



Designation: C1482 – 24<sup>ε1</sup>

# Standard Specification for Polyimide Flexible Cellular Thermal and Sound Absorbing Insulation<sup>1</sup>

This standard is issued under the fixed designation C1482; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

<sup>ε1</sup> NOTE—Corrected 6.1 and 6.1.2 editorially in April 2024.

## 1. Scope

1.1 This specification covers the composition and physical properties of lightweight, flexible open-cell polyimide foam insulation intended for use as thermal and sound-absorbing insulation for temperatures from  $-328^{\circ}\text{F}$  up to  $+572^{\circ}\text{F}$  ( $-200^{\circ}\text{C}$  and  $+300^{\circ}\text{C}$ ) in commercial and industrial environments.

1.1.1 **Annex A1** includes faced polyimide foam as specified by the U.S. Navy for marine applications.

1.1.2 This standard is designed as a material specification and not a design document. Physical property requirements vary by application and temperature. No single test is adequate for estimating either the minimum or maximum use temperature of polyimide foam under all possible conditions. Consult the manufacturer for specific recommendations and physical properties for specific applications.

1.1.3 The use of an appropriate vapor retarder is required in all applications where condensation could occur and cause a decrease in thermal performance or affect other system properties.

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 is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire-hazard or fire-risk assessment of the materials, products, or assemblies under actual fire conditions.

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.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- C165 Test Method for Measuring Compressive Properties of Thermal Insulations
- 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
- C302 Test Method for Density and Dimensions of Preformed Pipe-Covering-Type 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
- C421 Test Method for Tumbling Friability of Preformed Block-Type and Preformed Pipe-Covering-Type Thermal Insulation
- C423 Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
- 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
- C585 Practice for Inner and Outer Diameters of Thermal

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- Insulation for Nominal Sizes of Pipe and Tubing
- 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
- C1559** Test Method for Determining Wicking of Fibrous Glass Blanket Insulation (Aircraft Type)
- D395** Test Methods for Rubber Property—Compression Set
- D543** Practices for Evaluating the Resistance of Plastics to Chemical Reagents
- D638** Test Method for Tensile Properties of Plastics
- D2126** Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
- D3574** Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams
- D3675** Test Method for Surface Flammability of Flexible Cellular Materials Using a Radiant Heat Energy Source
- E84** Test Method for Surface Burning Characteristics of Building Materials
- E96/E96M** Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
- E176** Terminology of Fire Standards
- E662** Test Method for Specific Optical Density of Smoke Generated by Solid Materials
- E795** Practices for Mounting Test Specimens During Sound Absorption Tests
- E800** Guide for Measurement of Gases Present or Generated During Fires
- E1354** Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter
- E2231** Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics
- 2.2 *U.S. Federal Standards:*
- FAR 25.853(a), Appendix F, Part I, (a) (1) (i) Test Criteria and Procedures for Showing Compliance with Sec. 25.853, or 25.855<sup>3</sup>**
- FAR 25.856(a), Appendix F, Part VI, Test Method to Determine the Flammability and Flame Propagation Characteristics of Thermal/Acoustic Insulation Materials**

- MIL-C-20079** Cloth, Glass; Tape, Textile Glass; and Thread, Glass<sup>4</sup>
- MIL-A-3316** Adhesive, Fire-Resistant, Thermal Insulation<sup>4</sup>
- DOD-E-24607** Enamel, Interior, Nonflaming (Dry), Chlorinated Alkyd Resin, Semigloss (Metric)<sup>4</sup>
- 2.3 *Private Sector Standards:*
- Boeing BSS 7239** Test Method for Toxic Gas Generation by Materials on Combustion<sup>5</sup>
- TAPPI T 803** Puncture and Stiffness Test of Container Board<sup>6</sup>
- TM-232** Vertical Pipe-Chase Test to Determine Flame-Propagation Characteristics of Pipe Covering<sup>7</sup>

### 3. Terminology

3.1 *Definitions*—Terms used in this specification are defined in Terminology **C168**, Terminology **C634**, and Terminology **E176**. In the case of a conflict, Terminology **C168** shall be the dominant authority.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *flexible cellular product*—a cellular organic polymeric material that will not rupture when a specimen 8 by 1 by 1 in. (200 by 25 by 25 mm) is bent around a 1 in. (25 mm) diameter mandrel at a uniform rate of one lap in 5 s at a temperature between 64 and 85°F (18 and 29°C), in accordance with the description of a flexible cellular product (currently Subsection 3.1.3) in Test Methods **D3574**.

