MIL-I-16411E
21 October 1975
SUPERSEDING
MIL-I-16411D
10 June 1968
(See 6.4)

MILITARY SPECIFICATION

INSULATION FELT, THERMAL, GLASS FIBER

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers glass fiber insulation felt for thermal insulation of machinery and equipment.

1.2 Classification. Insulation felt shall be of the following types, as specified (see 6.2.1)

Type I - Felted rovings.
Type II - Laminated and felted.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATIONS

FEDERAL
PPP-B-585 - Boxes, Wood, Wirebound.
PPP-B-601 - Boxes, Wood, Cleated-Plywood.
PPP-B-621 - Boxes, Wood, Nailed and Lock Corner.
PPP-B-640 - Boxes, Fiberboard, Corrugated, Triple Wall.

MILITARY
MIL-P-116 - Preservation-Packaging, Methods of.
MIL-Y-1140 - Yarn, Cord, Sleeving, Cloth, and Tape Glass.

STANDARDS

FEDERAL
FED-STD-191 - Textile Test Methods.

MILITARY
MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-1623 - Fire Performance Requirements and Approved Specifications for Interior Finish Materials and Furnishings (Naval Shipboard Use).

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
C-177-71 - Thermal Conductivity of Materials by Means of the Guarded Hot Plate, Test for.
D-1448-74 - Micronaire Reading of Cotton Fibers, Test for.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

NATIONAL MOTOR FREIGHT TRAFFIC ASSOCIATION, INC., AGENT
National Motor Freight Classification Rules

(Application for copies should be addressed to the American Trucking Associations, Inc., Traffic Order Section, 1616 "P" Street, N.W., Washington, D.C. 20036.)

UNIFORM CLASSIFICATION COMMITTEE
Uniform Freight Classification Rules.

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, Illinois 60606.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Sample for first article inspection. Prior to beginning production a sample shall be tested as specified in 4.3 (see 6.3).

3.2 Material and construction.

3.2.1 Type I. The material shall consist of staple glass fibers felted into rovings and woven or bound with wire-inserted yarn.

3.2.1.1 Yarn. Yarn shall be asbestos-free.

3.2.2 Type II. The material shall consist of 100 percent glass fibers in accordance with MIL-Y-1140, composed of adhered laminates without use of additional binders. No organic fiber or shot shall be included in the material used in the manufacture of the insulations.

3.3 Dimensions and weight.

3.3.1 Type I.

3.3.1.1 Length. Unless otherwise specified (see 6.2.1), the insulation shall be furnished in rolls of 50 feet (ft) in length for 3/4 inch thickness. For thickness in excess of 3/4 inch, 25 ft lengths shall be furnished.

3.3.1.2 Width. Unless otherwise specified (see 6.2.1), width of each roll shall be 60 inches.

3.3.1.3 Thickness and weights. The insulation shall be furnished in thicknesses shown in table I as specified (see 6.2.1), and shall vary not more than plus or minus 10 percent from the weight specified for the ordered thickness.

Table I - Thickness and weights, type I.

Nominal thickness	Thickness tolerance ±	Nominal weight per square foot (ft^2)
Inches	Inch	Ounces
3/4	1/8	9.0
1	1/8	12.0
1-1/2	1/8	18.0
2	1/8	24.0

3.3.2 Type II.

3.3.2.1 Length. Unless otherwise specified (see 6.2.1), the insulation shall be furnished in rolls of 75 ft lengths for 1/2-inch thick material and 45 ft lengths for 1-inch thick material.

3.3.2.2 Width. Unless otherwise specified (see 6.2.1), width of roll shall be 60 inches.

3.3.2.3 Thickness and weights. The insulation shall be furnished in the thicknesses shown in table II, as specified (see 6.2.1), and shall vary not more than ± 10 percent from the weight specified for the ordered thickness.

Table II - Thickness and weights, type II.

Nominal thickness	Thickness tolerance ±	Nominal weight per square foot (ft^2)
Inch	Inch	Ounces
1/2	1/8	6.0
1	1/8	15.0

3.4 Thermal conductivity. Thermal conductivity (k) in British thermal unit (Btu) per square foot per hour of insulation for 1° Fahrenheit (F) gradient per inch thickness shall not exceed the values at the mean temperatures shown in table III (see 4.7.3).

