



# Standard Specification for Glass Fiber Felt Thermal Insulation<sup>1</sup>

This standard is issued under the fixed designation C 1086; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers glass fiber unsupported needled felt binder-free insulation for thermal insulation. This material is used as the thermal insulation component in the fabrication of insulation systems for use on machinery and equipment, such as steam turbines, boilers, boiler feed pumps, and piping at temperatures up to 1200°F (650°C).

1.2 *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.*

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

NOTE 1—This standard is a consensus standard to provide a substitute for military specification MIL-I-16411E.

## 2. Referenced Documents

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

- C 167 Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations
- 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 411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation
- C 518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
- C 1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions
- C 1058 Practice for Selecting Temperatures for Evaluating

and Reporting Thermal Properties of Thermal Insulation  
D 578 Specification for Glass Fiber Strands

### 2.2 U.S. Federal Standard:

FED-STD-191 Textile Test Methods<sup>3</sup>

### 2.3 U.S. Military Standards:

MIL-I-16411E Insulation Felt, Thermal, Glass Fiber<sup>3</sup>

MIL-STD-1623 Fire Performance Requirements and Approved Specifications for Interior Finish Materials and Furnishings (Naval Shipboard Use)<sup>3</sup>

## 3. Terminology

### 3.1 Definitions:

3.1.1 Terminology C 168 shall be considered as applying to the terms used in this specification.

3.1.2 Definitions in Specification D 578 shall be considered as applying to the terms used in defining glass fiber composition code, process, and fiber diameter.

## 4. Classification

4.1 Thermal insulation shall be glass fiber, unsupported needled felt insulation, for use on surfaces with temperatures up to 1200°F (650°C).

## 5. Ordering Information

5.1 The purchase order or contract shall specify the following:

5.1.1 Quantity of each thickness (10.1).

5.1.2 Any special requirements for nonstandard sizes or dimensions (10.2 and 10.3).

5.1.3 Any requirements for certification (19.1).

5.1.4 Any special requirements for supplementary testing requirements (9.1).

## 6. Materials and Manufacture

6.1 The material shall consist of 100 % glass fiber yarns needled into insulation felts without the use of binders. No organic fibers and no glass or mineral shot shall be included in the product. The insulation felt may be composed of laminates formed without the use of binders. The glass fibers shall meet the designation C, Continuous Filament Yarns, in accordance with Specification D 578 (see Note 2).

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.23 on Blanket and Loose Fill Insulation.

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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.

<sup>3</sup> Available from Standardization Documents, Order Desk, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, ATTN: NPODS.

6.2 The fiber diameter of the glass fiber yarns used in the final product, when determined in accordance with the Filament Diameter section of Specification D 578 shall conform to the requirements of Table 1. The certification of the fineness of fiber may be either by the felt manufacturer or by certification of the glass yarn supplier and documentation by the manufacturer as to sources of supply.

6.3 All materials used shall be asbestos-free.

NOTE 2—The fibers from glass composition designated as “E” glass (electrical glass) in the range from D through G meet the requirements of Tables 1 and 2.

## 7. Physical Properties

7.1 When tested in accordance with Section 16, the insulation shall conform to the physical requirements listed in Table 2.

## 8. Performance Characteristics

8.1 Needled felt glass fiber insulation may be damaged if any of the following conditions are encountered:

- 8.1.1 Direct exposure to hydrofluoric acid.
- 8.1.2 Prolonged direct exposure to strong caustics.
- 8.1.3 Prolonged exposure to boiling water.

8.2 Conditions outlined in 8.1 are mentioned only to make the user aware of such applications that require special consideration. Contact the insulation manufacturer for recommendations when the above conditions are anticipated.

## 9. Other Requirements

9.1 Supplementary requirements include qualification tests and acceptance tests to special standards. These supplementary requirements may be made by agreement to the supplier and the purchaser only when specified in the purchase order or contract.

## 10. Standard Sizes and Dimensions

10.1 *Thickness*—The insulation shall be furnished in the thicknesses shown in Table 3.

10.2 *Insulation Length*—Unless otherwise specified, the insulation shall be furnished in rolls of the lengths given in Table 3.