3.2.2 *slab*—a rectangular section, piece, or sheet of foam that is cut from a bun, or block of foam.

3.2.3 *polyimide foam*—a flexible cellular product in which the bonds formed between monomers during polymerization are imide or amide bonds. The theoretical mole fraction of imide bonds must be greater than the theoretical mole fraction of amide bonds.

### 4. Classification

4.1 The flexible polyimide cellular insulations of this specification are classified into Types I through VII as listed in **Tables 1 and 2 (Note 2)**. Type I is further subdivided into two grades based on maximum allowable thermal conductivity at 75°F (24°C). The Types II and III are subdivided into classes (**Note 3**).

**NOTE 2**—Although all types find application in a wide variety of markets, the current primary market for each type is as follows:

*Type I*—marine and industrial applications.

*Type II*—Type II is Type I foam faced and used in specific marine applications, as specified for the U.S. Navy in **Annex A1**.

*Type III*—Type III is Type I foam pipe shaped and used in specific marine applications, as specified for the U.S. Navy in **Annex A1**.

*Types IV, V, and VII*—aerospace applications depending on density.

<sup>4</sup> Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.

<sup>5</sup> Available from Boeing Commercial Airplane Group, Material Division, P.O. Box 3707, Seattle, WA 98124-2207.

<sup>6</sup> Available from Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, <http://www.tappi.org>.

<sup>7</sup> Available from Armstrong World Industries, Inc., Research and Development, P.O. Box 3511, Lancaster, PA 17604.

<sup>3</sup> Federal Aviation Regulations Part 25 (Airworthiness Standards, Transport Category Aircraft, and Section 25.853. Procedure in appendix F, Part I, (a) (1) (i) and (ii). Available from Superintendent of Documents, U.S. Government Printing Office P.O. Box 371954, Pittsburgh, PA 15250-7954.

**TABLE 1 Polyimide Foam Classification (inch-pound)**

	TYPE I Grade 1	TYPE I Grade 2	TYPE IV	TYPE V	TYPE VI	TYPE VII
Density, range, lb/ft <sup>3</sup>	0.36–0.53	0.36–0.53	0.28–0.37	0.50–0.58	0.35–0.55	0.42–0.52
Maximum Apparent Thermal Conductivity Btu-in./h ft <sup>2</sup> –°F						
–238°F	0.14	0.14	0.14	0.14	0.14	0.14
–58°F	0.23	0.22	0.23	0.23	0.23	0.23
75°F	0.32	0.29	0.34	0.30	0.34	0.34
212°F	0.51	0.47	0.54	0.47	0.50	0.50
356°F	0.74	0.70	0.81	0.70	0.74	0.74
572°F	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	1.15	NA <sup>A</sup>
Upper Temperature Limit – test temperature for C411, °F	400	400	400	400	572	400
High Temperature Stability – % of initial tensile strength retained after 336 h in air oven at 400° F, min, %	60	60	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>
High Temperature Stability – % of initial tensile strength retained after 336 h in air oven at 572° F, min, %	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	70	NA <sup>A</sup>
Compressive Strength, min, lb/in. <sup>2</sup> at 25% deflection	0.5	0.5	NA <sup>A</sup>	NA <sup>A</sup>	0.5	NA <sup>A</sup>
50% Compression Deflection, min, lb/in. <sup>2</sup>	1.2	1.2	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>
Compression Set, max, %	NA <sup>A</sup>	NA <sup>A</sup>	45	40	NA <sup>A</sup>	40
Steam Aging						
Change in Tensile Strength, max, %	25	25	NA <sup>A</sup>	NA <sup>A</sup>	25	NA <sup>A</sup>
Dimensional and weight changes, max, %	10	10	NA <sup>A</sup>	NA <sup>A</sup>	10	NA <sup>A</sup>
Corrosiveness	pass	pass	pass	pass	pass	pass
Chemical Resistance	pass	pass	pass	pass	pass	pass
Surface Burning Characteristics, 2 in. thickness						
Flame Spread Index, max	10	10	15	15	10	15
Smoke Developed Index, max	15	15	20	20	15	20
Radiant Panel Surface Flammability, Radiant Panel Index, max	5	5	5	5	2	NA <sup>A</sup>
Vertical Burn <sup>B</sup>						
Burn Length, max, in.	NA <sup>A</sup>	NA <sup>A</sup>	2	2.4	NA <sup>A</sup>	2.4
After Flame Time, max, s	NA <sup>A</sup>	NA <sup>A</sup>	1	1	NA <sup>A</sup>	1
Total heat release (2 min), max, Btu/ft <sup>2</sup>	79	79	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>
Flammability and Flame Propagation						
After Flame Time, max., s	NA <sup>A</sup>	NA <sup>A</sup>	3.0	3.0	NA <sup>A</sup>	3.0
Flame Propagation, max., in.	NA <sup>A</sup>	NA <sup>A</sup>	2.0	2.0	NA <sup>A</sup>	2.0
Maximum heat release rate, max, Btu/min-ft <sup>2</sup>	106	106	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>
Specific Optical Smoke Density, D <sub>m</sub> , max						
non-flaming mode	5	5	5	5	5	5
flaming mode	10	10	10	10	5	10
Total Hydrogen Halide (HCl, HBr, and HF) Gases in Smoke, Flaming Exposure, max, ppm (Above background for empty chamber)	10	10	NA <sup>A</sup>	NA <sup>A</sup>	10	NA <sup>A</sup>
Toxic Gas Generation: max, ppm						
CO	300	300	300	300	300	300
HCN	5	5	5	5	5	5
HF	5	5	5	5	5	5
HCl	10	10	10	10	10	10
HBr	5	5	5	5	5	5
SO <sub>2</sub>	5	5	5	5	5	5
NO <sub>x</sub>	10	10	10	10	10	10
Acoustical Absorption Coefficient 2 in. thickness, min Noise Reduction Coefficient (NRC)	0.75	0.70	0.75	0.85	0.70	0.85
Tumbling Friability						
600 Revolutions, mass loss, Max %	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
Odor Emission	Pass	Pass	Pass	Pass	Pass	Pass
Fungi Resistance	Pass	Pass	Pass	Pass	Pass	Pass
Wicking, 48h, distance above water line, max at 72°F, in.	0.5	0.5	0.5	0.5	0.5	0.5

