

INCH-POUND

MIL-PRF-64154A
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SUPERSEDING
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PERFORMANCE SPECIFICATION

LAMINATE: FIBERGLASS-FABRIC-REINFORCED, PHENOLIC

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 fiberglass-fabric-reinforced phenolic laminate for use in composite armor systems (see 6.1).

1.2 Classification. The laminates should be of the type specified (see 6.2):

Type I	Flat
Type II	Curved

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, U.S. Army Research Laboratory, Weapons and Materials Research Directorate, ATTN: AMSRL-WM-M, APG, MD 21005-5069 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

STANDARDS

DEPARTMENT OF DEFENSE

MIL-STD-662 - V50 Ballistic Test For Armor

MIL-STD-810 - Environmental Test Methods And Engineering Guidelines

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094).

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C393	- Flexural Properties of Sandwich Constructions
ASTM D123	- Standard Terminology Relating To Textiles
ASTM D570	- Water Absorption of Plastics
ASTM D579	- Greige Woven Glass Fabrics
ASTM D618	- Conditioning Plastics and Electrical Insulating Materials for Testing
ASTM D695	- Compressive Properties of Rigid Plastics
ASTM D790	- Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D792	- Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D870	- Testing Water Resistance of Coatings Using Water Immersion
ASTM D1505	- Density of Plastics by the Density-Gradient Technique
ASTM D2343	- Tensile Properties of Glass Fiber Strands, Yarns, and Rovings Used in Reinforced Plastics
ASTM D2563	- Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
ASTM D2583	- Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM D2584	- Ignition Loss of Cured Reinforced Resins
ASTM D3039/D3039M	- Tensile Properties of Polymer Matrix Composite Materials

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ASTM D3410/D3410M - Compressive Properties of Polymer Matrix Composite Materials with Unsupported Gage Section by Shear Loading

ASTM E84 - Surface Burning Characteristics of Building Materials

ASTM E162 - Surface Flammability of Materials Using a Radiant Heat Energy Source

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428).

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified in the contract or purchase order, a sample shall be subjected to first article inspection (see 4.2.1 and 6.2).

3.2 Materials. Unless otherwise specified (see 6.2), the materials are the prerogative of the contractor as long as all the operating and environmental requirements are fully met.

3.3 Reinforcement. The reinforcement shall be a high tensile strength fiberglass or equivalent, consisting of G filament and a sizing system compatible with epoxy resin.

3.4 Fiber properties and fabric.

3.4.1 Density. The fiber shall have a package ball density of not less than 0.035 lb/in.³ (0.969 g/cm³) nor greater than 0.065 lb/in.³ (1.799 g/cm³).

3.4.2 Hardness. The fiber shall have a shore "O" package ball durometer hardness of not less than 50 nor greater than 90.

3.4.3 Catenary. The fiber shall have a catenary requirement of not greater than 1.0 in./50 ft (25.4 mm/15.24 m).

3.4.4 Roving yield (yd/lb). The nominal roving yield shall be within $\pm 8.5\%$ of the tolerance specified in the contract unless otherwise agreed to by the supplier and the procuring activity.

3.4.5 Resistance to fusion. An ignited specimen shall be examined for fusion. The specimen shall not fuse during the specified ignition.

3.4.6 Tensile strength. The fiber shall have a tensile strength of not less than 400 ksi (2758 MPa).

3.4.7 Fabric. The fabric shall be fiberglass plain weave woven roving (nominal 5 ends warp by 5.2 ends fill) with a nominal weight of 24 oz/yd² $\pm 5\%$ (814 g/m² $\pm 5\%$) or an equivalent.

3.5 Resin. The resin shall be of the phenolic or modified phenolic thermosetting laminating type. The component materials of the resin shall be such that the cured resin shall not be corrosive to metals.

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3.6 Laminate properties. The glass fabric base laminate shall meet the mechanical and physical property requirements and values listed in table I.

3.7 Peel-ply. The peel-ply shall be porous and polytetra-fluoroethylene (PTFE) coated with a thickness of 0.003 in. (0.076 mm).

