MIL-P-17549D(SH)
31 August 198
SUPERSEDING
MIL-P-17549C(SHIPS)
21 March 1960
(See 6.4)

MILITARY SPECIFICATION

PLASTIC LAMINATES, FIBROUS GLASS REINFORCED, MARINE STRUCTURAL

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers fibrous glass reinforced plastic laminates for use in marine applications. The characteristics defined for specific grades of laminate are representative of those laminates produced by good commercial practice.

1.2 Classification. Plastic laminates shall be classified by grades in accordance with the mechanical properties listed in table I (see 6.2).

Grade 1 - Grade 1 is the highest strength, bi-directional laminate reinforced with style 1581 or 7581 woven glass cloth or equivalent.

Grade 2 - Grade 2 is a high strength, bi-directional laminate reinforced with style 7500 woven glass cloth or equivalent.

Grade 3 - Grade 3 is a medium strength, bi-directional or isotropic laminate reinforced with style 7544 woven glass cloth or equivalent or random glass mat.

Grade 4 - Grade 4 is a bi-directional or isotropic laminate reinforced with random glass mat or equivalent.

Grade 5 - Grade 5 is a bi-directional or isotropic laminate reinforced with random glass mat or equivalent, having higher resin content and lower strength than grade 4.

Grade W - Grade W is a medium strength, bi-directional laminate reinforced with woven glass roving.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 3112, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications. Unless otherwise specified, the following specifications 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

MILITARY

MIL-R-7575 - Resin, Polyester, Low Pressure Laminating.
MIL-C-9084 - Cloth, Glass, Finished, For Resin Laminates.
MIL-C-19663 - Cloth, Woven Roving, for Plastic Laminate.
MIL-R-21607 - Resins, Polyester, Low Pressure Laminating, Fire Retardant.
MIL-M-43248 - Mats, Reinforcing Glass Fiber.

2.1.2 Other Government publications. The following Government publications form a part of this specification to the extent specified herein.

PUBLICATIONS

MILITARY

NAVAL SEA SYSTEMS COMMAND

NAVSHIPS 0939-LP-000-0010 - Inspections Manual for Fibrous Glass Reinforced Plastic Laminates.
NAVSHIPS 0900-LP-006-0010 - Reinforced Plastics - Preventive Maintenance and Repair Manual.

(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.)

2.1.3 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.

2.2 Other publications. The following documents 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.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 638 - Tensile Properties of Plastics, Test for.
D 695 - Compressive Properties of Rigid Plastics, Test for
D 790 - Flexural Properties of Plastics and Electrical Insulating Materials, Tests for.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) - Continued
D 792 - Specific Gravity and Density of Plastics by Displacement, Test for.
D 2584 - Ignition Loss of Cured Reinforced Resins, Test for.

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

3. REQUIREMENTS

3.1 First article. When specified (see 6.2.1), the contractor shall furnish a sample unit for first article inspection (see 4.3 and 6.3).

3.2 Materials.

3.2.1 Resin.

3.2.1.1 General purpose polyester resin. Unless otherwise specified (see 6.2.1), the base resin shall be in accordance with the requirements of grade A or grade B, class O of MIL-R-7575.

3.2.1.1.1 Flexible resin. Ten percent flexible polyester resin, plus or minus 2 percent, shall be mixed with the resin specified in 3.2.1.1. This flexible resin shall be obtained from the same manufacturer and shall be compatible with the base resin.

3.2.1.2 Fire resistant resin. When specified (see 6.2.1), the resin shall be in accordance with the requirements for grade 1 (standard flame resistance) or grade 2 (superior flame resistance) of MIL-R-21607.

3.2.1.3 Fillers, pigments, and other additives. The handling characteristics of the resin may be modified with a maximum of five percent (based upon the weight of resin) of fillers or other additives, providing the clarity of the resin and the translucency of the resultant laminate remain unaffected. Pigments or similar additives which would interfere with visual inspection shall not be used.

3.2.1.4 Gel coat. Unless otherwise specified, a gel coat may be used. If used, it shall consist of one brush or spray coat of clear thermosetting resin having a thickness of 0.01 to 0.02 inch and shall show no tendency to delaminate, peel, or craze.

3.2.2 Reinforcements.

3.2.2.1 Woven glass cloth reinforcements. Finished cloth shall conform to the requirements of class 1 of MIL-C-9084 for the applicable type.

3.2.2.2 Random glass mat reinforcements. Mat reinforcements shall conform to the requirements of the applicable type and class of MIL-M-43248.

