

MILITARY SPECIFICATION

MATS, REINFORCING, 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 a group of mats made of randomly oriented strands of glass filaments, with or without surfacing mats and backings. These mats are produced by continuous processes and are used primarily for making glass reinforced plastic items by either the wet layup or matched die molding process (see 6.1). This specification does not cover surfacing mats per se, mats for use in the paneling market, or those made by batch processes or with very short strands.

1.2 Classification. The fiber reinforcing mats shall be of the following types, classes, and grades, with or without surfacing mats (see 1.2.1), as specified (see 6.2).

Type I - Chopped strands bonded with high solubility resin.

Class 1 - Standard strand

Class 2 - Fine strand

Type II - Chopped strands bonded with low solubility resin.

Class 1 - Standard strand

Class 2 - Fine strand

Type III - Chopped strands, mechanically bonded.

Class 1 - Standard strand

Class 2 - Fine strand

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, US Army Materials and Mechanics Research Center, ATTN: DRXMR-SSS, Watertown, MA 02172 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

Type IV - Continuous strands, resin bonded.

Class 1 - Standard strand

Class 2 - Fine strand

Type V - Backed mats. Backed mats shall consist of one of the above types and classes as specified, deposited on one or both sides of a backing made of a parallel glass rovings, woven glass roving, or glass cloth, of the composition and construction specified (see 6.2).

Grades - (Applicable to all types and classes)

Grade A - Mats whose randomly-oriented portions are made of "E" glass (see 3.1.1). Unless otherwise specified, all mats supplied against this specification shall be grade A.

Grade B - Mats made of other than "E" glass, as specified (see 6.2).

1.2.1 Surfacing mats. When specified (see 6.2), any of the above mats shall be provided with a surfacing mat on one or on each face.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

PPP-B-585 - Boxes, Wood, Wirebound
PPP-B-601 - Boxes, Wood, Cleated-Plywood
PPP-B-636 - Box, Fiberboard

MILITARY

MIL-P-116 - Preservation-Packaging, Methods of
MIL-L-10547 - Liners, Case, and Sheet, Overwrap, Water-Vaporproof or Waterproof Flexible

STANDARDS

FEDERAL

Fed. Std. No. 356 - Commercial Packaging of Supplies and Equipment

MILITARY

MIL-STD-129 - Marking for Shipment and Storage
MIL-STD-414 - Sampling Procedures and Tables for Inspection by Variables for Percent Defective

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

2.2 Other publications. The following document(s) form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

National Motor Freight Traffic Association, Inc., Agent:

National Motor Freight Classification

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

Uniform Classification Committee, Agent:

Uniform Freight Classification

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

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Material. All unbacked mats and all facings of type V mats covered by this specification shall be made of chopped or unchopped strands of continuous glass filaments. For grade A mats, these filaments shall be made of "E" glass (see 3.1.1). For grade B mats, they shall be of the composition specified (see 6.2). The strands shall be treated with a suitable silane size or coupling agent and shall be bonded together either mechanically or with a suitable bonding resin. Backing of type V mats shall have the composition and construction specified. Unless otherwise specified (see 6.2), surfacing mats, when used, shall be of the composition and construction normally furnished by the supplier of the base mat.

3.1.1 "E" glass. The chemical composition of "E" glass, as percent by weight, shall be within the limits, as follows:

B ₂ O ₃	5-10
CaO	16-25
Al ₂ O ₃	12-16
SiO ₂	52-56
MgO	0-5
Na ₂ O and K ₂ O	0-2
TiO ₂	0-1.5
Fe ₂ O ₃	0-0.8
F ₂	0-1.0

3.1.2 Certification. The supplier shall furnish a certificate stating that the mat was made by a continuous process, using the type class and grade of glass, the filament diameter, the number of filaments per strand (as fed to the choppers or distributors), and chopped strand length (when applicable) specified, and that a suitable silane size or coupling agent was applied. When a different type or a particular variety and percentage by weight, of a size or coupling agent has been specified, the certificate shall state that the required kind and percent of that agent has been applied. When a backing is specified as being required to conform to the requirements of a particular roving, woven roving, or cloth specification, the certificate shall state that the backing conforms to the referenced specification (see 1.1, 1.2, 3.1, 3.2, and 6.2).

3.2 Construction. The mats shall conform to the following construction requirements, as certified in accordance with 3.1.2 and table V.

3.2.1 Filament diameter. Unless otherwise specified (see 6.2), all continuous strand mats (type IV) shall be made of filaments having diameters between 0.0006 and 0.0009 inch, and all chopped strand mats shall be made of filaments having any one of the code designations shown below. Not more than two code designations of chopped strand filament shall be included in any one roll of mat, and the certificate (see 3.1.2) shall state the code designations used.

<u>Code designation</u>	<u>Average filament diameter, inch</u>
G	0.00035 - 0.00040
H	0.00040 - 0.00045
J	0.00045 - 0.00050
K	0.00050 - 0.00055

3.2.2 Strand size. The average number of filaments per strand shall be as follows:

<u>Designation</u>	<u>Number</u>
Standard chopped strand	200 \pm 50
Fine chopped strand	100 \pm 50
Continuous strand (fine)	30 \pm 10
Continuous strand (standard)	35 \pm 10

3.2.3 Chopped strand length. Unless otherwise specified (see 6.2) the lengths of chopped strands shall be between the limits of 1/2 inch and 4 inches. When specified, the average length and the length distribution of the chopped strands shall be as specified (see 6.9.2).