3.8 Construction (fabrication).

3.8.1 Dimensions and structure. The laminates shall conform to the dimensions stated in the acquisition documents (see 6.2). The laminates shall consist of the specified number of plies of prepreg made with the above fabric and resin. The laminates shall be symmetric about the center line. Laminates of 25 plies or more shall have no more than 4% of plies containing a splice. Laminates of less than 25 plies shall have no splices.

3.8.2 Thickness. The average thickness of the finished laminates shall fall within the ranges established by table II and table IIa.

3.8.3 Unit weight. The unit weight or areal density of the finished laminates shall fall within the ranges established by table III and table IIIa.

3.8.4 Finished laminate. The finished laminate shall consist of the specified number of plies with exterior peel-ply incorporated in the lamination process. All cutting and machining of laminate panels shall be done with the peel-ply intact.

3.9 Performance.

3.9.1 Peel-ply removal. The peel-ply is intended to keep panel surfaces clean and shall be easily removable by hand, without requiring heat or solvents. Laborious or difficult removal shall be unacceptable.

3.9.2 Temperature resistance. The composite armor laminate shall not show evidence of delamination following a two-cycle exposure to a temperature range of -65°F to 250°F (-54°C to 121°C).

3.9.3 Ballistic resistance. The V50 protection ballistic limit, as defined by MIL-STD-662, the velocity at which the probability of penetration of an armor material is 50 percent, shall not be less than 2400 ft/s (732 m/s) for a laminate of twenty five (25) plies.

3.10 Workmanship. The laminates shall satisfy visual acceptance Level 1 of ASTM D2563 for the following defects: (1) blister, (2) burned, (3) crack, (4) crack surface, (5) crazing, (6) edge delamination, (7) internal delamination, (8) dry spot, (9) lack of fillout, and (10) wrinkles. Fabric reinforcement layers shall not have pleats, wrinkles, or creases. Fabric layers shall be free of tears, reasonably straight, and perpendicular warp-to-fill.

4. VERIFICATION

4.1 Verification alternatives. Alternative test methods, techniques, or equipment, including the application of statistical process control, tool control, or cost effective sampling procedures may be proposed by the contractor. Acceptable alternative verification approaches shall be identified in the contract.

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

- a. First article inspection (see 4.2.1)
- b. Conformance inspection (see 4.2.2)

4.2.1 First article inspection. When required (see 3.1), the first article sample shall be examined for compliance with the requirements and verifications in section 3 and section 4. All samples shall be produced with materials and processes proposed for use on production laminates. Inspection shall be carried out by the contractor under Government surveillance, when specified (see 6.2).

4.2.2 Conformance inspection.

4.2.2.1 Lot formation. An inspection lot shall consist of all the laminated assemblies of one type and part number, from an identifiable production period, from one manufacturer, submitted at one time for acceptance.

4.2.2.2 Sampling. Each sample selected from an inspection lot shall be examined as specified herein for the defects listed in 3.10. Conformance to a lot shall be accepted when zero (0) defects are found and rejected when one (1) or more defects are found. First article test samples shall not be shipped.

4.2.2.3 In-process examination. The contractor shall initiate, perform, and document on a recurring basis an in-process procedure consisting of process controls and examination criteria satisfactory to the Government, and include the requirements and verifications in section 3 and section 4.

4.2.2.4 Control test. The contractor shall supply two (2) test samples 20 in. by 20 in. (508 mm by 508 mm), for each month of laminate fabrication, for control testing. The samples shall have the contract designated plies and shall be produced with materials and processes used for production laminates. Testing shall be carried out by the contractor under Government surveillance and shall consist of tests to show conformance to the requirements in 3.6, 3.8.2, 3.8.3, 3.9.1 through 3.9.3, and 3.10.

4.3 Fiber properties and fabric.

4.3.1 Density. The package ball density shall be tested in accordance with ASTM D792.

4.3.2 Hardness. The shore "O" durometer or equivalent shall be used to test the outermost layer of the roving ball. Three readings shall be taken randomly spaced around the circumference and along the length of the ball.

4.3.3 Supplier option. The supplier has the option to perform either the package ball density or the shore "O" package ball durometer hardness test. Only one of the two tests is required.

4.3.4 Catenary. Measure the distance between the furthestmost separated strands perpendicular to the lengthwise direction.

4.3.5 Roving yield. The roving yield shall be computed by dividing the weight of the specimen into the measured length of the specimen resulting in units such as yd/lb.