Table III - Thermal conductivity.

Mean temperature	Thermal conductivity (k)	
Degrees F	Type I	Type II
300	0.45	0.40
500	0.56	0.50
700	0.70	0.65

3.5 Fineness of fiber. The diameter of the individual fibers shall average 0.00035 inch or less. Ninety percent of the fibers shall be less than 0.00040 inch diameter (see 4.7.4).

3.5.1 Length of fiber. Fibers less than 1 inch in length shall not be used before processing of the fiber into felt (see 4.7.4.1).

3.6 Alkalinity. The alkalinity of the finished material expressed as sodium oxide (Na_2O) shall not exceed 0.20 percent (see 4.7.5).

3.7 Fusing temperature. The fusing temperature of the fibers shall be not less than 1300°F (see 4.7.6).

3.8 Stability. The insulation shall reveal no apparent physical change in the glass fibers. The glass fibers shall show no appreciable deterioration when tested in accordance with 4.7.7.

3.9 Tensile strength, (type II only). The tensile strength before and after heating to 1200°F shall not be less than 5.0 pounds per square inch (lb/in^2) (see 4.7.8).

3.10 Fire resistance. The flammability requirements shall conform to the requirements set forth in MIL-STD-1623 (see 4.7.9).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection. The inspection requirements specified herein are classified as follows:

(a) First article inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).

4.3 First article inspection. First article inspection shall consist of the examination of 4.5 and the tests specified in 4.7.

4.3.1 First article sample. If more than one thickness of type I or II insulation felt is procured at any one time, one roll of each thickness and type shall constitute the first article sample, unless otherwise indicated by the procuring activity (see 6.2.1).

4.4 Quality conformance inspection. Inspection shall be in accordance with the provisions of MIL-STD-105 except where otherwise indicated. For purposes of sampling, an inspection lot may number up to 325 rolls for type I or 135 rolls for type II provided the total number of square feet represented by the rolls for each type and thickness does not exceed 40,000 square feet. The lot size shall be expressed in rolls.

4.5 Examination. Each of the sample rolls selected in accordance with MIL-STD-105, AQL 2.5 major and 4.0 minor shall be surface examined and measured to determine conformance with the requirements of this specification which do not require tests. Examination shall be conducted as specified in table IV, and at least 15 ft in length of each roll shall be examined. Any roll in the sample containing one or more visual or dimensional defects shall not be offered for delivery, and if the number of defective rolls in any sample exceeds the acceptance number for that sample, this shall be cause for rejection of the lot represented by the sample.

Table IV - Classification of defects.

Categories	Defects
Critical:	None defined:
Major:	
101	Type of insulation not as specified.
102	Material less than minimum requirements; evidence of unauthorized materials and processes used; insulation not composed of specified materials.
103	Construction of type I insulation nonconforming or not as specified; not woven or bound with wire-inserted yarn as specified.
104	Construction of type II insulation nonconforming or not as specified; not adhered laminates as specified; evidence of use of binders, or presence of shot.
105	Insulation not furnished in rolls (when applicable); length and width of insulation not as specified.
106	Thickness of insulation not within the specified minimum and maximum tolerances.
Minor:	
201	Packaging, and packing not as specified.
202	Gross weight of containers exceeds the specified maximum.

4.6 Testing of the end item (felt). The testing specified in 4.7 shall be in accordance with level S-1 of MIL-STD-105. For these tests, the lot size shall be expressed in rolls and the sample size in the number rolls. The AQL for these characteristics shall be 6.5. The unit of product for test purposes shall be one linear yard of felt. All tests specified in 4.7 shall be conducted for quality conformance testing except that fire resistance and thermal conductivity shall be conducted only if specified by the procuring activity (see 6.2.1) or at least once per year whichever is more frequent.

4.7 Test procedures.

4.7.1 Thickness. The test specimen shall be ruled off into approximately 20 square and equal areas, and the thickness measurement taken at the center of ten areas, no two of which shall have a common side. In determining the thicknesses, the test specimen shall be placed on a hard, flat surface, and the penetrating pin of the depth gage shall be forced downward through the specimen, perpendicular to the flat surface as shown on figure 1. If necessary to prevent compression of the specimen by the depth gage pin, the specimen shall first be pierced. When the point of the pin touches the flat surface, the sliding disk shall be lowered to the point of contact with the top surface of the specimen. The gage shall be withdrawn, and the distance from the point of the pin to the sliding disk shall be measured to the nearest 1/32 inch. The average of the 20 thickness measurements shall be taken as the thickness of the test specimen.