3.2.2.3 Woven glass roving reinforcements. Woven roving shall be in accordance with MIL-C-19663.

3.2.3 The contractor shall comply with all existing laws and regulations governing personnel safety associated with the handling and fabricating process of the materials used in this specification.

3.2.4 Recovered materials. Unless otherwise specified herein, material incorporated in the products covered by this specification shall be new and shall be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

3.3 Mechanical and physical properties.

3.3.1 Mechanical and physical properties shall be as specified in table I. No individual specimen tested for mechanical strength shall indicate a value lower than 80 percent of the average of the results of the 5 specimens tested for the property. No individual sample tested for void content shall exceed the maximum percentage specified in table I for applicable grade.

3.3.2 Flexural strength of post-cured materials (see 4.5.2) shall not exceed the average flexural strength of first article specimens tested under standard conditions by more than 15 percent (see 4.3.4.1). Failure to meet this requirement will be considered an indication of undercure and basis for rejection of the first article sample.

3.3.3 The average of ten Barcol hardness measurements that are made on production units shall not be more than 5 points lower than the average Barcol hardness measurement on the first article sample (see 4.3.4.2).

3.4 Production control. A plastic manufacturer shall have an established quality control procedure consisting of raw materials inspection, inspection of production operations, witnessing of destructive and performance tests, visual inspection, and maintenance of adequate records which is consistent with NAVSHIPS 0939-LP-000-0010.

Type MAT - This type is a mineral-filled, polyester compound for use where good dielectric

TABLE I. Mechanical properties - fibrous glass reinforced plastic laminates.

Property to be tested	Direction	Test method		Specimens		Conditioning procedure (see 4.5.1.2)	Unit of value	Value required for each grade of laminate 2/					
		ASTM	Modified by	Size	Number tested			Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade W
Flexural strength flatwise	Lengthwise 1/ Crosswise	D 790	----	Standard	5	Standard	lb/in^2 (min avg)	50,000	37,000	31,000	23,000	18,000	32,000
Flexural strength flatwise	Lengthwise 1/	D 790	----	Standard	5	Wet	lb/in^2 (min avg)	45,000	33,000	27,000	20,000	15,000	29,000
Flexural module flatwise	Lengthwise 1/ Crosswise	D 790	----	Standard	5	Standard	lb/in^2 (min avg)	2,500,000	2,000,000	1,450,000	1,100,000	850,000	1,650,000
Flexural module flatwise	Lengthwise 1/	D 790	----	Standard	5	Wet	lb/in^2 (min avg)	2,300,000	1,800,000	1,250,000	990,000	770,000	1,500,000
Tensile strength	Lengthwise 1/	D 638	----	Standard	5	Standard	lb/in^2 (min avg)	37,000	28,000	20,000	14,000	9,000	35,000
Compressive strength edgewise	Lengthwise 1/	D 695	----	Standard	5	Standard	lb/in^2 (min avg)	33,000	25,000	21,000	17,000	16,000	18,000
Compressive strength edgewise	Lengthwise 1/	D 695	----	Standard	5	Wet	lb/in^2 (min avg)	28,000	23,000	19,000	15,000	14,000	17,000
Void content	-----	-----	4.5.3	2 inch dia	3	-----	Percent (max)	1.5	1.5	2.5	2.5	3.0	2.0
Resin content range	-----	D 2584	----	2 inch dia	3	-----	Percent	35-43	42-52	49-59	55-65	65-75	45-56

1/ Lengthwise is direction of maximum strength.
2/ No individual specimen shall indicate a value lower than 80 percent of the average value.

MIL-P-17549D(SH)

3.5 Visual inspection. Unless the requirements for acceptance criteria are modified by the contract or order, they shall be consistent with Chapter VI of NAVSHIPS-0939-LP-000-0010.

3.6 Repairs. Defective areas or areas from which test specimens have been cut shall be repaired by the fabricator in accordance with procedures outlined in NAVSHIPS-0900-LP-006-0010 prior to conducting the required performance tests. No repairs shall be permitted in high stress areas (see NAVSHIPS-0939-LP-000-0010) or in other areas where such repair may impair the performance of the unit, as determined by the inspector.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, 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 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 visual examination of 4.4.1 and tests specified in 4.3.4.

4.3.1 First article inspection report. The contractor shall furnish a first article inspection report in accordance with the data ordering document included in the contract (see 6.2.2).