3.2.4 Mechanical bonding. Type III mats shall be mechanically bonded in the manner specified (see 6.2).

3.2.5 Orientation. Both chopped strands and continuous strands shall be randomly oriented.

3.2.6 Backings. The composition, construction, and weight of each type V mat shall be as specified (see 6.2). Each mat layer shall be securely bound to the backing.

3.2.7 Surfacing mats. Surfacing mats shall be placed on one or both sides when specified (see 6.2). Unless otherwise specified, the type and weight of each surfacing mat shall be that ordinarily supplied by the manufacturer of the base mat.

3.3 Properties. The properties of the mats shall be as specified (see table I and 6.2). Unless otherwise specified, the tolerances and methods of determination shall be in accordance with table I.

3.4 Form. The mats shall be supplied in the form of rolls of the widths and lengths specified, wound on substantial tubes or cores of the inside diameter specified (see 6.2).

3.4.1 Width. The width of the mat shall be as specified plus or minus 1/8 inch.

3.4.2 Length.

3.4.2.1 Length - Types I, II, III and V mats. A minimum of 65 percent of the rolls in each shipment shall be full length rolls of the minimum length specified. A maximum of 35 percent of the rolls may contain random length pieces, none shorter than 30 feet, wrapped-in on other such lengths to form a full diameter roll approximately the same total length as that of a full roll. If less than 2000 pounds is ordered at one time, the minimum full length roll in each shipment shall be 35 percent of the rolls, and the maximum of rolls containing random length pieces, none shorter than 30 feet, shall be 65 percent. Cartons containing wrapped-in lengths shall be marked accordingly.

3.4.2.2 Type IV continuous strand mats. A minimum of 60 percent of the rolls in each shipment shall be full length rolls of the minimum length specified. A maximum of 40 percent of the rolls may contain random length pieces, none shorter than 20 feet, wrapped-in on other such lengths to form a full diameter roll approximately the same total length as that of a full roll. If less than 2000 pounds is ordered at one time, the minimum full length roll in each shipment shall be 35 percent of the rolls, and the maximum of rolls containing random length pieces, none shorter than 20 feet, shall be 65 percent. Cartons containing wrapped-in lengths shall be marked accordingly.

3.5 Visible defects. The mats shall be free from visible defects of the types and to the extent specified in paragraphs 4.3.3 and 4.3.4 and in table IV.

Table I. Property Requirements^{1/}

<u>Property</u>	<u>Applicable to types</u>	<u>Sta- tistic</u> <u>2/</u>	<u>Permissible deviation</u> <u>percent 3/</u>	<u>AQL</u> <u>percent</u>	<u>Test method paragraph</u>
Weight, ounces, per square foot					
Of mat	All	\bar{X}	± 12	Pass <u>6/</u>	4.4.4
Of mat	All	X_i	± 20	4	4.4.4
Of each random strand layer	V	<u>4/</u>	± 20	Pass <u>6/</u>	4.4.4.1
Weight loss on ignition, percent	I, II, III; V made with above	X_i	<u>5/</u>	1	4.4.5
Fusion resistance	All grade A	X_i	none	Pass <u>6/</u>	4.4.5
Color after ignition	When spec'd	X_i	none	Pass <u>6/</u>	4.4.5
Tensile strength, pounds	I, II	X_i	30 lbs. min.	1	4.4.6
Thickness, inches	I, II	X_i	± 30	1	4.4.7
Binder solubility, seconds	I	\bar{X}	90 max.	Pass <u>6/</u>	4.4.8
	II	\bar{X}	300 min.	Pass <u>6/</u>	4.4.8

1/ When specified, any of the listed requirements shall be deleted, applied to other classifications of mat, or modified (see 6.2, 6.6, 6.7, and 6.9).

2/ \bar{X} - Average of all specimens tested for that property
 X_i - Individual specimen value (see 4.3.8.2).

3/ Of nominal value (see 6.2), unless otherwise indicated.

4/ Single determination.

5/ ± 75 percent of nominal or ± 2.5 percent absolute, whichever is smaller.

6/ Each specimen tested shall pass.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor 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 inspection set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 User's examination. Additional examination by the user, after acceptance and delivery of the lot, with permissible rejection of individual defective rolls, is provided under 4.3.3.3.

4.2 Lot. For purposes of sampling and inspection, a lot shall consist of all mats of the same type, class, grade, construction, and weight, submitted for delivery at the same time.

4.3 Sampling and inspection.

4.3.1 Materials and components. In accordance with 4.1, the suppliers shall be responsible for assuring that all materials and components used have been inspected and found to conform to all applicable requirements of this specification and, to the extent specified herein, of referenced specifications and standards. In case of conflict, this specification shall govern. The supplier's certificate of compliance with 3.1.2 shall be furnished.

4.3.2 Width. A sample of rolls of mat shall be inspected for width in accordance with table II. Unless otherwise specified, or unless visual inspection of the rolled mat indicates that there may be a systematic variation in width along the length of a roll, the width of each roll in the sample shall be measured at a location just below the outer convolution of the roll.

Table II. Inspection for width of mat

Lot size, rolls	1-150	151-500	501-1200	1201-3200
Sample size, rolls	13 ^{1/}	50	80	125
Acceptance no., rolls	0	1	2	3

^{1/} If the sample size exceeds the number of rolls in the lot, each roll in the lot shall be sampled.