<sup>A</sup> NA = not applicable

<sup>B</sup> The material shall not melt, drip, or flow when tested as required.

Type VI—applications requiring improved high temperature and fire performance.

NOTE 3—The Type II and Type III designations as well as the subdivision of Types into Classes is to maintain uniformity with existing U.S. Navy nomenclature (Annex A1).

## 5. Materials and Manufacture

5.1 Polyimide foam shall be manufactured from the appropriate monomers, and necessary compounding ingredients to conform to 3.2.3. This is not intended to imply that foam

products made using different materials are equivalent with respect to all physical properties.

## 6. Physical Properties

6.1 The insulation shall conform to the requirements in Tables 1 and 2 for each type, unless specifically stated otherwise by agreement between the supplier and the purchaser. Tests shall be made in accordance with the methods specified in Section 11.

**TABLE 2 Polyimide Foam Classification (SI units)**

	TYPE I Grade 1	TYPE I Grade 2	TYPE IV	TYPE V	TYPE VI	TYPE VII
Density, range, kg/m <sup>3</sup>	5.8–8.5	5.8–8.5	4.5–5.9	8.0–9.3	5.6–8.8	6.7–8.3
Maximum Apparent Thermal Conductivity W/m-K						
–150°C	0.020	0.020	0.020	0.020	0.020	0.020
–50°C	0.033	0.032	0.033	0.033	0.033	0.033
24°C	0.046	0.042	0.049	0.043	0.049	0.049
100°C	0.074	0.068	0.078	0.068	0.072	0.072
180°C	0.107	0.101	0.117	0.101	0.107	0.107
300°C	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	0.166	NA <sup>A</sup>
Upper Temperature Limit – test temperature for C411, °C	204	204	204	204	300	204
High Temperature Stability – % of initial tensile strength retained after 336 h in air oven at 204°C, min, %	60	60	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>
High Temperature Stability – % of initial tensile strength retained after 336 h in air oven at 300°C, min, %	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	70	NA <sup>A</sup>
Compressive Strength, min, kPa at 25 % deflection	3.4	3.4	NA <sup>A</sup>	NA <sup>A</sup>	3.4	NA <sup>A</sup>
50% Compression Deflection, min, kPa	8	8	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>
Compression Set, max, %	NA <sup>A</sup>	NA <sup>A</sup>	45	40	NA <sup>A</sup>	40
Steam Aging,						
Change in Tensile Strength, max, %	25	25	NA <sup>A</sup>	NA <sup>A</sup>	25	NA <sup>A</sup>
Dimensional and weight changes, max, %	10	10	NA <sup>A</sup>	NA <sup>A</sup>	10	NA <sup>A</sup>
Corrosiveness	pass	pass	pass	pass	pass	pass
Chemical Resistance	pass	pass	pass	pass	pass	pass
Surface Burning Characteristics, 50 mm thickness						
Flame Spread Index, max	10	10	15	15	10	15
Smoke Developed Index, max	15	15	20	20	15	20
Radiant Panel Surface Flammability, Radiant Panel Index, max	5	5	5	5	2	NA <sup>A</sup>
Vertical Burn <sup>B</sup> ,						