10.3 *Insulation Width*—Unless otherwise specified (5.1.2), the width of the insulation shall be 60 in. (1.52 m).

10.4 *Nominal Weight per Area*—The insulation shall be furnished in the weight per area shown in Table 4.

## 11. Dimensional Tolerances

11.1 *Thickness Tolerance*—The average thickness as determined in accordance with 16.1.1 shall be within  $\pm 0.125$  in. (3.2 mm) of the specified thickness.

11.2 *Mass per Area Tolerance*—The average weight per area shall be within  $\pm 10\%$  of that specified in Table 4.

**TABLE 1 Requirements for Fineness of Fiber**

Fineness of Fiber	Inch (Millimetre)
Average diameter shall not exceed	0.00036 (0.009)
90 % shall be less than	0.00040 (0.102)

**TABLE 2 Physical Requirements**

Thickness, length of roll	See Table 3
Mass per unit area	See Table 4
Apparent Thermal Conductivity, Max <sup>A</sup>	
Btu in./h ft <sup>2</sup> F (W/mK) at mean temp. of:	
75°F (24°C)	0.29 (0.042)
300°F (149°C)	0.40 (0.058)
500°F (260°C)	0.50 (0.072)
700°F (371°C)	0.65 (0.094)
Hot Surface Performance at 1200°F (650°C)	no melting, no significant shrinkage (max 5 %)
Tensile strength: psi (kPa)	
Minimum	5 (34.5)
Non-Combustible	Pass

<sup>A</sup> The thermal transmission properties of felted glass fiber thermal insulation may vary with temperature, temperature gradient, thickness and shape. Note that the apparent thermal conductivity requirements specified in the table are based on samples tested under conditions specified in 16.1.3. These are comparative values for establishing specification compliance. They may not represent the installed performance of the insulation under use conditions of the insulation differing substantially from the test conditions.

**TABLE 3 Standard Dimensions**

Nominal Thickness, in. (mm)	Insulation Length, ft (m)
0.3 (7.6)	150 (45.2)
0.5 (12.7)	75 (22.9)
1.0 (25.4)	45 (13.7)
0.75 (19.1)	55 (16.8)

**TABLE 4 Standard Parameters**

Nominal Thickness, in. (mm)	Mass per Area oz/ft <sup>2</sup> (kg/m <sup>2</sup> )
0.3 (7.6)	3.5 (1.07)
0.50 (12.7)	6.0 (1.83)
1.0 (25.4)	15.0 (4.58)
0.75 (19.1)	12.25 (3.74)

11.3 *Insulation Length/Tolerance*—The tolerance on the lengths, listed in Table 3, shall be  $-6$  in. ( $-152$  mm), with excess permitted. A roll may either contain a maximum of one full thickness splice or consist of a maximum of two pieces.

11.4 *Width*—The width shall be within  $-0.5$  in. (13 mm), to  $+1.0$  in. (25 mm) of the specified width.

## 12. Workmanship, Finish, and Appearance

12.1 Since some requirements for this material are not easily defined by a numerical value, the insulation shall not have visible defects that will adversely affect its service qualities.

## 13. Qualification Requirements

13.1 The following requirements are generally employed for the purpose of initial material or product qualification in accordance with Criteria C 390:

- 13.1.1 Standard sizes and dimensions,
- 13.1.2 Thermal conductivity,
- 13.1.3 Fineness of fiber,
- 13.1.4 Hot surface performance,
- 13.1.5 Tensile strength, and
- 13.1.6 Non-combustible.

## 14. Sampling

14.1 The insulation shall be sampled for qualification testing and for inspection in accordance with Criteria C 390. Specific provision for sampling shall be agreed upon between the purchaser and the supplier.

## 15. Inspection Requirements

15.1 *Inspection for Quality Assurance*—The following requirements are generally employed for purposes of acceptance sampling of lots or shipments of qualified felted insulation.

15.1.1 Thickness.

15.1.2 Mass per unit area.

15.2 *Points of Inspection*—When agreed to by the purchaser and the manufacturer, and when specified in the purchase order or contract, the inspection of the material may be made at either the point of shipment or point of delivery.