4.3.2 First article sample. The first item that is manufactured under the contract or, in the case of a large structure consisting of various shaped structural members or panels, one individually laminated part of each kind shall be considered the first article sample. It shall be tested and shall meet the specification requirements (see 4.2). This first article sample, when accepted by the Government shall be considered as one of the total number to be delivered under the contract.

4.3.3 Test specimens. Test specimens shall be taken from locations on the first article sample (see 3.1) as approved by the inspector. Where possible, the test samples shall be obtained from areas normally cut-out of the part. In the unusual cases where the item is of such a nature that satisfactory samples cannot be obtained, or where removal of such samples and subsequent repair, will seriously impair its serviceability, prctotype sheets may be fabricated to the same thicknesses using the same materials and process to be employed under the contract.

4.3.4 First article tests. The first article tests shall consist of all ASTM test methods listed in table I and the tests specified in 4.3.4.1 and 4.3.4.2.

4.3.4.1 Determination of cure. The degree of cure of the first article sample shall be determined by comparing the average flexural strength of five specimens tested after standard conditioning with the average of five specimens tested after post-cure (see 4.5.2.1).

4.3.4.2 Barcol hardness. If the first article sample meets the requirements of 3.3.2, ten readings of Barcol hardness shall be made as specified in 4.5.2.2 and the average of the readings shall be used as a base measurement for comparison with Barcol hardness readings obtained on first article samples (see 3.3.3).

4.4 Quality conformance inspection. Quality conformance inspection consists of the examination of 4.4.1 and the tests specified in 4.4.4.1 and 4.4.4.2.

4.4.1 Visual and dimensional examination. Each individually laminated part as well as each final assembled structure shall be examined for visual and dimensional characteristics. The inspection shall follow the detailed procedures described in NAVSHIPS 0939-LP-000-0010 prior to painting, and shall be consistent with the first article inspection (see 4.3). The acceptance criteria (unless modified by the contract) shall be consistent with Chapter VI of NAVSHIPS 0939-LP-000-0010.

4.4.2 Test lot. A test lot shall consist of the units offered for delivery at one time or during a fixed period of time, which have been manufactured or processed under substantially the same conditions as the first article sample with no change in glass reinforcement or resin formulation.

4.4.3 Sampling for quality conformance tests. A random sample of units shall be selected from each lot in accordance with table II.

TABLE II. Sampling of units for quality conformance tests.

Number of units in lot	Number of units in sample for tests specified in: 4.4.4.1	4.4.4.2	Acceptance numbers for tests specified in: 4.4.4.1	4.4.4.2
2 to 9	2	2	0	0
10 to 15	2	3	0	0
16 to 25	3	5	0	0
26 to 40	3	7	0	0
41 to 65	5	10	0	1
66 to 110	7	15	0	1
111 to 180	10	25	1	2
181 to 300	15	35	1	3

4.4.4 Quality conformance tests. Specimens from each of the units in the sample selected in accordance with 4.4.3 shall be subjected to the tests specified in 4.4.4.1 and 4.4.4.2. A failure of the average of the test results to conform with any of the applicable requirements shall be

considered a failure of that production unit, and if the number of nonconforming units in any sample exceeds the acceptance number in table II for that lot size, this shall be cause for rejection of the lot represented by the sample.

4.4.4.1 Flexural strength (wet). The test for flexural strength (wet) determined in one direction shall be conducted on sample units selected in accordance with table II to determine conformance with the requirements shown in table I for the applicable grade.

4.4.4.2 Resin content, percent voids, and Barcol hardness. Tests shall be conducted on samples selected in accordance with table II to determine conformance with requirements shown in table I and 3.3.2 for the applicable grade.

4.5 Test methods.

4.5.1 Mechanical and physical tests. Mechanical tests shall be made in accordance with the applicable ASTM test methods specified in table I.

4.5.1.1 Test specimens. The number and size of specimens per sample unit shall be as specified in table I.

4.5.1.2 Conditioning. Specimens shall be conditioned before test, as specified in table I.

4.5.1.2.1 Standard condition. Standard condition shall be 73.5 $\pm$ 2°F and 50 $\pm$ 4 percent relative humidity. The conditioning period prior to test shall be 48 hours for specimens of 1/8 inch or less in thickness and 96 hours for thicker specimens.

4.5.1.2.2 Wet condition. Wet condition shall be 2 hours immersion in boiling, distilled water. The specimens shall be cooled to room temperature in the same water. The tests shall be made immediately after removal of the specimen from the water.