Burn Length, max, mm	NA <sup>A</sup>	NA <sup>A</sup>	50	60	NA <sup>A</sup>	60
After Flame Time, max, s	NA <sup>A</sup>	NA <sup>A</sup>	1	1	NA <sup>A</sup>	1
Total heat release (2 min), max, kW-min/m <sup>2</sup>	15	15	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>
Flammability and Flame Propagation						
After Flame Time, max., s	NA <sup>A</sup>	NA <sup>A</sup>	3.0	3.0	NA <sup>A</sup>	3.0
Flame Propagation, max., in.	NA <sup>A</sup>	NA <sup>A</sup>	51	51	NA <sup>A</sup>	51
Maximum heat release rate, max, kW/m <sup>2</sup>	20	20	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>	NA <sup>A</sup>
Specific Optical Smoke Density, D <sub>m</sub> , max						
non-flaming mode	5	5	5	5	5	5
flaming mode	10	10	10	10	5	10
Total Hydrogen Halide (HCl, HBr, and HF) Gases in Smoke, Flaming Exposure, max, ppm (Above background for empty chamber)	10	10	NA <sup>A</sup>	NA <sup>A</sup>	10	NA <sup>A</sup>
Toxic Gas Generation: max, ppm						
CO	300	300	300	300	300	300
HCN	5	5	5	5	5	5
HF	5	5	5	5	5	5
HCl	10	10	10	10	10	10
HBr	5	5	5	5	5	5
SO <sub>2</sub>	5	5	5	5	5	5
NO <sub>x</sub>	10	10	10	10	10	10
Acoustical Absorption Coefficient 50.8 mm thickness, min Noise Reduction Coefficient (NRC)	0.75	0.70	0.75	0.85	0.70	0.85
Tumbling Friability						
600 Revolutions, mass loss, Max %	3.0	3.0	NA <sup>A</sup>	NA <sup>A</sup>	3.0	3.0
1200 Revolutions, mass loss Max, %	5.0	5.0	NA <sup>A</sup>	NA <sup>A</sup>	5.0	5.0
Odor Emission	Pass	Pass	Pass	Pass	Pass	Pass
Fungi Resistance	Pass	Pass	Pass	Pass	Pass	Pass
Wicking, 48 h, distance above water line, max at 22°C, mm	13.0	13.0	13.0	13.0	13.0	13.0

<sup>A</sup> NA = not applicable

<sup>B</sup> The material shall not melt, drip, or flow when tested as required.

6.1.1 *Upper Temperature Limit*—Upper temperature limit shall be determined according to 11.4 at the intended maximum use temperature of the application, or at a temperature determined by agreement between the purchaser and manufacturer.

6.1.2 *Burning Characteristics*—The uncoated and unfaced foam shall conform to the requirements in Tables 1 and 2 for each type, when tested in accordance with 11.12-11.19, without the use of flame/smoke or heat suppressant barriers or coatings.

6.1.3 *Sound Absorbing Performance*—Unless specifically otherwise agreed to between the supplier and the purchaser, all tests shall be made in accordance with the methods specified in 11.20.

6.2 The values stated in **Tables 1 and 2** are not to be used as design values. It is the responsibility of the buyer to specify design requirements and obtain supporting documentation from the material supplier.

## 7. Workmanship and Appearance

7.1 The slab offered as saleable material shall be free of foreign materials and defects that will adversely affect its performance in service.

