

**MIL-P-15037E****2 DECEMBER 1965****SUPERSEDING****MIL-P-0015037D(SHIPS)****28 JUNE 1963****MIL-P-15037C****10 MARCH 1961****(Sec 6.7)****MILITARY SPECIFICATION****PLASTIC SHEET, LAMINATED, THERMOSETTING,  
GLASS-CLOTH, MELAMINE-RESIN**

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

**1. SCOPE**

1.1 This specification covers type GME glass cloth, melamine resin plastic thermo-setting sheet materials.

Sheet, Overwrap;  
Water - Vaporproof  
or Waterproof,  
Flexible.

**2. APPLICABLE DOCUMENTS**

2.1 The following documents, of the issue in effect on date of invitation for bids or requests for approval, form a part of this specification to the extent specified herein:

**SPECIFICATIONS****FEDERAL**

- UU-P-268 — Paper, Kraft, Untreated, Wrapping.
- PPP-B-636 — Box, Fiberboard.
- PPP-T-76 — Tape, Pressure-Sensitive Adhesive Paper, (For Carton Sealing).

**MILITARY**

- MIL-L-10547 — Liners, Case, and

**STANDARDS****FEDERAL**

- FED-STD-406 — Plastics: Methods of Testing.

**MILITARY**

- MIL-STD-105 — Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-129 — Marking for Shipment and Storage.

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

2.2 Other publications. The following documents form a part of this specification to the

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extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

**AMERICAN SOCIETY FOR TESTING  
AND MATERIALS**

D-150 — A-C Capacitance, Dielectric Constant, and Loss Characteristics of Electrical Insulating Materials.

D-229 — Methods of Testing Rigid Sheet and Plate Materials Used for Electrical Insulation.

D-495 — High-Voltage, Low-Current Arc Resistance of Solid Electrical Insulating Materials.

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

**KENTS MECHANICAL ENGINEERS  
HANDBOOK**

Design and Production

(Application for copies should be addressed to John Wiley and Sons, Inc., 440 4th Avenue, New York, N. Y. 10016.)

**UNITED STATES TESTING COMPANY**

Report of Test #83413

(Application for copies should be addressed to Bureau of Ships, Code 634C, Washington, D. C. 20360.)

**OFFICIAL CLASSIFICATION COMMITTEE**

Uniform Freight Classification Rules.

(Application for copies should be addressed to the Official Classification Committee, 1 Park Avenue at 33rd Street, New York, N. Y. 10016.)

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

### 3. REQUIREMENTS

**3.1 Qualification.** Glass cloth, melamine-resin thermosetting sheets shall be a product which has been tested, and passed the qualification tests specified herein, and has

been listed on or approved for listing on the applicable qualified products list.

### 3.2 Material.

**3.2.1 Construction.** The material shall consist of a glass cloth properly impregnated and bonded with a melamine-resin compound or binder, processed to conform to this specification.

**3.2.2 Property values.** The material shall conform to the property values shown in tables IV, VI, VII, and VIII. The values obtained for each set of specimens taken from the same sheet shall be averaged before comparison with the applicable table.

**3.2.3 Uniformity.** All sheets of any lot shall be uniform in texture, finish, and specified properties, other than respect to color (see 3.4).

**3.2.4 Surface defects.** The material shall be free from blisters, wrinkles or cracks, and reasonably free from other small defects such as scratches, dents, heat marks, etc.

**3.2.5 Warp or twist.** (Applicable only to sheets 36 inches and greater in length and in width.) The warp or twist of material as delivered, shall not exceed that shown in table I (see 4.7.13). Percentage of warp is given in terms of the lateral dimensions (length and width) of the material and percentage of twist is given in terms of dimensions from one corner to the opposite corner.

TABLE I. Warp or twist.

Thickness	Permissible variation, on basis of 36 inch dimension
Inches	Maximum percent
$\frac{1}{32}$ to under $\frac{1}{16}$	5.00
$\frac{1}{16}$ to under $\frac{1}{8}$	2.50
$\frac{1}{8}$ to $\frac{1}{4}$ , inclusive	1.00
Over $\frac{1}{4}$ , up to and including $\frac{1}{2}$	0.50
Over $\frac{1}{2}$	.25

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### 3.3 Dimensions and tolerances.