4.3.3 Length and visual defects (major and minor)

4.3.3.1 Production examination. As a part of the manufacturing process, the mat shall be 100 percent visually inspected for visual defects. Each portion of mat containing one or more such defects shall be cut out. The remainder of the mat shall be wound into rolls. The length of mat included in each roll shall be measured (preferably by means of suitable automatic equipment) and this length, together with the number of pieces contained in it shall be either marked on the roll or be flagged within the roll in a way such that they are readily noticeable at the point in the roll where it has been wrapped in. The roll content label shall note that it contains wrap-ins. Major visual defects are defined as fluffy masses or dirt spots greater than 3/4 inch in length, or obvious tears or holes. Obvious tears and holes shall be defined prior to the contract or purchase order by mutual agreement between supplier and purchaser, preferably by means of comparison standards. Minor visual defects are defined in table IV. These definitions may vary with the type and weight of mat and with its intended use.

4.3.3.2 Purchaser's inspection. At the option of the purchaser, an examination for major visual defects (see 4.3.3.1), plus roll length and construction, may be made during use by the customer, after acceptance and delivery of lot. Any roll containing any piece shorter than 30 feet (except for type IV which shall be 20 feet) or having one or more major visual defects, may be rejected. During this examination, the following additional departures from specified requirements shall also be considered major visual defects: Improper type or class, surfacing mat or backing of type V mat missing, improper, or not securely attached (when applicable), mat layers stuck together causing tearing or unrolling.

4.3.4 Minor visual defects. The following sampling and examination for minor visual defects shall be performed:

4.3.4.1 Samples. A sample of rolls shall be selected at random from that lot in accordance with table III.

Table III. Sampling of rolls for minor visual defects

Total no. of rolls in lot	Sample size, rolls ^{1/}	Total no. of rolls in lot	Sample size, rolls
1-3	all	181-300	20
4-25	4	301-500	25
26-40	5	501-800	30
41-65	7	801-1300	35
66-110	10	1301-3200	40
111-180	15	3201-8000	50
		over 8000	75

^{1/} When the number of rolls shown in this table is greater than the maximum number of feet required by table IV to be examined for any category of minor visual defect, a number of rolls equal to this required number of feet shall be selected at random from the lot.

4.3.4.2 Examination for defects in table IV. For each classification of defect in table IV, lengths of mat from the sample of 4.3.4.1 shall be examined (see 4.3.4.3). The number of feet of mat to be examined from each sample roll for each class of defect shall be equal to the quotient of the total number of feet required by table IV (to be examined for that defect), divided by the number of rolls in the sample. After examination, the number of defects of that classification found in the sample units from each roll shall be added together to give the total number in the lot sample. That number shall be equal to or less than the acceptance number shown in table IV for that category of defect. Exception: In the event that for a particular category of defect the above quotient is smaller than one, a one foot long sample unit from each of a number of rolls equal to the number of feet required shall be examined for this defect. These rolls shall be selected at random from the sample of 4.3.4.1.

Table IV. Sampling Plans for Minor Visual Defects

Lot size (lineal feet)	Description of Defect							
	L = total length (ft.) to be inspected							
	Na = Acceptance number							
	Under 1/16 inch		Discolored fibers		1/16 to 1/8 inch		Over 1/8 ^{1/} inch	
	L	Na	L	Na	L	Na	L	Na
Type I Mats								
91-150	8	30	8	10	8	5	8	0
151-280	13	44	13	14	13	7	13	0
281-500	▲	▲	20	22	20	10	20	0
501-1200	▲	▲	▲	▲	32	14	32	1
1201-3200	▲	▲	▲	▲	50	22	50	1
3201-10,000	▲	▲	▲	▲	▲	▲	80	2
10,001-35,000	▲	▲	▲	▲	▲	▲	125	3
35,001-150,000	▲	▲	▲	▲	▲	▲	200	5
150,001-500,000	▲	▲	▲	▲	▲	▲	315	7
over 500,000	▲	▲	▲	▲	▲	▲	500	10
Types II, III, and IV Mats ^{2/}								
91-150	8	44	8	14	8	7	8	0
151-280	▲	▲	13	21	13	10	13	1
281-500	▲	▲	▲	▲	20	14	20	1
501-1200	▲	▲	▲	▲	32	21	32	2
1201-3200	▲	▲	▲	▲	▲	▲	50	3
3201-10,000	▲	▲	▲	▲	▲	▲	80	5
10,001-35,000	▲	▲	▲	▲	▲	▲	125	7
35,001-150,000	▲	▲	▲	▲	▲	▲	200	10
150,001-500,000	▲	▲	▲	▲	▲	▲	315	14
over 500,000	▲	▲	▲	▲	▲	▲	500	21

(See next page for example of use of table IV)

^{1/} Includes, but is not limited to, major visual defects (see 4.3.3.2).^{2/} A type V mat shall be examined and rated in accordance with its type of facing, that is, a backed mat faced with type I mat shall be examined in accordance with type I mats.

Example for use of table IV:

Assume: Mat type I, total number of lineal feet in lot = 3000;
number of rolls in lot = 25.

Required: Sampling plan for "Discolored fibers".

Procedure:

(1) From table III, number of rolls in sample = 4.

(2) From table IV.

a. Total number of feet to be examined (L) = 20.

b. Number of feet to be examined from each of 4 rolls = $\frac{20}{4} = 5$

c. Maximum number of these defects (Na) permitted in the 20 foot examined length = 22.

d. The presence of 23 or more such defects would warrant the rejection of the entire lot.

e. The 5 foot specimens of (b) should be portions selected at random from the 50/4 - 12.5 foot specimens required for examination for defects measuring 1/16 to 1/8 inch in length.