7.2 *Voids and Surface Damage*—It is acceptable to repair surface damage due to handling, and voids that are between 0.24 in. (6 mm) and 1.4 in. (35 mm) in diameter, and extend through the entire slab, by gluing, plugging, or cutting and splicing. Voids greater than 1.4 in. (35 mm) in diameter shall be cause for rejection of the affected material. It is acceptable to achieve plugging using compression fit or by using adhesives. Adhesives used for repair shall not affect the overall smoke, fire, or acoustic performance required for the material in this specification. Material used for repairs shall be of the same composition and quality as undamaged material. The acceptance of type and amount of repair shall be as agreed upon by the supplier and the user.

## 8. Sampling

8.1 *Sampling*—The insulation shall be sampled in accordance with Practice **C390**. Otherwise, specific provisions for sampling shall be as agreed upon between the user and the supplier.

8.2 *Specimen*—For polyimide foam insulation, specimens of dimensions 12 by 12 by 1 in. (300 by 300 by 25 mm) are sufficient for purposes of acceptance inspection of samples.

## 9. Qualification Requirements

9.1 The following requirements shall be employed for initial material or product qualification:

- 9.1.1 Upper Temperature Limit (11.4),
- 9.1.2 Compressive Strength (11.6),
- 9.1.3 Compression Set (11.8),
- 9.1.4 Chemical Resistance (11.11),
- 9.1.5 Apparent Thermal Conductivity at 75°F (24°C) (11.3),
- 9.1.6 Specific Optical Smoke Density (11.17),
- 9.1.7 Hydrogen Halide Gases in Smoke (11.18),
- 9.1.8 Surface Burning Characteristics (11.12),
- 9.1.9 Radiant Panel Surface Flammability (11.13),
- 9.1.10 Flammability and Flame Propagation (11.15),
- 9.1.11 Heat Release Rate (11.16),
- 9.1.12 Sound Absorption Coefficients (11.20),
- 9.1.13 Density (11.2),
- 9.1.14 Tumbling Friability (11.21),
- 9.1.15 Odor Emission (11.22),
- 9.1.16 Fungi Resistance (11.23), and
- 9.1.17 Wicking (11.24).

## 10. Inspection

10.1 The following requirements shall be employed for acceptance sampling of lots or shipments of qualified polyimide foam insulation:

- 10.1.1 Density,
- 10.1.2 Apparent Thermal Conductivity at 75°F (24°C),
- 10.1.3 Vertical burn—Type IV and V only,
- 10.1.4 Workmanship, and
- 10.1.5 Tumbling Friability.

10.2 As agreed to by the purchaser and the manufacturer, the inspection of the material shall be made at either the point of shipment or point of delivery.

## 11. Test Methods

### 11.1 *Sample Preparation*:

11.1.1 In cases where the material is cut into pipe insulation and other shapes without further treatment, slab foam test results are generally representative. If other processes are used for specific applications, it is recommended that qualification testing be conducted using slab specimens, and that inspection testing be on the processed material.

11.1.2 Tests for physical and mechanical properties shall be carried out at a temperature of  $73.4 \pm 3.6^\circ\text{F}$  ( $23 \pm 2^\circ\text{C}$ ) and at a relative humidity of  $50 \pm 5\%$ . Sound absorbing, thermal, and flammability tests shall be carried out at conditions specified in the applicable test methods.

11.1.3 All test specimens for testing of physical and mechanical properties in **Tables 1 and 2** shall be preconditioned by twice mechanically reducing (flexing) their thickness to a 25 % deflection of their original thickness except for Test Methods **C421**, **C1559**, and **D3574**, Test C, where unflexed foam shall be used. In cases where a specified test method itself contains this requirement, additional flexing is not to be performed.

### 11.2 *Density*—Test Methods **D3574**, Test A.

11.3 *Apparent Thermal Conductivity*—Test Methods **C177**, **C1114**, and **C518** in conjunction with Practice **C1045**. Test Method **C518** shall not be used at temperatures or resistances other than those in the range of the calibration. Test temperatures shall be chosen in accordance with Table 3 of Practice **C1058**. Use the large temperature difference recommended in Table 3 of Practice **C1058** for temperatures between 25 and 110°F (−4 and 43°C); for mean temperatures under 25°F (−4°C) and over 110°F (43°C) use the smaller temperature difference.

11.4 *Upper Temperature Limit*—Test Method **C411** and Practice **C447** shall be used at the maximum use temperature of the insulation and at maximum design thickness. No special requirements for heat-up shall be specified by the manufacturer. The foam shall not flame, glow, smolder, smoke, soften, collapse, melt, or drip during hot surface exposure.