4.3.6 Resistance to fusion. A specimen of accurately measured length weighing 10 grams shall be ignited at a temperature of $1500 \pm 45^{\circ}\text{F}$ ($812 \pm 25^{\circ}\text{C}$).

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4.3.7 Tensile strength. The tensile strength shall be tested in accordance with ASTM D2343.

4.3.8 Fabric. The fabric shall meet the requirements of ASTM D579 except section 36 "Breaking Strength". In lieu of section 36 refer to ASTM D2343

4.4 Laminate.

4.4.1 Determination of thickness. The thickness of a finished laminate is determined as follows: Choose a square laminate of nominal size at least 20 in. by 20 in. (508 mm by 508 mm), and remove peel-ply. Measure thickness to nearest 0.001 in. (0.0254 mm) at least 1.0 in. (25.4 mm) in from each of four (4) corners. Average the four (4) readings (see table II and IIa).

4.4.2 Determination of unit weight. The unit weight or areal density of a finished laminate is determined as follows: Choose a square laminate of nominal size at least 20 in. by 20 in. (508 mm by 508 mm), and remove peel-ply. Dry the panel in a forced draft or convection type oven in a stream of ambient air heated to $200 \pm 10^{\circ}\text{F}$ ($93 \pm 5^{\circ}\text{C}$). Dry the panel until no further change of mass occurs when it is weighed with an error of less than 0.1% after cooling to room temperature in the standard atmosphere for testing textiles as defined in ASTM D123. Calculate the unit weight to three significant figures as follows:

$$\text{Unit weight} = \frac{144M}{LW} \quad \text{lb/ft}^2$$

Where M is the dry panel weight in pounds measured with an error of less than 0.1%, L is the length of the panel in inches measured to the nearest 0.063 in. and W is the width of the panel in inches measured to the nearest 0.063 in. (see table III).

$$\text{Unit weight} = \frac{1 \times 10^6 M}{LW} \quad \text{kg/m}^2$$

Where M is the dry panel weight in kilograms measured with an error of less than 0.1%, L is the length of the panel in millimeters measured to the nearest 1.5 mm, and W is the width of the panel in millimeters measured to the nearest 1.5 mm (see table IIIa).

4.4.3 Mechanical and physical properties. The mechanical and physical properties shall be tested in accordance with table IV.

4.4.4 Peel-ply test. The peel-ply test shall consist of removing the peel-ply by hand.

4.4.5 Temperature resistance test. The temperature resistance test shall be performed in accordance with method 503.3 of MIL-STD-810, except the temperature extremes and number of cycles shall be as specified in 3.9.2.

4.4.6 Ballistic control test. The contractor shall supply two (2) test samples 20 in. by 20 in. (508 mm by 508 mm) by 25 plies for each three months of laminate fabrication for ballistic control testing at a Government approved facility to show conformance to 3.9.3. The test panels shall be adequately identified as to contractor, contract number, manufacturer, and date. The testing facility shall report raw data, velocities, penetration observation, thickness, and the laminate type (see 1.2) for each test sample.

4.4.7 Ballistic test. The ballistic resistance test shall be conducted in accordance with MIL-STD-662. The test projectile shall be a 0.30 caliber

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(7.62 mm) (44 grain) fragment-simulating projectile at 0° obliquity. The V50 ballistic limit protection reported shall be the average of two determinations made on separate 25 ply laminates. Each determination shall be a six round V50 ballistic limit with a maximum velocity spread of 125 ft/s (38 m/s).

4.5 Failure. Failure of the samples to meet any of the test requirements shall be cause for the procuring activity to stop acceptance of quality conformance samples until the cause of failure(s) is identified, corrective action is taken by the contractor, and approved by the procuring activity.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The laminates furnished under this specification are military unique because they are intended for use as a component of composite armor and must meet ballistic limit protection requirements.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of the specification.
- b. Type of laminate (see 1.2).
- c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2 and 2.3).
- d. When first article is required (see 3.1).
- e. Whether the material is to be specified (see 3.2).
- f. Dimensions and structure (see 3.8.1).
- g. Whether inspection is carried out by the contractor under Government surveillance (see 4.2.1).
- h. Packaging requirements (see 5.1).