4.3.4.3 Examination of surfaces of mat. A suitable and convenient means shall be provided for visual inspection of both surfaces of the sample units of the mat, without cutting the units from the roll. The portion of the mat to be inspected shall be unrolled and visually inspected by means of back lighting from a light table or fluorescent panel, assuring, during the inspection process, that the mat does not come in contact with the floor or other objects that may result in contamination of the mat.

4.3.4.4 Examination for dirt spots.

4.3.4.4.1 Types I, II, III and V mats. Dirt spots are defined as consisting of all foreign matter, dirt, or grease spots, and discolored fibers less than 1/8 inch in length. Dirt spots do not include white or light gray binder flakes which are permitted. Discolored fibers are defined as fibers which are discolored over a length of 1/8 inch or longer. Discolored fibers less than 1/8 inch in length are classified as dirt spots.

4.3.4.4.2 Type IV mats. Dirt spots are defined as consisting of all foreign matter, binder spots, dirt, or grease spots, and discolored fibers greater than 1/8 inch in length. Dirt spots do not include white or light gray binder flakes, which are permitted. If the number of dirt spots 1/8 to 3/4 inch in diameter exceeds one defect per 80 lineal feet in a roll, the roll is rejectable. Brown spots are defined as a brown discoloration throughout the mat thickness and on the top and bottom surfaces of the mat. The spots are a mixture of compounds, organic and inorganic, which discolor during mat cure. If the average number of the defects exceeds 8 per 100 lineal feet in a roll, the roll is rejectable.

4.3.5 Sampling for examination for construction. A sample shall be selected from the lot at inspection level III of MIL-STD-414. The lot size for purpose of determining the sample size shall be expressed in units of strips one foot wide, neglecting fractions of a foot, and the full length of a roll (number of rolls in lot multiplied by the roll length times the roll width in feet). A sufficient number of test specimens shall be cut from each sample unit to permit the examination of 4.3.6 and the testing of 4.3.8. When a test does not damage the specimen, two or more tests may be performed on the same specimen. Unless otherwise specified, in the individual test procedure or in contractual documents (see 6.9.4), each specimen shall be approximately 12 inches square by the full thickness of the mat. The specimens shall be cut out using a metal template and a suitable knife or rotary cutter or by other means which will cut to the required accuracy without pulling fibers. Unless there is reason to suspect that there may be a systematic variation in quality along the length of a roll, the specimens shall be taken from between rolls when sampling is performed by the manufacturer at the time of production, or from just inside the outer convolution when sampling is done from packaged rolls.

4.3.6 Sampling and preliminary examination for construction. One specimen shall be selected at random from each of the unit samples of 4.3.5. These specimens shall be visually compared. If they all appear to have the same construction, one of the specimens shall be selected at random for examination in accordance with table V. If they appear to be different, the two specimens which appear to differ the most shall be examined and tested separately, and both shall pass. However, when the ignition test (see table I and 4.4.5) is required to be performed on a larger number of specimens (see 4.3.8.2) and when color, clarity, or resistance to fusion is required, each ignited specimen shall pass. For type IV mats (for which weight loss on ignition is not normally required but for which ignition loss is specified), specimens shall be ignited for the determination of the property and all shall pass.

Table V. Examination for construction

Defect	Method of examination
Filament diameter improper (see 3.2.1)	4.4.3.1
Number of filaments in strand improper (see 3.2.2)	4.4.3.1
Average strand length or strand length distribution improper (see 3.2.3)	4.4.3.1
Strands not randomly oriented (see 3.2.5)	Visual
Needling improper (type III) (see 3.2.4)	4.4.3.2
Surfacing mat or carrier, when specified, missing or applied to wrong face	Visual
Not proper weight or type when weight or type is specified (see 6.2)	As specified
Backing of type V mat not parallel roving, woving roving, or cloth, as specified; not specified weave; facing not applied to one or both sides as specified; facing not bonded to backing (see 3.2.6)	4.4.3.2
Suppliers certificate missing or improper (see 3.1.2)	Visual
Grade A specimen fuses during ignition of 4.4.5.1 (see table I)	Visual
When color (or freedom from color) is specified, specimen of 4.4.5.4 shows improper color	4.4.3.2

4.3.7 Examination of packaging. An examination shall be made, in accordance with table VI to determine that preservation, packing and markings comply with the requirements of section 5 of this specification. The sample unit for this examination shall be one shipping container, fully packed, selected just prior to the closing operation. Shipping containers fully prepared for delivery shall be examined for closure defects. The AQL for each examination in table IV shall be 4.0 using level III of MIL-STD-414.

Table VI. Examination for packaging

Examine	Defect
Preservation	Not level specified; not in accordance with contract requirements. Rolls not unit or intermediately packed as specified. Unit or intermediate packing material not as specified; closures not accomplished by specified or required methods or materials.
Packing	Not level specified; not in accordance with contract requirements. Any nonconforming component; component missing, damaged or otherwise defective affecting serviceability. Container not as specified; closures not accomplished by specified or required methods of materials. Inadequate application of components, such as: Incomplete closures of case liners or container flaps, loose or inadequate strappings, bulged or distorted containers.
Count	Less than specified or indicated quantity of rolls per shipping containers.
Weight	Gross or net weight exceeds specified requirements.
Markings	Interior or exterior markings (as applicable) omitted, illegible, incorrect, of improper size, location or sequence or method of application. Not in accordance with contract requirements.

