terms in Terminology C 168 shall apply to this specification.
3.2 *Definitions of Terms Specific to this Standard —*
3.3 *Foam Core*—rigid cellular thermal installation without any facers or barriers on the surface of the installation.
3.4 *Closed Cell Material*—foam where more than 90 % of the cells are totally enclosed by cell walls, and not interconnected with other cells.
3.5 *Open Cell Material*—foam whose cells are not totally enclosed by its walls and therefore exhibits a predominance of interconnecting cells.

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. Produced without integral vapor retarder facers.
4.1.2 *Type II*—For use as sheathing or rigid panel for non-load bearing applications. Produced with integral vapor retarder facers.
4.1.3 *Type III*—For use as pipe insulation. Produced without integral vapor retarder facers.
4.1.4 *Grade 1—Closed cell material.* Foam for Type I of this grade will have an ~~average~~ apparent thermal conductivity of 0.16 Btu·in./h·ft^2·°F (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·ft^2 ·°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—Open cell material.* Foam of this grade will have an ~~average~~ apparent thermal conductivity of 0.23 Btu·in./h·ft^2·°F (0.033 W/mK) or less at a mean temperature of 75°F (24°C).

NOTE ~~1~~2—The average thermal conductivities shown in this section are for classification only, not for qualification purposes as indicated by Section 10.1.

[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~~, Vol 04.06.~~ volume information, refer to the standard's Document Summary page on the ASTM website.

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,~~ on Type II material 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 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 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity, these types shall conform to the following:
8.2.1.1 *Length*—Not to exceed ±¼ in. (±6.4 mm).
8.2.1.2 *Width*—Not to exceed ±¼ in. (±6.4 mm).
8.2.1.3 *Thickness*—Not to exceed ±⅛ 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 ±¼ 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 ¼ 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.~~ Practice C 390.

TABLE 1 Physical Properties

NOTE—As Type II insulation is produced with integral vapor retarder facers, the orientation of the facer is important in preventing moisture penetration into the insulation and the water vapor permeance of the Type II faced insulation is valid as long as the facer does not fail.

Property	Unit	Type I	Type II	Type III[A]
~~Density, min 16/ft^3 (kg/m^3)~~		~~N/A[B]~~	~~2 (32)~~	~~2 (32)~~
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	Btu·in./h·ft^2·°F (W/mK)			
Conductivity, max[C]				
(foam core):				
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)~~			
Water vapor permeance, perms, (facer only)	grains/h·ft^2·in.·Hg (ng/s·m^2·Pa)			
~~Grade 1~~		[E]	~~≤1.0 (57)[F]~~	~~<0.02 (1.15)~~
Grade 1		[E]	≤1.0 (57)[F]	
~~Grade 2~~		[E]	~~>3.0 (170)~~	~~<0.02 (1.15)~~
Grade 2		[E]	>3.0 (170)	
~~Water vapor permeability, max, perm-in. (foam core)~~				
Water vapor permeability, max, perm-in. (foam core)	Perm-inch (ng/s.m.Pa)			
~~Grade 1~~		~~0.15 (0.22)~~	~~0.15 (0.22)~~	~~0.15 (0.22)~~
Grade 1		0.9 (1.3)	0.9 (1.3)	0.9 (1.3)
~~Grade 2~~		~~>4.0 (5.8)~~	~~>4.0 (5.8)~~	~~>4.0 (5.8)~~
Grade 2		>4.0 (5.8)	N/A[B]	>4.0 (5.8)
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.

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 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity.

12.2 All Type II test specimen have facers present and Type I and Type III 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 ± 3.6°F (23 ± 2°C) and 50 ± 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~~ 3 and Footnote A of Table 1.

NOTE ~~2~~3—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 ± 2°F (23 ± 1°C), 50 ± 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~~ shall be aged as 1-in. (25 mm) thick specimens for 180 days at 73 ± 2°F (23 ± 1°C), 50 ± 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 ± 15°F (24 ± 8°C) and a hot-face temperature of 225 ± 15°F (107 ± 8°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 4—Additional thickness of Grade I foam core specimen shall be tested by aging at use thickness for 180 days at 73 ± 2°F (23 ± 1°C), 50 ± 5 % relative humidity prior to testing.

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 ± 15°F (24 ± 8°C) and a hot-face temperature of 225 ± 15°F (107 ± 8°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 5.

NOTE 5—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~~ C 1363, 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~~ shall not be less than 90 % of the manufacturer's stated values. See Note ~~4.~~ 6.

NOTE ~~4~~6—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.~~ 7.

NOTE 57—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 and Permeability* —Determine permeance in accordance with Test Method E 96, Desiccant Method on faced specimen. Determine permeability in accordance with Test Method E 96, Desiccant Method on foam core 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 at the thickness supplied. 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