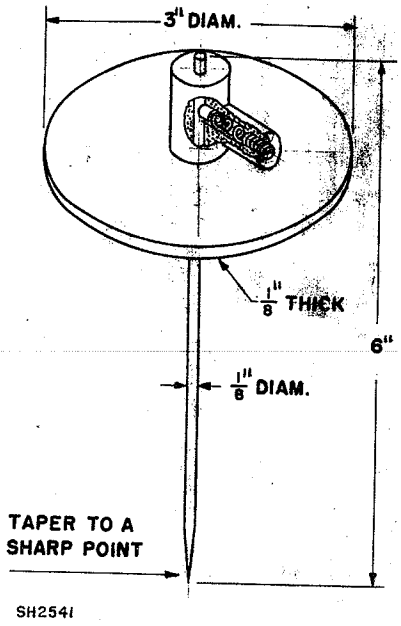

Figure 1 - Depth gage for thickness measurements.

4.7.2 Weight. Each sample shall be weighed on a suitable scale to verify compliance with the requirements of 3.3.1.3 and 3.3.2.3.

4.7.3 Thermal conductivity. Thermal conductivity shall be determined in accordance with ASTM C-177-71.

4.7.4 Fineness of fibers. Diameter of fibers shall be determined microscopically on the basis of at least seven checks on each of the samples. The average diameter for purposes of determining conformance with 3.5 shall be the average of all measurements on all samples. An alternate micronaire method (ASTM D 1448-74) may be used, however, in case of dispute the microscopic technique shall be the referee test method.

4.7.4.1 Length of fibers. A minimum of seven checks for fiber length shall be made on each of the samples. Ninety percent of the fibers selected shall be over 1/4 inch in length after being processed into felt. Two checks for fiber length are required for the raw fiber before processing and after processing into felt.

4.7.5 Alkalinity. Weigh a 5 ± 0.01 gram (g) representative sample of the felt, and place in a 500 milliliter (ml) pyrex Erlenmeyer flask. Wet with 5 ml of 95 percent ethyl alcohol and add 400 ml of distilled water. Reflux for 4 hours ± 5 minutes. At the end of this period, disconnect the condenser and filter at once through a No. 41 Whatman paper, or equal, supported in a Buechner funnel and connected to a suction source. Wash the flask and residual material three times with 25 ml portions of hot distilled water. Titrate the combined filtrate and wash solution immediately with 0.02N H_2SO_4 using 6 to 8 drops of a 1 percent solution of phenol-red indicator, to the disappearance of the pink color. Run a blank determination on the total amount of distilled water and alcohol and substitute the titration value in the formula below:

$$\text{Percent alkalinity expressed as } Na_2O = \frac{(A-B)N \times 0.031 \times 100}{W}$$

Where A = ml H_2SO_4 required to titrate sample.
B = ml H_2SO_4 required to titrate the blank.
N = Normality of the H_2SO_4.
W = Weight of sample in grams.

4.7.6 Fusing temperature. Weigh 1 g of glass fiber into a crucible and place a muffle furnace at room temperature. Turn all heating elements on at start of test and adjust so that the specified temperature of 1300°F is reached in 45 minutes. When this temperature is reached, remove crucible from furnace immediately, allow to cool, and examine visually for fusion. Fusion shall be said to have taken place if any part of the sample has melted and formed a homogeneous mass.

4.7.7 Stability. Samples of felt 4 inches square shall be encased in a metal wire screen and placed on a rack above the water level in a steam digester. The samples shall be subjected to saturated steam at 225 pounds per square inch gage (lb/in^2g) for 16 hours. Samples shall then be removed and the insulation and glass fibers examined for deterioration.

4.7.8 Tensile strength, (type II only). Tensile strength shall be determined by the grab method described in method 5100 of FED-STD-191 with the following modifications: Test specimens shall be 12 by 14 inches in size. The specimens shall be clamped at the top and bottom sections by 1/2-inch pipe covered with 1/4-inch thick sponge rubber to prevent cutting and slipping of the specimens. The clamped specimens, having a test area of one ft^2 shall be attached to the grips of the testing machine which shall separate at a rate of 2 inches per minute until rupture occurs. Tensile strength determinations shall be made on specimens before and after being subjected to soaking heat to 1200°F for 6 hours. The tensile strength shall be expressed in lb/in^2 of cross-sectional area.