6.3 Certification activity. Unless otherwise designated, the U.S. Army Weapons and Materials Research Directorate (WMRD), Aberdeen Proving Ground, MD 21005, is responsible for the certification of ballistic testing facilities and equipment.

6.4 First time suppliers. First time suppliers who have not previously supplied composite armor laminate to MIL-L-64154 and wish to have their material tested, may do so at their own expense. It is recommended that inquiries for testing be directed to Commander, U.S. Army Test and Evaluation Command, ATTN: AMSTE-TM-O, Aberdeen Proving Ground, MD 21005. Technical questions regarding testing may be directed to U.S. Army Aberdeen Test Center, ATTN: STEAC-LI, Aberdeen Proving Ground, MD 21005.

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6.5 Subject term (key word) listing.

Ballistic resistance
Composite armor
Resin
Peel-ply

Custodians:

Army - MR
Navy - AS
Air Force - 11

Preparing activity:

Army - MR

Project No. CMPS-0154

Review activities:

Army - AT, AV, IE
Navy - SH
Air Force - 13
DLA - DH

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TABLE I. Lengthwise mechanical and physical properties of glass fabric base laminate, continued on next page. ^{1/}

Property	Requirements and values ^{2/}
Under standard conditions (73.4 ± 2°F at 50% ± 4% relative humidity)	
Flexural, flatwise: Ultimate strength	73 ksi (503 MPa)
Initial modulus of elasticity	3.5 msi (24,132 MPa)
Ultimate tensile strength	46 ksi (317 MPa)
Ultimate compressive strength edgewise	58 ksi (400 MPa)
Flammability, inches per minute	1.0 (max.)
Water absorption, 24 hours immersion, percent change in weight	+ 1.25 (max.)
Barcol hardness	55
Specific gravity ^{3/}	
Resin content, percent ^{3/}	
Wet conditions (2 hours in boiling distilled water then remove, cool in water to 73.4 ± 2°F and immediately test samples wet)	
Flexural, flatwise: Ultimate strength	70 ksi (483 MPa)
Initial modulus of elasticity	3.0 msi (20,684 MPa)
Ultimate tensile strength	44 ksi (303 MPa)
Ultimate compressive strength, edgewise	53 ksi (365 MPa)
Tested at 160°F (exposure to 160°F for 1/2 hour then tested immediately at same temperature)	
Flexural, flatwise: Ultimate strength	69 ksi (476 MPa)
Initial modulus of elasticity	3.3 msi (22,753 MPa)

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TABLE I. Lengthwise mechanical and physical properties of glass fabric base laminate, concluded. ^{1/}

Property	Requirements and values ^{2/}
After immersion in chemical fluids (specimen size 1" x 4") (specimens shall be immersed in fluid for 24 hours at 73.4 ± 2°F) ^{4/}	
Hydraulic Fluid:	
Percent change in weight (increase or decrease)	0.2 (max.)
Percent change in thickness (increase or decrease)	0.2 (max.)
Ultimate flexural strength	70 ksi (483 MPa) (min.)
Isopropyl Alcohol:	
Percent change in weight (increase or decrease)	0.2 (max.)
Percent change in thickness (increase or decrease)	0.1 (max.)
Ultimate flexural strength	70 ksi (483 MPa) (min.)
Hydrocarbon, Type III:	
Percent change in weight (increase or decrease)	0.2 (max.)
Percent change in thickness (increase or decrease)	0.2 (max.)
Ultimate flexural strength	70 ksi (483 MPa) (min.)
Tested at 500°F after 1/2 hour exposure to 500°F	
Flexural, flatwise:	
Ultimate strength	52 ksi (359 MPa)
Initial modulus of elasticity	3.1 msi (21,374 MPa)
Ultimate compressive strength, edgewise	32 ksi (221 MPa)
Tested at 500°F after 100 hours exposure to 500°F	
Flexural, flatwise:	
Ultimate strength	45 ksi (310 MPa)
Initial modulus of elasticity	2.9 msi (19,995 MPa)

^{1/} Lengthwise direction of test specimens is parallel to warp direction of glass fabric.

^{2/} Unless otherwise specified, all values are minimum for the average of five specimens.