4.3.8 Testing.

4.3.8.1 Number of specimens. One specimen from each sample unit of 4.3.5 shall be subjected to each applicable test of table I, except that:

a. Only one specimen of type V mat shall be tested in accordance with 4.4.4.1.

b. The number of specimens tested for color and resistance to fusion shall be in accordance with 4.3.6.

c. When applicable, 5 specimens shall be subjected to the test of 4.4.8. If the average value is outside the required range, 5 additional specimens may be tested at the discretion of the supplier. The lot shall be considered to have passed this test if either the 5 specimen or the 10 specimen average meets the requirement.

d. The number of specimens tested for the following properties shall be not less than shown as follows:

<u>Property</u>	<u>Minimum number of determinations</u>
Mat weight (see 4.4.4)	10
Weight loss on ignition (4.4.5) when required	5
Tensile strength (4.4.6) when required	5
Thickness (4.4.7) when required	10

When the number of sample units in the lot is less than the number of specimens required for any property, two or more specimens shall be tested for that property from the same sample units.

4.3.8.2 Calculations. When "X" is required (see table I), the values for the property shall be averaged and the average value shall be reported. When the AQL based on " X_1 " of a property is required, both the average and the standard deviation shall be calculated. From those statistics, conformity of the lot to the requirement shall be determined in accordance with MIL-STD-414, Section B-II (variability unknown, standard deviation method, double specification limit).

4.4 Tests and examination for construction.

4.4.1 Conditions. Unless otherwise specified or permitted (see 4.4.5.2), all weighings shall be performed and the test for tensile strength shall be conducted at a temperature of $23^{\circ} \pm 2^{\circ}\text{C}$ ($73.4^{\circ} \pm 3.6^{\circ}\text{F}$). Before being subjected to any test, each specimen shall be reasonably dry. In cases of dispute, the specimen shall be conditioned to equilibrium and tested at the above temperature and at a relative humidity of 50 ± 5 percent.

4.4.2 Glass composition. Unless otherwise specified, the composition of the glass shall be assumed to be that certified by the supplier (see 3.1.2), except that fusing of the specimens of 4.4.5.1 shall be considered evidence that the mat is not made of "E" glass, and excessive color in the ignited specimens shall be considered evidence that the mat is not "clear glass" (see 6.8.1).

4.4.3 Comparison standards.

4.4.3.1 Filament and strand. A rough estimate of the filament and strand construction of the mat shall be made by visual comparison against a standard. The standard shall consist of a sample of the particular designation of mat specified, supplied by the manufacturer and approved by the procuring agency, or furnished by the inspecting agency. Conformity of a standard furnished by the inspecting agency shall be determined by pulling out a minimum of 20 filaments and by measuring the diameter of each by means of a microprojector or other suitable means, by counting the number of filaments in a sample of representative strands, and by measuring the lengths of a sufficient number of chopped strands to determine the approximate average length, maximum and minimum length, and the length distribution. Because there always will be some variation in diameter between the filaments in a strand, and because there always will be some disintegration of strands during the processing of the mat, this visual comparison can detect only gross departures from certified constructions (see 4.3.6 and table V).

4.4.3.2 Other mat construction features. When standards are required for other visual comparisons, such as type of needling of type III mats, weaves of type V backings, or color of ignited specimens, these standards shall be provided and verified in a manner similar to that described in 4.4.3.1, but using the specified characteristics. The construction of the backings of type V mats shall be verified after removal of the random strand facing(s), as in 4.4.4.1.

4.4.4 Mat weight. Each applicable specimen of 4.3.5 and 4.3.8 shall be individually measured to the nearest 0.1 inch of length and width (or diameter if round (see 6.9.4)), and weighed to the nearest 0.5 percent of its weight. Its unit weight, in ounces per square foot, shall be calculated. Calculations will be simplified if each specimen is cut 12 ± 0.1 inches square and if the weighing is performed on a balance or scale reading in ounces, since in that case the dimensions need not be remeasured and the weight of the specimen will be equal to its unit weight in ounces per square foot. The average unit weight and conformity to the specified AQL for individual specimens shall be calculated in accordance with 4.3.8.2.

4.4.4.1 Weight of mat layers and verification of backing construction. For type V mats, the weight of each layer shall be determined as follows: The weights of the undivided type V mats shall be determined in accordance with 4.4.4, using 12 ± 0.1 inch square specimens. The specimen which had the weight nearest to the average shall be split into its component layers by means of careful cutting and pulling, leaving as little random strand attached to the backing as possible without damaging the backing. Each random strand layer shall be weighed separately and its weight in ounces shall be reported. The construction of the backing shall be verified in accordance with 4.4.3.2.

4.4.5 Percent weight loss on ignition and glass composition.

4.4.5.1 Grade A. Each applicable specimen of grade A mats (see table I, 4.3.5, 4.3.8 and 4.4.5.3) shall be weighed to a precision of ± 0.5 percent or better, ignited in a muffle furnace at $625^\circ \pm 25^\circ\text{C}$ ($1157^\circ \pm 45^\circ\text{F}$) to constant weight and similarly reweighed. Its percent loss on ignition shall be calculated as:

$$\frac{(100) (\text{weight loss})}{(\text{initial weight of specimen})}$$

The ignited specimen shall be examined for fusing together of the filaments (see table I and V and 4.4.2).

4.4.5.2 Grade B. When the mat is specified to be made of a glass having a lower fusing temperature than "E" glass, a lower ignition temperature, as specified by the procuring activity shall be used (see 6.2 and 6.8.1).

4.4.5.3 Specimens. When suitable equipment is available, specimens shall be one square foot and all weighings shall be made while the specimen is in the furnace. The furnace and weighing equipment shall be constructed so as to prevent errors from convection currents. When this special equipment is not available, each specimen shall consist of a piece, full thickness, of the mat weighing not less than 5 grams. Each specimen, cut into smaller pieces if necessary, shall be placed in a previously ignited, cooled, and weighed porcelain crucible, weighed, ignited to constant weight, cooled in a desiccator, and reweighed.

