



Designation: C1594 – 10

Standard Specification for Polyimide Rigid Cellular Thermal Insulation¹

This standard is issued under the fixed designation C1594; 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 composition and physical properties of polyimide foam insulation with nominal densities from 1.0 lb/ft³ to 8.0 lb/ft³ (16 kg/m³ to 128 kg/m³) and intended for use as thermal and sound-isolating insulation for temperatures from –423°F to +600°F (–253°C to +316°C) in commercial and industrial environments.

1.1.1 The annex shall apply to this specification for marine applications.

1.1.2 This standard is designed as a material specification and not a design document.

1.1.3 The values stated in [Table 1](#) and [Table 2](#) are not to be used as design values. It is the buyer's responsibility to specify design requirements and obtain supporting documentation from the material supplier.

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

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 requirements prior to use.*

NOTE 1—The subject matter of this material specification is not covered by any other ASTM specification. There is no known ISO standard covering the subject of this standard.

2. Referenced Documents

2.1 *ASTM Standards:*²

[C168 Terminology Relating to Thermal Insulation](#)

[C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus](#)

[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](#)

[C421 Test Method for Tumbling Friability of Preformed Block-Type and Preformed Pipe-Covering-Type Thermal Insulation](#)

[C447 Practice for Estimating the Maximum Use Temperature of Thermal Insulations](#)

[C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus](#)

[C634 Terminology Relating to Building and Environmental Acoustics](#)

[C665 Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing](#)

[C1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions](#)

[C1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation](#)

[C1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus](#)

[C1304 Test Method for Assessing the Odor Emission of Thermal Insulation Materials](#)

[C1338 Test Method for Determining Fungi Resistance of Insulation Materials and Facings](#)

[C1482 Specification for Polyimide Flexible Cellular Thermal and Sound Absorbing Insulation](#)

[C1559 Test Method for Determining Wicking of Fibrous Glass Blanket Insulation \(Aircraft Type\)](#)

[D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents](#)

[D638 Test Method for Tensile Properties of Plastics](#)

[D1621 Test Method for Compressive Properties of Rigid Cellular Plastics](#)

[D2126 Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging](#)

[D2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics \(Oxygen Index\)](#)

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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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.

TABLE 1 Polyimide Foam Classification (inch pound)