11.5 *High Temperature Stability*—Test Method **D2126** incorporating Test Method **D638**. Use Test Method **D2126**, with a modified test temperature of 400°F (204°C) or 572°F (300°C) as shown in **Tables 1 and 2**. Test before and after aging using Test Method **D638**, type III specimens.

11.6 *Compressive Strength*—Test Method **C165**, Procedure B.

11.7 *50 % Compression Deflection*—Test Methods **D3574**, Test C.

11.8 *Compression Set*—Test Methods **D395**, test temperature is 158°F (70°C) and aging time is 22 h.

11.9 *Steam Aging*—Test Methods **D3574**, Procedure J1 and Test E.

11.10 *Corrosiveness*—Test Method in Specification **C665**.

11.11 *Chemical Resistance*—Practices **D543**, practice A, procedure I at room temperature with reagents 6.3.8, 6.3.40, 6.3.46, 6.3.50, aviation turbine fuel grade JP-5 and ethylene glycol antifreeze from Table 1, and SKYDROL hydraulic fluid. Final weight and dimensions are to be determined 24 h after removal from immersion.

11.12 *Surface Burning Characteristics*—Test Method **E84** and for material used in pipe and duct applications use Test Method **E84** with Practice **E2231**.

11.13 *Radiant Panel Surface Flammability*—Test Method **D3675**.

11.14 *Vertical Burn*—Test Method FAR 25.853(a), Appendix F, Part 1, (a) (1) (i).

11.15 *Flammability and Flame Propagation*—Test Method FAR 25.856(a), Appendix F, Part VI.

11.16 *Heat Release Rate*—Test Method **E1354**, with an initial test heat flux of 185 Btu/min-ft<sup>2</sup> (35 kW/m<sup>2</sup>).

11.17 *Specific Optical Smoke Density*—Test Method **E662**.

11.18 *Hydrogen Halides in Smoke*—Test Method **E662**, with integrated sampling, and anion detection using ion chromatography, in accordance with Guide **E800**.

11.19 *Toxic Gas Generation*—Boeing BSS 7239, Flaming mode.

11.20 *Sound Absorption Coefficients*—Test Method **C423**, using the Type A Mounting described in Practices **E795**.

11.21 *Tumbling Friability*—Test Method **C421**. The test shall be run for a total of 1200 revolutions (20 min.). The mass

loss shall not be greater than 3 % after the first 600 ± 3 revolutions (10 min.) and not greater than 5 % after the next 600 ± 3 revolutions (10 min.; 20 min. total).

11.22 *Odor Emission*—Test Method **C1304**. A strong and objectionable odor shall not be detected by more than two judges.

11.23 *Fungi Resistance*—Test Method **C1338**. The foam shall not exhibit greater growth than the comparative item.

11.24 *Wicking*—Test Method **C1559**, Procedure A. Only the room temperature water test shall be used and for only 48 h, ±2 h. Wicking shall not exceed 0.5 in. above the water line. In addition, precipitates shall not form in the water bearing the wicking specimens.

## 12. Certification

12.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished. For the purpose of this specification, a lot consists of all material of the same type manufactured in one unchanged production run and offered for delivery at the same time.

## 13. Packaging and Marking

13.1 *Packaging*—Unless otherwise specified, the insulation shall be supplied in the standard commercial packaging of the manufacturer.

13.2 *Marking*—Unless otherwise specified, each container shall be plainly marked with the name of the manufacturer, the product name, trademark, and the address of the manufacturer, with dimensions or volumes, or both, expressed in units agreed upon by the supplier and customer.

## 14. Keywords

14.1 flexible cellular insulation; pipe insulation; polyimide; ship insulation; sound absorbing; thermal insulation

## ANNEXES

### (Mandatory Information)

## SUPPLEMENTAL REQUIREMENTS TO POLYIMIDE FLEXIBLE CELLULAR THERMAL AND SOUND ABSORBING INSULATION FOR U.S. NAVY SPECIFIED MARINE APPLICATIONS

### A1. SCOPE

A1.1 This annex gives the requirements for fire resistant thermal and acoustic absorptive polyimide foam insulation panels and for preformed thermal insulation for use on pipes at surface temperatures from 100 to 400°F (38 to 204°C) for use in U.S. Navy shipboard applications.