4.5.2 Determination of cure.

4.5.2.1 Flexural strength method. Five post-cured specimens shall be prepared by heating at 220°F for 24 hours and then cooling to room temperature. The flexural test method shall be that specified by table I for flexural strength under the standard condition.

4.5.2.2 Barcol hardness method. Hardness of the laminate shall be determined by using a Barcol impressor instrument manufactured by Barber-Colman Company, or its equivalent. Measurements shall be made on surfaces which do not have gel coat or overlay by a method which conforms to the following: Hardness is measured by the depth of indentation made by a hardened steel truncated cone with an included angle of 26 degrees with a flat tip of 0.0062 inch in diameter. The penetrator fits into a hollow spindle and is held down by a spring loaded plunger. The depth of penetration under the spring-loaded pressure is transmitted to a dial indicator by a lever. The hardness scale on the dial has 100 divisions, each representing a depth of about 6.4 microns. In making the test, the

leg plate in the rear of the instrument is set on the surface to be tested and a pressure of about 16 pounds applied against the point by pressing on the instrument housing; the hardness number is then read.

4.5.3 Percent voids. The percent voids shall be calculated from samples cut from at least three areas in the plastic unit as designated by the Government inspector (see table I).

4.5.3.1 Method of calculation for clear unfilled laminate:

$$\text{Percent voids} = 100 - x.$$

$$x = \frac{a(d)}{c} \text{ plus } \frac{a(e)}{b}$$

Where:

x = total calculated volume of laminate.
a = specific gravity of laminate (method 5011 of ASTM D 792 x 100 = weight of 100 cubic centimeters of laminate.
b = 2.57 = specific gravity of glass.
c = specific gravity of cured resin (obtained from resin manufacturer or determine in accordance with ASTM D 792.
d = resin content (expressed as a decimal) (determine in accordance with ASTM D 2584).
e = glass content (expressed as a decimal) = (1-d).

4.5.3.2 Method of calculation for filled laminate:

$$\text{Percent voids} = 100 - x.$$

$$x = \frac{a(d)}{c} \text{ plus } \frac{a(e)}{b} \text{ plus } \frac{a(f)}{g}$$

Where:

x, a, b, c and d are the same as in 4.5.3.1.
e = glass content (expressed as a decimal) = (1-d-f).
f = filler content (expressed as a decimal).
g = specific gravity of filler (obtain from filler supplier).

5. PACKAGING

5.1 The packaging for a laminated product shall be as specified in the contract or the applicable product specification in which this material is used. For materials (see 3.2), packaging requirements shall be as specified in the contract in accordance with the applicable material specification.

6. NOTES

6.1 Intended use.

6.1.1 Grade 1. It is intended for use where most severe service conditions are encountered.

6.1.2 Grade 2. It is intended for use where less severe service conditions are encountered.

6.1.3 Grade 3. It is intended for use where moderate service conditions are encountered.

6.1.4 Grade 4. It is intended for use where good all around mechanical properties can be sacrificed for economy.

6.1.5 Grade 5. Laminate reinforced with random glass mat or equivalent, having higher resin content and lower strength than grade 4.

6.1.6 Grade W. It is intended for use where a lower edgewise compressive strength can be tolerated (for example in the construction of small boat hulls).

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

(a) Title, number, and date of this specification.
(b) Grade required (see 1.2).
(c) Delivery schedule for first article (see 3.1) and production units.
(d) Resin type (if fire retardant type is required)(see 3.2.1).
(e) Gel coat required (see 3.2.1.4).
(f) Packaging requirements for material.

6.2.2 Data requirements. When this specification is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of DAR 7-104.9 (n) (2) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this specification is cited in the following paragraph.

Paragraph	Data requirements	Applicable DID no.	Option
4.3.1	First Article Inspection Report	DI-T-4902	----

(Data item descriptions related to this specification, and identified in section 6 will be approved and listed as such in DoD 5000.19L., Vol. II, AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.2.2.1 The data requirements of 6.2.2 and any task in section 3, 4, or 5 of the specification required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by the offeror and

accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract, regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 First article inspection. 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 acquired 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 contract.

6.4 Changes from previous issue. Asterisks (*) are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 9330-N861)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*:
b. ADDRESS *(Street, City, State, ZIP Code)*	

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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DD FORM 82 MAR 1426 PREVIOUS EDITION IS OBSOLETE.

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for you in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document*(s)* or to amend contractual requirements.

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