4.7.9 Fire resistance. The felt shall be tested in accordance with the requirements of MIL-STD-1623.

4.8 Inspection of preparation for delivery. Sample rolls and shipping containers shall be selected and examined in accordance with MIL-P-116 to verify conformance to the requirements of section 5 herein.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements.)

5.1 Preservation-packaging. Preservation-packaging shall be level A or C, as specified (see 6.2.1).

5.1.1 Level A. Rolls shall be individually covered with standard 7-1/2 ounce (weight) burlap tubing drawn together at each end with wire ties.

5.1.2 Level C. Rolls shall be preserved and packaged in such manner that will afford adequate protection against deterioration and physical damage during shipment from the supply source to the first receiving activity for immediate use. The suppliers normal retail or wholesale preservation-packaging methods may be utilized when such meet the requirements of this level.

5.2 Packing. Packing shall be level A, B, or C, as specified (see 6.2.1).

5.2.1 Type I.

5.2.1.1 Level A. Rolls, packaged as specified (see 6.2.1), shall be packed in wood-cleated plywood, nailed wood or wire-bound boxes conforming to PPP-B-601 (overseas type), PPP-B-621 (class 2) or PPP-B-585 (class 3) respectively, or in triwall corrugated fiberboard boxes conforming to PPP-B-640 (class 2) at the option of the contractor. Boxes shall be closed, banded, or strapped in accordance with the applicable box specification or appendix thereto. Flat steel strapping, when used, shall be type I, class B. The gross weight of the containers shall not exceed 200 pounds.

5.2.1.2 Level B. Rolls, packaged as specified (see 6.2.1), need not be overpacked for shipment. Alternatively, rolls may be packed in containers specified for level A (see 5.2.1) except containers shall be of the domestic type of class as applicable. Closure of boxes, when used as shipping containers, shall be as specified in the applicable box specification or appendix thereto.

5.2.1.3 Level C. Rolls, packaged as specified (see 6.2.1), shall be prepared for shipment in a manner which will insure acceptance by common carrier and safe delivery at destination. Containers or method of shipment shall comply with the Uniform Freight or National Motor Freight Classification Rules or other carrier regulations as applicable to the mode of transportation.

5.3 Marking. In addition to any special marking required by the contract or order, packages and shipping containers shall be marked in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. This material is intended as thermal insulation of machinery and equipment, such as steam turbines, boilers, boiler feed pumps, and piping at temperatures up to 1200°F.

6.2 Ordering data.

6.2.1 Procurement documents should spefify:

(a) Title, number, and date of this specification.
(b) Type required (see 1.2).
(c) Length and width when other than specified (see 3.3.1.1, 3.3.1.2, 3.3.2.1, and 3.3.2.2).
(d) Thickness of insulation required (see 3.3.1.3 and 3.3.2.3).
(e) If first article sample is to be other than indicated (see 4.3.1).
(f) Whether fire resistance and thermal conductivity tests shall be performed (see 4.6).
(g) Levels of preservation-packaging, and packing required (see 5.1 and 5.2).
(h) Special marking, if required (see 5.3).

6.3 First article inspection.

6.3.1 Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection as to those bidders offering a product which has been previously procured or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending procurement.

6.4 THE MARGINS OF THIS SPECIFICATION ARE MARKED "#" TO INDICATE WHERE CHANGES (ADDITIONS, MODIFICATIONS, CORRECTIONS, DELETIONS) FROM THE PREVIOUS ISSUE HAVE BEEN MADE. THIS WAS DONE AS A CONVENIENCE ONLY AND THE GOVERNMENT ASSUMES NO LIABILITY WHATSOEVER FOR ANY INACCURACIES IN THESE NOTATIONS. BIDDERS AND CONTRACTORS ARE CAUTIONED TO EVALUATE THE REQUIREMENTS OF THIS DOCUMENT BASED ON THE ENTIRE CONTENT IRRESPECTIVE OF THE MARGINAL NOTATIONS AND RELATIONSHIP TO THE LAST PREVIOUS ISSUE.

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