4.4.5.4 Color after ignition. When the glass, after ignition, is specified to have a particular color or absence of color, the ignited specimens of 4.4.5.1 or 4.4.5.2 shall be compared with color standards (see table V).

4.4.6 Tensile strength. Each specimen (see 4.3.5 and 4.3.8) shall be 12" by 12" and shall be clamped between two pairs of flat-faced grips each not less than 12 inches long in such a manner that 1 inch \pm 1/8 inch of the specimen is within each grip, 10 inches \pm 1/4 inch is between the grips, the edges of the two pairs of grips are parallel and the longitudinal (machine) direction of the mat is parallel with the 10 \pm 1/4 inch dimension. Using a suitable tension testing machine, the grips shall be pulled apart at such a rate as to cause failure of the specimen in between 5 and 15 seconds. The load in pounds required to cause failure of each specimen shall be recorded. Conformance to specified requirements shall be determined in accordance with 4.3.8.2.

4.4.7 Thickness. Each applicable specimen (see table I, 4.3.5, 4.3.8, and 6.7), shall be tested for no-load thickness as follows: The specimen shall consist of a one foot square piece full thickness of the mat and may be the same specimen as that tested under 4.4.4. It shall be placed on a flat steel surface larger than itself. A flat steel plate 1/8 inch thick and one foot square shall be determined by means of a dial gage having its base resting on the surface and its presser foot resting on the center of the plate. The pressure exerted by the mechanism of the reading instrument shall be negligible in relation to the weight of the plate. The dial gage may be zeroed either with the plate resting directly on the surface, thereby reading thickness directly, or with the plate separated from the surface by a distance equal to the nominal thickness of the mat, thereby causing the dial to read plus and minus deviations from the nominal thickness. Conformance with specified requirements shall be determined in accordance with 4.3.8.2.

4.4.8 Binder solubility. The specimens for binder solubility shall be 5.0 inches long in the machine direction of the mat and 4.0 inches wide. Each applicable specimen (see table I and 4.3.8) shall be clamped between two pairs of flat metal grips not less than 4 inches wide so that a 4 by 4 inch area of the specimen is exposed between the clamps. One clamp shall be provided with a hook for hanging and the other shall be weighted to make a total weight of 104 \pm 2 grams. The hook and weights shall be so located that the assembly shall hang straight with the edges of the clamps horizontal when hung from the hook. The assembly shall be suspended in a vessel sufficiently deep and containing sufficient styrene at 23 $^{\circ}$ \pm 2 $^{\circ}$ C (73.4 $^{\circ}$ \pm 3.6 $^{\circ}$ F) that the exposed area of the specimen is completely immersed in the styrene and that the lowest part of the lower clamp and weight is not less than 2 inches from the bottom of the container. The test shall be timed from the moment that the specimen is immersed in the styrene until it breaks, allowing the lower clamp to drop. These times shall be averaged and the average time reported. With low solubility mats, the tests may be stopped after the specimens have hung long enough that it is seen that the average breaking time will be greater than 300 seconds.

5. PACKAGING

Application. The requirements of Section 5 apply only to purchase by or direct shipment to the Government. Unless otherwise specified (see 6.2 (q)), preservation, packaging and packing shall be commercial.

5.1 Preservation. Preservation shall be level A or commercial, as specified (see 6.2).

5.1.1 Level A.

5.1.1.1 Unit packing. Unless otherwise specified in the contract or purchase order (see 6.2) mats shall be unit packed in quantities specified by the procuring activity in accordance with method III of MIL-P-116.

5.1.1.2 Intermediate packing. When required, specified quantities of unit packed materials shall be intermediately packed as specified in the contract or purchase order (see 6.2).

5.1.2 Commercial. Mats shall be unit packed or intermediately packed to provide a sufficient level of protection to prevent deterioration during shipment, and to ensure safe delivery at destination.

5.1.3 Disposability. (see 6.12).

5.2 Packing. Packing shall be level A, B, or commercial as specified (see 6.2).

5.2.1 Level A. Mats unit or intermediately packed as specified in 5.1.1 shall be packed in containers conforming to PPP-B-585 (class 3), PPP-B-601 (overseas type) or PPP-B-636 (class-weather resistant, grade V2s). Unless otherwise specified containers shall be provided with a case liner conforming to MIL-L-10547. Closure and strapping shall be in accordance with the appendix to the applicable container specifications, except that fiberboard boxes shall be closed, waterproofed and reinforced in accordance with method V of the appendix to PPP-B-636.

5.2.2 Level B. Mats unit or intermediately packed as specified in 5.1.1 shall be packed in containers conforming to PPP-B-585 (class 1), PPP-B-601, or PPP-B-636 (variety DW, grade 350). Closure shall be in accordance with the appendix to the applicable container specification.

5.2.3 Commercial. Mats shall be packed in accordance with commercial practice adequate to ensure acceptance and delivery by the carrier for the mode of transportation employed. Containers shall comply with the requirements of the Uniform Freight Classification Rules or National Motor Freight Classification Rules, as applicable.

5.2.4 Disposability. (see 6.12).

5.3 Marking. In addition to any special marking required, unit packages and shipping containers shall be marked in accordance with MIL-STD-129, with the exception that commercial marking in accordance with Fed. Std. No. 356 applies for commercial packaging only.