## 16. Test Methods

16.1 The properties enumerated in this specification shall be determined in accordance with the following test methods:

16.1.1 *Thickness*—Test Methods C 167. Follow the specified pressure alternative procedure of Test Methods C 167 except that the expansion procedure for sample preparation is not necessary. A test specimen shall be taken that is 4 ft long by the full width of the insulation felt. The test specimen shall be ruled off into 20 approximately square and equal areas, and the thickness measurement taken at the center of ten areas, no two of which shall have a contiguous side. The specimen shall be placed on a hard flat surface and the thickness shall be measured using a dial gage indicator. The gage shall have a circular presser foot 3–4 in. (76–102 mm) in diameter. The foot shall exert a pressure of  $0.1 \text{ lb/in.}^2$  ( $7 \text{ gm/cm}^2$ )  $\pm 10\%$ . The gage shall be calibrated before use with a gage block. The average of the ten thickness measurements shall be taken as the thickness of the test specimen.

16.1.2 *Area Weight*—Test Methods C 167, except that the expansion procedure for sample preparation is not necessary. The weight per unit area shall be reported in ounces per square foot (kilograms per square metre). The test specimen shall be 4 ft long by the full width of the felt. The specimen taken for the thickness measurement may also be used for the weight per unit area measurement.

16.1.3 *Apparent Thermal Conductivity*—Apparent thermal conductivity shall be determined in accordance with Test Methods C 177 or C 518. In case of dispute, Test Method C 177 shall be used.

16.1.3.1 See Guide C 1045 for requirements and guidelines for the determination of thermal transmission properties.

16.1.3.2 See Guide C 1058 for guidelines for reporting thermal properties.

16.2 *Hot Surface Performance*—Test Method C 411. The test temperature shall be that specified in 3.1, or the manufacturer's recommended temperature, whichever is higher.

16.3 *Tensile Strength*—The tensile strength shall be determined by the grab test method described in Method 5100 of FED-STD-191 with the following exceptions: The test sample

shall be from 12 to 14 in. long by the full width of the felt. Five test specimens measuring 12 in. in the width direction by 12 to 14 in. (305 by 355 mm) long shall be cut from the sample. The specimens shall be clamped at the top and bottom sections by a nominal  $\frac{1}{2}$  in. (12 mm) pipe covered with 0.25-in. (6-mm) thick sponge rubber to prevent cutting and slipping of the specimens. The clamped specimens, having a test area of about  $1 \text{ ft}^2$  ( $0.09 \text{ m}^2$ ) shall be attached to the grips of the testing machine that shall separate at a rate of  $2 \pm 0.2 \text{ in.}$  ( $51 \pm 5 \text{ mm}$ )/min until rupture occurs. Tensile strength determinations shall be made on specimens before and after being subjected to soaking heat to  $1200^\circ\text{F}$  ( $650^\circ\text{C}$ ) for 6 h. The tensile strength shall be expressed in pounds per square inch (kilopascals) based on the nominal cross-sectional area. The tensile strength for purposes of determining conformance shall be the average of the five measurements on these specimens (see Table 2).

16.4 *Fire Resistance*—Test method USCG 164.009 (in accordance with MIL-STD-1623).

## 17. Rejection and Rehearing

17.1 Material that fails to conform to the requirements of the agreed upon specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or the supplier may make claim for a rehearing.

17.2 Upon the request of the purchaser in the contract or order, the certification of an independent third party indicating conformance to the requirements of this specification may be accepted instead of the manufacturer's certification.

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

## 18. Certification

18.1 When specified in the purchase order or contract, the producer or the supplier shall furnish a certificate to the purchaser that the material was manufactured, sampled, and tested or inspected in accordance with this specification and has been found to meet the requirements. The supplier shall furnish a summary of the documentation of the qualification test results or the inspection test results, or both, upon request.


## 19. Packaging and Package Marking

19.1 *Packaging*—Unless otherwise agreed upon or specified between the purchaser and manufacturer or supplier, insulation shall be packed in the manufacturer's standard commercial containers.

19.2 *Package Marking*—Unless otherwise specified, each container shall be plainly marked with the manufacturer's name, the product name, and quantity of the material in the container.

## 20. Keywords

20.1 binder free; glass fiber felt; glass fiber yarns; needled felt

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