3.3.1 *Length and width.* Unless otherwise specified by the procuring activity, the manufacturer's standard sizes between 36 and 50 inches in width and between 36 and 96 inches in length will be acceptable. The length and width of sheets may vary 1 inch over or

under the manufacturer's standard size. Nonuniform standard sheet dimensions caused by cutting specimens for test required by this specification shall not be cause for rejection, unless particular dimensions are specified. When particular sheet dimensions are specified (see 6.2), the permissible variation from the specified length or width shall be as shown in table II.

TABLE II. Permissible variations in length or width.

Nominal thickness	Permissible variations in length or width, in inches ( $\pm$ )		
	6 inches and under	Over 6 to under 24 inches	24 inches and over
<i>Inches</i>			
Up to $\frac{1}{8}$ , inclusive	0.010	0.015	$\frac{1}{32}$
$\frac{1}{8}$ to $\frac{1}{4}$ , inclusive	.012	.017	$\frac{1}{16}$
$\frac{3}{8}$ to 1, inclusive	.015	.020	$\frac{1}{8}$
$1\frac{1}{4}$ to $1\frac{1}{2}$ , inclusive	.018	.030	$\frac{1}{4}$
$1\frac{3}{4}$ to $3\frac{1}{2}$ , inclusive	.022	.040	$\frac{1}{2}$

3.3.2 *Thickness.* Sheets shall be furnished in the nominal thicknesses shown in table III, as specified (see 6.2). At least 90 percent of the area of the sheet shall be within the

variations shown in table III, and at no point shall the thickness as measured vary from the nominal thickness by a value greater than 125 percent of the permissible variations.

TABLE III. Thicknesses,<sup>1</sup>

Nominal thickness		Permissible variations in inches ( $\pm$ )	Nominal thickness		Permissible variations in inches ( $\pm$ )
Inches	Decimal equivalent in inches		Inches	Decimal equivalent in inches	
$\frac{1}{32}$	0.031	0.0065	$\frac{3}{8}$	.875	.046
$\frac{3}{64}$	.047	.0075	1	1.000	.049
$\frac{1}{16}$	.0625	.0075	$1\frac{1}{8}$	1.125	.053
$\frac{3}{32}$	.094	.009	$1\frac{1}{4}$	1.250	.055
$\frac{1}{8}$	.125	.012	$1\frac{3}{8}$	1.375	.058
$\frac{5}{32}$	.156	.015	$1\frac{1}{2}$	1.500	.061
$\frac{3}{16}$	.1875	.019	$1\frac{5}{8}$	1.625	.064
$\frac{7}{32}$	.219	.021	$1\frac{3}{4}$	1.750	.067
$\frac{1}{4}$	.250	.022	$1\frac{7}{8}$	1.875	.070
$\frac{5}{16}$	.3125	.026	2	2.000	.073
$\frac{3}{8}$	.375	.030	$2\frac{1}{8}$	2.250	.079
$\frac{7}{16}$	.438	.033	$2\frac{1}{4}$	2.500	.085
$\frac{1}{2}$	.500	.036	$2\frac{3}{4}$	2.750	.090
$\frac{5}{8}$	.625	.040	3	3.000	.097
$\frac{3}{4}$	.750	.043	$3\frac{1}{2}$	3.500	.110

<sup>1</sup> On sheets of nominal thickness not listed in this table, the permissible variations shall be the same as for the next greater thickness.  
<sup>2</sup> Thicknesses less than  $1/32$  inch may, one glass cloth of thinner weave, but in no case shall the material consist of less than two plies of glass cloth. Permissible variations in thickness for sheets of approximately 0.001 to  $1/32$  inch shall conform to best commercial practice.

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**3.4 Color.** The material shall be furnished in a grey-white color obtained when using glass cloth with chemical finishes or in a natural brown color produced by heat treatment of the glass cloth. The brown color may contain streaks or be mottled, if it can be shown that such nonuniform color does not impair the performance characteristics of the material.