^{3/} The specific gravity and resin content by weight shall be noted for the panels tested.

^{4/} The samples shall show no cracking, crazing, delamination, or any other visible deterioration after exposure or immersion cycle.

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TABLE II. Finished laminate thickness range (inches). ^{1/}

Thickness Range		Thickness Range		Thickness Range		Thickness Range	
Plies	(inches)	Plies	(inches)	Plies	(inches)	Plies	(inches)
1	0.019 - 0.021	11	0.207 - 0.233	21	0.395 - 0.445	31	0.583 - 0.657
2	0.038 - 0.042	12	0.226 - 0.254	22	0.414 - 0.466	32	0.602 - 0.678
3	0.056 - 0.064	13	0.244 - 0.276	23	0.432 - 0.488	33	0.620 - 0.700
4	0.075 - 0.085	14	0.263 - 0.297	24	0.451 - 0.509	34	0.639 - 0.721
5	0.094 - 0.106	15	0.282 - 0.318	25	0.470 - 0.530	35	0.658 - 0.742
6	0.113 - 0.127	16	0.301 - 0.339	26	0.489 - 0.551	36	0.677 - 0.763
7	0.132 - 0.148	17	0.320 - 0.360	27	0.508 - 0.572	37	0.696 - 0.784
8	0.150 - 0.170	18	0.338 - 0.382	28	0.526 - 0.594	38	0.714 - 0.806
9	0.169 - 0.191	19	0.357 - 0.403	29	0.545 - 0.615	39	0.733 - 0.827
10	0.188 - 0.212	20	0.376 - 0.424	30	0.564 - 0.636	40	0.752 - 0.848

^{1/} Laminates greater than 40 plies will use the thickness range 0.0188n - 0.0212n (inches), where n is the number of plies.

TABLE IIa. Finished laminate thickness range (millimeters). ^{1/}

Thickness Range		Thickness Range		Thickness Range		Thickness Range	
Plies	(millimeters)	Plies	(millimeters)	Plies	(millimeters)	Plies	(millimeters)
1	0.478 - 0.538	11	5.25 - 5.92	21	10.0 - 11.3	31	14.8 - 16.7
2	0.955 - 1.08	12	5.73 - 6.46	22	10.5 - 11.8	32	15.3 - 17.2
3	1.43 - 1.62	13	6.21 - 7.00	23	11.0 - 12.4	33	15.8 - 17.8
4	1.91 - 2.15	14	6.69 - 7.54	24	11.5 - 12.9	34	16.2 - 18.3
5	2.39 - 2.69	15	7.16 - 8.08	25	11.9 - 13.5	35	16.7 - 18.8
6	2.87 - 3.23	16	7.64 - 8.62	26	12.4 - 14.0	36	17.2 - 19.4
7	3.34 - 3.77	17	8.12 - 9.15	27	12.9 - 14.5	37	17.7 - 19.9
8	3.82 - 4.31	18	8.60 - 9.69	28	13.4 - 15.1	38	18.1 - 20.5
9	4.30 - 4.85	19	9.07 - 10.2	29	13.8 - 15.6	39	18.6 - 21.0
10	4.78 - 5.38	20	9.55 - 10.8	30	14.3 - 16.2	40	19.1 - 21.5

^{1/} Laminates greater than 40 plies will use the thickness range 0.4775n - 0.5385n (millimeters), where n is the number of plies.

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TABLE III. Finished laminate unit weight - pounds/square foot (lb/ft²). ^{1/}