| Property | Type I Grade 1 | Type I Grade 2 | Type I Grade 3 | Type II Grade 1 Class 1 | Type II Grade 2 Class 1 | Type II Grade 3 Class 1 | Type II Grade 1 Class 2 | Type II Grade 2 Class 2 | Type II Grade 3 Class 2 | Type III Grade 4 |
|--|-------------------|-------------------|-------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|---------------------|
| Density, lb/ft ³ (max) | 8.0 | 6.0 | 3.0 | 8.0 | 6.0 | 3.0 | 8.0 | 6.0 | 3.0 | 1.5 |
| Thermal Conductivity, Btu-in./h-ft ² -°F (max) | | | | | | | | | | |
| -238°F | * | * | * | * | * | 0.048 | * | * | * | * |
| -150°F | * | * | * | * | * | 0.036 | * | * | * | * |
| -50°F | * | * | * | * | * | 0.096 | * | * | * | * |
| 24°F | 0.230 | 0.220 | 0.210 | * | * | 0.180 | * | * | * | * |
| 65°F | 0.248 | 0.238 | 0.220 | * | * | 0.228 | * | * | * | * |
| 75°F | 0.250 | 0.240 | 0.240 | 0.260 | 0.250 | 0.246 | 0.234 | 0.250 | 0.225 | 0.240 |
| 100°F | 0.260 | 0.250 | 0.250 | * | * | 0.264 | * | * | * | * |
| 150°F | 0.280 | 0.270 | 0.270 | * | * | 0.324 | * | * | * | * |
| 200°F | 0.305 | 0.295 | 0.300 | * | * | 0.396 | * | * | * | * |
| 300°F | * | * | * | * | * | 0.516 | * | * | * | * |
| 572°F | * | * | * | * | * | 0.876 | NA | NA | NA | * |
| Upper Temperature Limit – test temperature for C411, °F | 600 | 600 | 600 | 600 | 600 | 600 | 400 | 400 | 400 | 600 |
| High Temperature Stability – % of initial tensile strength retained after 1000 hours in air oven at 572°F, (min.) | * | * | * | * | * | 95 | * | * | * | * |
| Tensile Strength PSI (min.) | 244 | 134 | 41 | 180 | 80 | 14 | 180 | 80 | 14 | 41 |
| Compressive Strength PSI @ 10% def. (min.) | 95 | 65 | 28 | * | * | * | * | * | * | * |
| Compressive Force Deflection PSI @ 20% def. (min.) | * | * | * | 18 | 6 | 2 | 18 | 6 | 2 | 26 |
| Steam Aging | | | | | | | | | | |
| Change in tensile Strength % (max.) | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Dimensional and weight changes % (max.) | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Water Vapor Permeability Perm in. (max.) | 0.5 | 0.5 | 3.5 | 2.5 | 5.0 | 8.0 | 2.0 | 2.5 | 5.0 | 2.9 |
| Oxygen Index % (min.) | 46 | 45 | 43 | 52 | 50 | 48 | 30 | 30 | 30 | 47 |
| Surface Burning Characteristics, 2 in. thickness | | | | | | | | | | |
| Flame Spread Index, (max.) | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Smoke Developed Index, (max.) | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Vertical Burn | | | | | | | | | | |
| Flame Application sec | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| Flame Time sec (max.) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Burn Length in. (max.) | 0.6 | 0.6 | 1.6 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 | 0.6 |
| Dripping | None | None | None | None | None | None | None | None | None | None |
| Specific Optical Density | | | | | | | | | | |
| Avg. Dm. Flaming Exposure (max.) | 3 | 2 | 1 | 2 | 2 | 2 | 5 | 5 | 5 | 1 |
| Avg. Dm. Non-Flaming Exposure (max.) | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 1 |
| Corrosiveness | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| Chemical resistance | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| By-Products of Combustion, ppm (max.) | | | | | | | | | | |
| Carbon Monoxide | | | | | | | | | | |
| Flaming | 275 | 200 | 100 | 300 | 300 | 300 | 300 | 300 | 300 | 125 |
| Non-Flaming | 3 | 2 | 1 | 10 | 10 | 10 | 10 | 10 | 10 | 3 |
| Hydrogen Fluoride | | | | | | | | | | |
| Flaming | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 2 |
| Non-Flaming | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 2 |
| Hydrogen Chloride | | | | | | | | | | |
| Flaming | 9 | 7 | 5 | 10 | 10 | 10 | 10 | 10 | 10 | 3 |
| Non-Flaming | 9 | 7 | 5 | 10 | 10 | 10 | 10 | 10 | 10 | 3 |
| Nitrogen Oxides | | | | | | | | | | |
| Flaming | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 6 |
| Non-Flaming | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 3 |
| Sulfur Dioxide | | | | | | | | | | |
| Flaming | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 2 |
| Non Flaming | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 2 |
| Hydrogen Cyanide | | | | | | | | | | |
| Flaming | 5 | 5 | 5 | 5 | 5 | 5 | 10 | 10 | 10 | 4 |
| Non Flaming | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 3 |
| ¼ Scale Room Burn – No Flash Over | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| Percent closed cell (range) | 100–76 | 100–76 | 100–76 | 30–0 | 30–0 | 30–0 | 30–0 | 30–0 | 30–0 | 75–20 |
| Tumbling Friability | | | | | | | | | | |
| 600 Revolutions, mass loss, max, % | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| 1200 Revolutions, mass loss, max, % | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Odor Emission | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| Fungi Resistance | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| Wicking, 48 hrs, distance above water line, max. @ 72°F, in. | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

* = Not available consult manufacturer for additional information.

NA = Not Applicable

NB = A manufacturer can only claim conformance to this standard to the values reported in this table. The * notes are confidential data to the manufacturers and as such are not considered part of any qualifying requirements for the standard and only tell the user to inquire about that data.

TABLE 2 Polyimide Foam Classification (SI)