6. NOTES

6.1 Intended use. The fiberglass reinforcing mats covered by this specification are intended for use for making glass reinforced plastic items, particularly those of larger size, having irregular thickness, compound curvature or requiring deep draws. Reinforced plastic items made from mat are usually intermediate in cost between those made from glass cloth and those made by spraying a mixture of chopped glass fibers and resin (see 6.3).

6.1.1 Type I. Type I mat is used primarily for hand layup work, as for building boats. The high solubility binder gives that mat sufficient strength for carrying it into place when dry. However, when wet with resin, the binder softens permitting the mat to be fitted over irregular contours. Class 2 mats produce laminates having smoother surfaces than are obtained with class 1.

6.1.2 Type II. Type II mat is used primarily for matched die molding. Its low solubility binder holds the mat together when resin is introduced into the mold as high temperature and pressure, thereby preventing the glass fibers from being washed out of place by the rapidly moving resin. This type has been used for molding gunstocks.

6.1.3 Type III. Type III is used primarily in matched die molding of heavy sections of compound curvature. Since its glass filaments are not coated with binder, it tends to wet out faster when immersed in resin than do the resin-bonded mats.

6.1.4 Type IV. Type IV mat is used both for matched die molding, particularly in heavy sections requiring deep draws. Laminates made from it may not be quite as rigid as those made from chopped strand mat because its glass filaments are initially curved.

6.1.5 Type V. Type V mats are used primarily for hand layup operations where great dry or wet strength is needed so that large pieces can be carried into place without distortion and breakage, when thick layers are desired, and when the finished item requires high strength. When the backing is unidirectional glass roving, the resulting laminate can have very high strength in one direction. The labor cost of applying type V mat usually is lower than that of applying the backing material and chopped strand mat as separate operations.

6.2 Ordering data: Procurement documents should specify the following:

- a. Title, number, and date of this specification.
- b. Type, class, and grade required (see 1.2).
- c. Nominal mat weight required (see table I).
- d. When grade B is ordered, the kind of class (see 1.2), its ignition temperature, and color, when required (see table I, table V, 4.4.5.2 and 6.8.1).
- e. When backed mat (type V) is ordered, the weight, composition and construction of the backing, with reference to applicable specifications if required (see 6.3), and weight and designation of each facing (see 1.2 and 6.8.6).
- f. Whether one or more surfacing mats are required (see 3.2.6), with special requirements if required (see 1.2).
- g. Width required (see 3.4.1 and 6.8.3).
- h. Length required per roll (see 3.4.2 and 6.8.4).
- i. Core inside diameter required (see 3.4 and 6.8.5).
- j. Nominal weight loss on ignition (see table I and 6.5).
Weight loss on ignition for type IV, if required.
- k. Tensile strength required (see table I and 6.6).
- l. Thickness, if required (see table I and 6.7).
- m. Different values or closer limits for binder solubility, if required (see table I and 6.9.3).
- n. Type and degree of mechanical bonding of type III mat, if required (see 3.2.4).
- o. Definition of obvious tears and holes (see 4.3.3.1 and 4.4.3).
- p. Availability of comparison standards, if required (see 4.4.3).
- q. Additional requirements or different values or tolerances on existing requirements, if required (see 3.3, 6.3, 6.9, and 6.10).
- r. Level of preservation and packing if other than commercial.
- s. Quantities required in unit and intermediate packing (see 5.1.1.1 and 5.1.1.2).
- t. Special marking, if required (see 5.3).
- u. Rejection of individual rolls or a portion thereof (see 4.3.3.1, 4.3.3.2 and 4.3.3.3).

6.3 Other documents. It is recommended that, when possible, requirements outside the scope of this specification, such as those for the backings of type V mats, be specified using definitions, test methods, specifications, and standards generally recognized by the Industry. The following ASTM documents, available from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103, are suggested for consideration:

- D 123 - Definitions of Terms Relating to Textile Materials
- D 587 - Specifications and Methods of Testing Glass Yarn
- D 579 - Specifications and Methods of Test for Woven Glass Fabrics
- D 2150 - Specifications for Woven Roving Glass Fabrics for Polyester Glass Laminates
- D 2408 - Specifications for Woven Glass Fabric, Cleaned and After-Finished with Amino-Silane Type Finishes, for Plastic Laminates
- D 2409 - Specifications for Woven Glass Fabric, Cleaned and After-Finished with Vinyl-Silane Type Finishes, for Plastic Laminates

6.4 Inspection. Because of the danger of injury to the mat, it is recommended that full rolls of mat not be completely unwound and rewound merely for the purpose of inspection for defects, unless there is reason to suspect that there is a difference of quality between the inside and the outside of the roll.

6.5 Weight loss on ignition. The binder content of resin bonded mats is determined by percent weight loss on ignition and influences the stiffness, handleability and dry tensile strength of the mat. Different fabricators prefer different stiffnesses for similar applications. Different manufacturers can produce approximately the same degree of handleability by using different percentages of different types of binders. Therefore, values for weight loss on ignition should be determined by mutual agreement between the manufacturer and the fabricator. Typical values as offered by one manufacturer of type II mats are as follows:

<u>Bond strength</u>	<u>Nominal mat weight, oz/sq/ft</u>	<u>Nominal weight loss on ignition, percent</u>
Low	1-1/2 through 2-1/4	6.5
	2-1/2 through 3	5.5
Medium	1 and 1-1/4	8.5
	1-1/2 through 2-1/4	7.5
	2-1/2 through 3	6.5
High	0-3/4 through 2-1/4	10.0
	2-1/2 through 3	9.0

6.6 Dry tensile strength. Mats used in large sections, as for boat building, require high dry tensile strength to enable the large pieces to be carried into place without distortion or breakage, while those used for small parts need not be as strong. Since high dry tensile strength of resin bonded mat is obtained by using a high binder content, and since high fiber content may adversely affect wet-out and laminate strength, some fabricators prefer a low strength mat for some applications. Therefore, this property should be agreed upon between manufacturer and fabricator. The method of 4.4.6 is not applicable to mats of types III, IV, and V.