**3.5 Machinability.** The material shall be such that it can be drilled, tapped, sawed, and machined in all directions<sup>1</sup> (see 4.4.1) without cracking, splitting, or otherwise impairing the material for general use.

**3.6 Surface finish.** Unless otherwise specified by the procuring activity the surface finish of sheets shall be semi-gloss as produced by the laminating operation.

**3.7 Marking.** Each full-size sheet shall be legibly marked with the manufacturer's name or trademark. The method of marking shall be satisfactory to the bureau or agency concerned.

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<sup>1</sup> The nature of laminated material necessitates special precaution when drilling and tapping parallel to laminations.

**3.8 Workmanship.** Laminated materials shall be manufactured and processed in a careful and workmanlike manner, and shall be free from defects, other than with respect to color (see 3.4), which may affect the appearance or serviceability.

**4. QUALITY ASSURANCE PROVISIONS**

**4.1 Responsibility for inspection.** Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to 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 Qualification tests.** Qualification tests shall be conducted at a laboratory satisfactory to the Bureau of Ships. Qualification tests shall consist of the tests specified in table IV. Application for Qualification tests shall be made in accordance with "Provisions Governing Qualification" (see 6.3 and 6.4).

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TABLE IV. Qualification tests for property values.

Property to be tested	Test paragraph	Number of specimens for each thickness	Tests per specimen	Conditioning (see 4.6)	Unit of value	Values required for each sample thickness		
						1/16 inch	1/8 inch	1/4 inch
Dielectric breakdown parallel to laminations, step-by-step test	4.7.2	$\begin{Bmatrix} 1 \\ 2 \\ 1 \\ 2 \end{Bmatrix}$	$\begin{Bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{Bmatrix}$	$\begin{Bmatrix} A \\ D-366/50 \end{Bmatrix}$	Minimum kv.	$\begin{Bmatrix} 60.0 \\ 50.0 \end{Bmatrix}$	60.0 50.0	60.0 45.0
Impact strength, tested edgewise:								
Cut lengthwise	4.7.3	$\begin{Bmatrix} 4 \\ 4 \end{Bmatrix}$	$\begin{Bmatrix} 1 \\ 1 \end{Bmatrix}$	E-48/50	$\begin{Bmatrix} \text{Minimum foot-pounds per inch} \end{Bmatrix}$	"	13.0 8.0	12.0 8.0
Cut crosswise								
Flexural strength, tested flatwise:								
Cut lengthwise	4.7.4	$\begin{Bmatrix} 4 \\ 4 \\ 4 \\ 4 \end{Bmatrix}$	$\begin{Bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{Bmatrix}$	$\begin{Bmatrix} A \\ E-200/150 \end{Bmatrix}$	Minimum p. s. i.	60,000 40,000	55,000 35,000 30,000	45,000 30,000
Cut crosswise								
Cut lengthwise								
Cut crosswise								
Bonding strength	4.7.5	4	1	$\begin{Bmatrix} A \\ D-48/50 \end{Bmatrix}$	Minimum pounds	"	25,000	"
Water absorption	4.7.6	4	1	Precondition at E-1/105; condition at D <sub>1</sub> -24/23	Maximum percent	0.80	0.70	1,700 1,500 0.40
Dielectric constant at 1 megacycle	4.7.7	4	1	D-48/50	Maximum	"	7.5	"
Dissipation factor at 1 megacycle	4.7.7	4	1	D-48/50	Maximum	"	0.02	"
Volume resistivity	4.7.8	4	1	C-96/35/90	Minimum megohm cm.	"	5,000	"
Surface resistance	4.7.8	4	1	C-96/35/90	Minimum megohm	"	10,000	"
Arc resistance	4.7.9	4	1	D-48/50	Minimum seconds	180	180	180
Dielectric strength perpendicular to laminations, step-by-step test	4.7.10	$\begin{Bmatrix} 1 \\ 2 \\ 1 \\ 2 \end{Bmatrix}$	$\begin{Bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{Bmatrix}$	$\begin{Bmatrix} A \\ D-48/50 \end{Bmatrix}$	Minimum volts per mil	400 350	"	"

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TABLE IV. Qualification tests for property values—(Continued).