| Property | Type I Grade 1 | Type I Grade 2 | Type I Grade 3 | Type II Grade 1 Class 1 | Type II Grade 2 Class 1 | Type II Grade 3 Class 1 | Type II Grade 1 Class 2 | Type II Grade 2 Class 2 | Type II Grade 3 Class 2 | Type III Grade 4 |
|--|----------------------|----------------------|----------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|----------------------|
| Density, kg/m ³ (max) | 128 | 96 | 48 | 128 | 96 | 48 | 128 | 96 | 48 | |
| Thermal Conductivity, W/m-K (max) | | | | | | | | | | |
| -150°C | * | * | * | * | * | 0.007 | * | * | * | * |
| -101°C | * | * | * | * | * | 0.005 | * | * | * | * |
| -46°C | * | * | * | * | * | 0.014 | * | * | * | * |
| -4°C | 0.033 | 0.032 | 0.030 | * | * | 0.026 | * | * | * | * |
| 18°C | 0.036 | 0.034 | 0.032 | * | * | 0.033 | * | * | * | * |
| 24°C | 0.036 | 0.035 | 0.035 | 0.038 | 0.036 | 0.036 | 0.034 | 0.036 | 0.032 | 0.035 |
| 38°C | 0.038 | 0.036 | 0.036 | * | * | 0.038 | * | * | * | * |
| 66°C | 0.040 | 0.039 | 0.039 | * | * | 0.047 | * | * | * | * |
| 93°C | 0.044 | 0.042 | 0.043 | * | * | 0.057 | * | * | * | * |
| 149°C | * | * | * | * | * | 0.074 | * | * | * | * |
| 300°C | * | * | * | * | * | 0.126 | NA | NA | NA | * |
| Upper Temperature Limit – test temperature for C411 °C | 315 | 315 | 315 | 315 | 315 | 315 | 204 | 204 | 204 | 315 |
| High Temperature Stability – % of initial tensile strength retained after 1000 hours in air oven at 300°C, (min.) | * | * | * | * | * | 95 | * | * | * | * |
| Tensile Strength MPa (min.) | 1.68 | 0.92 | 0.28 | 1.24 | 0.55 | 0.096 | 1.24 | 0.55 | 0.096 | 0.28 |
| Compressive Strength MPa @ 10% def. (min.) | 0.65 | 0.45 | 0.19 | * | * | * | * | * | * | * |
| Compressive Force Deflection MPa @ 20% def. (min.) | * | * | * | 0.12 | 0.04 | 0.01 | 0.12 | 0.04 | 0.01 | 0.18 |
| Steam Aging | | | | | | | | | | |
| Change in tensile Strength % (max) | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Dimensional and weight changes % (max) | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Water Vapor Permeability g/Pa s m (max.) | 0.7×10 ⁻⁹ | 0.7×10 ⁻⁹ | 5.1×10 ⁻⁹ | 3.6×10 ⁻⁹ | 7.3×10 ⁻⁹ | 11.6×10 ⁻⁹ | 2.9×10 ⁻⁹ | 3.6×10 ⁻⁹ | 7.3×10 ⁻⁹ | 4.2×10 ⁻⁹ |
| Oxygen Index % (min.) | 46 | 45 | 43 | 52 | 50 | 48 | 30 | 30 | 30 | 47 |
| Surface Burning Characteristics, 50mm thickness | | | | | | | | | | |
| Flame Spread Index, (max.) | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Smoke Developed Index, (max.) | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Vertical Burn | | | | | | | | | | |
| Flame Application sec | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| Flame Time sec (max.) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Burn Length cm (max.) | 1.5 | 1.5 | 4.0 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 | 2.0 | 1.4 |
| Dripping | None | None | None | None | None | None | None | None | None | None |
| Specific Optical Density | | | | | | | | | | |
| Avg. Dm. Flaming Exposure (max) | 3 | 2 | 1 | 2 | 2 | 2 | 5 | 5 | 5 | 1 |
| Avg. Dm. Non-Flaming Exposure (max.) | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 1 |
| Corrosiveness | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| Chemical resistance | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| By-Products of Combustion, ppm (max.) | | | | | | | | | | |
| Carbon Monoxide | | | | | | | | | | |
| Flaming | 275 | 200 | 100 | 300 | 300 | 300 | 300 | 300 | 300 | 125 |
| Non-Flaming | 3 | 2 | 1 | 10 | 10 | 10 | 10 | 10 | 10 | 3 |
| Hydrogen Fluoride | | | | | | | | | | |
| Flaming | 5 | 4 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 2 |
| Non-Flaming | 5 | 4 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 2 |
| Hydrogen Chloride | | | | | | | | | | |
| Flaming | 9 | 7 | 5 | 10 | 10 | 10 | 10 | 10 | 10 | 3 |
| Non-Flaming | 9 | 7 | 5 | 10 | 10 | 10 | 10 | 10 | 10 | 3 |
| Nitrogen Oxides | | | | | | | | | | |
| Flaming | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 6 |
| Non-Flaming | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 3 |
| Sulfur Dioxide | | | | | | | | | | |
| Flaming | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 2 |
| Non-Flaming | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 2 |
| Hydrogen Cyanide | | | | | | | | | | |
| Flaming | 5 | 5 | 5 | 5 | 5 | 5 | 10 | 10 | 10 | 4 |
| Non-Flaming | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 3 |
| ¼ Scale Room Burn – No Flash Over | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| Percent closed cell (range) | 100–76 | 100–76 | 100–76 | 30–0 | 30–0 | 30–0 | 30–0 | 30–0 | 30–0 | 75–20 |
| Tumbling Friability | | | | | | | | | | |
| 600 Revolutions, mass loss, max, % | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| 1200 Revolutions, mass loss, max, % | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Odor Emission | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| Fungi Resistance | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass |
| Wicking, 48 hrs, distance above water line, max. @ 22°C, mm | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 |

* = Not available consult manufacturer for additional information.

NA = Not Applicable

NB = A manufacturer can only claim conformance to this standard to the values reported in this table. The * notes are confidential data to the manufacturers and as such are not considered part of any qualifying requirements for the standard and only tell the user to inquire about that data.