Weight Range				Weight Range				Weight Range				Weight Range			
Plies	(lbs/sq.ft.)	Plies	(lbs/sq.ft.)	Plies	(lbs/sq.ft.)	Plies	(lbs/sq.ft.)	Plies	(lbs/sq.ft.)	Plies	(lbs/sq.ft.)	Plies	(lbs/sq.ft.)	Plies	(lbs/sq.ft.)
1	0.184 - 0.216	11	2.02 - 2.38	21	3.86 - 4.54	31	5.70 - 6.70								
2	0.368 - 0.432	12	2.21 - 2.59	22	4.05 - 4.75	32	5.89 - 6.91								
3	0.552 - 0.648	13	2.39 - 2.81	23	4.23 - 4.97	33	6.07 - 7.13								
4	0.736 - 0.864	14	2.58 - 3.02	24	4.42 - 5.18	34	6.26 - 7.34								
5	0.920 - 1.08	15	2.76 - 3.24	25	4.60 - 5.40	35	6.44 - 7.56								
6	1.10 - 1.30	16	2.94 - 3.46	26	4.78 - 5.62	36	6.62 - 7.78								
7	1.29 - 1.51	17	3.13 - 3.67	27	4.97 - 5.83	37	6.81 - 7.99								
8	1.47 - 1.73	18	3.31 - 3.89	28	5.15 - 6.05	38	6.99 - 8.21								
9	1.66 - 1.94	19	3.50 - 4.10	29	5.34 - 6.26	39	7.18 - 8.42								
10	1.84 - 2.16	20	3.68 - 4.32	30	5.52 - 6.48	40	7.36 - 8.64								

^{1/} Laminates greater than 40 plies will use the unit weight range 0.184n - 0.216n (pounds/square foot), where n is the number of plies.

TABLE IIIa. Finished laminate unit weight - kilograms/square meter (kg/m²). ^{1/}

Weight Range				Weight Range				Weight Range				Weight Range			
Plies	(kg/sq.meter)	Plies	(kg/sq.meter)	Plies	(kg/sq.meter)	Plies	(kg/sq.meter)	Plies	(kg/sq.meter)	Plies	(kg/sq.meter)	Plies	(kg/sq.meter)	Plies	(kg/sq.meter)
1	0.900 - 1.06	11	9.90 - 11.6	21	18.9 - 22.2	31	27.9 - 32.8								
2	1.80 - 2.11	12	10.8 - 12.7	22	19.8 - 23.3	32	28.8 - 33.8								
3	2.70 - 3.17	13	11.7 - 13.7	23	20.7 - 24.3	33	29.7 - 34.9								
4	3.60 - 4.23	14	12.6 - 14.8	24	21.6 - 25.4	34	30.6 - 35.9								
5	4.50 - 5.28	15	13.5 - 15.9	25	22.5 - 26.4	35	31.5 - 37.0								
6	5.40 - 6.34	16	14.4 - 16.9	26	23.4 - 27.5	36	32.4 - 38.0								
7	6.30 - 7.40	17	15.3 - 18.0	27	24.3 - 28.5	37	33.3 - 39.1								
8	7.20 - 8.46	18	16.2 - 19.0	28	25.2 - 29.6	38	34.2 - 40.2								
9	8.10 - 9.51	19	17.1 - 20.1	29	26.1 - 30.6	39	35.1 - 41.2								
10	9.00 - 10.6	20	18.0 - 21.1	30	27.0 - 31.7	40	36.0 - 42.3								

^{1/} Laminates greater than 40 plies will use the unit weight range 0.900n - 1.058n (kilograms/square meter), where n is the number of plies.

TABLE IV. Test methods.

Property	Test Method
Ultimate flexural strength	ASTM C393, ASTM D790
Initial modulus of elasticity	ASTM C393, ASTM D790
Ultimate tensile strength	ASTM D3039/D3039M
Ultimate compressive strength	Modified ASTM D695, ASTM D3410/D3410M
Flammability	ASTM E84, ASTM E162
Water absorption	ASTM D570, ASTM D618
Barcol hardness	ASTM D2583
Specific gravity	ASTM D792, ASTM D1505
Resin content	ASTM D2584
Immersion	Modified ASTM D870

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

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I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-PRF-64154A

2. DOCUMENT DATE (YYMMDD)
980529

LAMINATE: FIBERGLASS-FABRIC-REINFORCED, PHENOLIC

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*

b. ORGANIZATION

c. ADDRESS *(Include Zip Code)*

d. TELEPHONE *(Include Area Code)*
(1) Commercial
(2) AUTOVON
(if applicable)

7. DATE SUBMITTED
(YYMMDD)

8. PREPARING ACTIVITY

a. NAME

US ARMY RESEARCH LABORATORY

b. TELEPHONE *Include Area Code)*

(1) Commercial
(410) 306-0725

(2) AUTOVON
458-0725

WEAPONS & MATERIALS RESEARCH DIRECTORATE
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ABERDEEN PROVING GROUND, MD 21005-5069