6.7 Thickness. The thickness of some types of mat is so dependent on previous compression history that no thickness requirements should be specified for those mats.

6.8 Forms available.

6.8.1 Weights. Most mat are available in weights between 1-1/2 and 3 ounces per square foot in increments of 1/4 ounce. Many are available in weights down to 3/4 ounce. Some type V mats are available in weights up to 10 ounces.

6.8.2 Widths. Most mats are supplied as standard in 1/4 inch width increments between 40 and 120 inches. Widths narrower than 40 inches can be obtained by slitting wider widths.

6.8.3 Lengths. The standard roll length vary with the weight, bulkiness, and width of the mat, being as low as 75 feet for bulky 3 ounce mats in wide widths, and as high as 600 feet for certain 3/4 ounce mats in widths of 50 inches or under.

6.8.4 Cores. Core inside diameters usually are 3 and 4 inches, the larger cores being required for the heavier, stiffer mats.

6.8.5 Type V mats. Since only certain constructions of type V mats are commonly available, manufacturers' catalogs should be consulted.

6.9 Closer tolerances.

6.9.1 Filament diameter. Although the body of this specification permits the filament diameters of a chopped strand mat to be of any one code letter between G and K, certain applications may require the diameter to be limited to only one of those code letters, as specified.

6.9.2 Length of chopped strands. Some fabricators prefer to use uniform 2 inch lengths of chopped strand for matched die molding and random 1/2 through 1-1/2 inch lengths for hand layup work. Others prefer the reverse. The fabricator should be permitted to choose the average length and the length distribution which works best in his process.

6.9.3 Binder solubility. Although it is common practice to specify a high solubility binder for hand layup work and a low solubility binder for matched die molding, some die molders prefer a high solubility binder for some of their applications. For some hand layup operations, 90 seconds is a sufficiently short styrene solubility time. In others, times as short as 10 seconds may be desirable. Some resin bonded chopped strand mat are made with a low solubility binder in the middle and with a high solubility binder on the faces. Those mats would show long solubility times on the test of 4.4.8. Again, mutual agreement is recommended.

6.9.4 Mat weight specimen. When, as in the use of mat for making small items, small thin or thick areas are considered serious defects, smaller specimens may be specified for use in determining the weight variation. One specimen which has been found useful is a die cut disc 3.60 inches in diameter having an area of 10.16 square inches. The weight of this disc in grams, divided by 2, gives the unit weight in ounces per square foot. This specimen should not be used with mats weighing over 3 ounces per square foot. The "X_i" weight requirements given in this specification are based on one foot square specimens. If smaller specimens are used, the tolerances or AQLs shown must be relaxed for the same quality of mat. However, for determining average mat weight, larger specimens, such as one foot squares or strips one foot or more in width, cut full width of the mat, should be used.

6.10 Additional properties and tests. If suitable additional property values and test methods can be agreed upon between manufacturer and user, they may be specified in the purchase order. Examples of such properties and tests are given as follows:

6.10.1 Laminate requirements. Flexural tests, conducted on molded items which have been immersed in boiling water for two hours or longer, have been found useful for giving information concerning the tensile and shear strengths of the laminate and the soundness on the bond between the glass and the resin. If the size and shape of the item is such that suitable flexural specimens cannot be cut from it, or if the cutting would be too destructive of expensive items, flat panels may be made from the mat and the particular resin used to make the item and the specimens may be cut from these panels. In this case, the manufacturer of the mat should be informed as to the type of resin, the glass to resin ratio and thickness of the laminate, the techniques of fabrication and curing of the panel, and the property values required.

6.10.2 Fabricators requirements. Certain mat properties, such as draperability, wet out, handleability, and resistance to washing during pressure molding, are necessary to enable a mat to be satisfactorily fabricated into useful items. However, no universally accepted standard methods for determining these properties are available at this time. In the event that manufacturers and fabricators can agree on satisfactory values and test methods, these may be specified.

6.11 Supersession data. There is no direct correlation between the types of superseded MIL-M-15617A and the types and classes of MIL-M-43248A and subsequent revisions. Drawings referring to the former specification should be reviewed and appropriate new designations substituted in line with the properties required. The relationship between the types and classes of MIL-M-43248(MR) and MIL-M-43248A along with subsequent revisions are as follows:

<u>MIL-M-43248(MR)</u>	<u>MIL-M-43248A and subsequent revisions</u>
Type I, class 1	Type II, class 1
Type I, class 2	Type II, class 1
Type I, class 3	Type V with type I or II facing
Type I, class 4	Type V with type I or II facing
Type I, class 5	Type IV
Type II, class 1	Type III, class 1
Type II, class 2	Type III, class 2
Type II, class 3	Type V with type III facing
Type II, class 4	Type V with type III facing
Type II, class 5	None
Type III, class 1	None

6.12 Disposability of preservation and packing materials. Environmental pollution preventive measures are contained in the preservation and packing material specifications indicated in Section 2. Refer to these specifications for recommended disposability methods.

Custodians:

Army - MR
Air Force - 20

Preparing activity:

Army - MR

Project No. 9340-0059

Review activities:

Army - MI, AR
Air Force - 99
DSA - GS

User activities:

Navy - AS, YD

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