Property to be tested	Test paragraph	Number of specimens for each thickness	Tests per specimen	Conditioning (see 4.6)	Unit of value	Values required for each sample thickness		
						1/16 inch	3/8 inch	1/2 inch
Flame resistance:								
Ignition time	4.7.11	5	1	A	Minimum seconds	"	"	140
Burning time					Maximum seconds	"	"	100
Analysis of pyrolysis products								15,000
Carbon dioxide								1,500
Carbon monoxide								2,500
Ammonia								100
Aldehydes as H. CHO	4.7.12	4	1	A	(Maximum parts per million)	"	"	100
Cyanide as HCN								150
Oxides of nitrogen as NO <sub>2</sub>								100
Hydrogen chloride								

1 Short time.

2 Step-by-step.

3 Not required.

4.2.1 *Qualification samples.* The manufacturer shall furnish three sheets of material for qualification tests.

4.2.2 *Test for property values.* Two specimens from each sheet shall meet the requirements of table IV.

4.3 *Sampling for quality conformance inspection.* Sampling for quality conformance inspection shall be performed in accordance with the provisions set forth in MIL-STD-105, except where otherwise indicated. For purposes of sampling, an inspection lot for examination and tests shall consist of all material of the same type and thickness range submitted for delivery at one time.

4.3.1 *Number of samples for quality conformance tests.* The number of samples for testing shall consist of 10 percent of the lot, but not less than one nor more than three sheets. At the discretion of the cognizant Inspector of Naval Material, if recent production has been tested in accordance with 4.4.1 and found to be in conformance as specified in 4.4.1, quality conformance tests may be waived on orders of less than 500 pounds.

4.3.2 *Inspection of the end item.*

4.3.2.1 *Examination of the end item.* Examination of the end item shall be made in accordance with the classification of defects, inspection levels and acceptable quality

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levels (AQLs) set forth below. The lot size, for purpose of determining the sample size in accordance with MIL-STD-105, shall be expressed in units of sheets for examination in 4.3.2.1.1, 4.3.2.1.2 and in units of shipping containers in 4.3.2.1.3.

**4.3.2.1.1 Examination of the end item for defects in appearance and workmanship.** The sample unit for this examination shall be one sheet.

<i>Examine</i>	<i>Defect</i>
Appearance .....	Color, not as specified (see 3.4). Not uniform texture or finish. Any cuts, tears, holes or imperfections that affect serviceability. Presence of dirt, foreign material or imbedded particles.
Workmanship .....	Resin not completely bonded to glass cloth, exposed reinforcement. Any separation or laminations.
Marking .....	Not legibly identified as specified (see 3.7).

**4.3.2.1.2 Examination of the end item for dimensional defects.** The sample unit for this examination shall be one sheet.

<i>Examine</i>	<i>Defect</i>
Length and width (commercial sizes) .....	Varies by more than $\pm 1$ inch from dimension specified or required in contract or purchase order.
(cut sizes) .....	Varies by more than the tolerances indicated in table II.
Thickness .....	Varies by more than $\pm$ tolerances indicated in table III.

**4.3.2.1.3 Examination of preparation for delivery.** An examination shall be made to determine that packaging, packing and markings shall 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.

<i>Examine</i>	<i>Defect</i>
Packaging	Not level specified. Materials or construction not as specified. Sheets not unit wrapped or interleaved; protective wrapping not as specified.
Packing	Not level specified. Container material or construction not as specified, closures not made by specified, or required methods or materials. Any non-conforming component, component missing or otherwise damaged, affecting serviceability.
Count	Less than specified or indicated quantity of sheets.
Weight	Gross weight exceeds specified requirements.
Markings	Interior or exterior markings (as applicable) omitted, illegible, incorrect, incomplete or not in accordance with contract requirements.

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**4.3.2.1.4 Inspection levels and acceptable quality levels (AQLs) for examinations.** The inspection levels for determining the sample size and the acceptable quality levels (AQLs) expressed as defects per 100 units shall be as follows:

Examination paragraph	Inspection level	AQL
4.3.2.1.1	I	1.5
4.3.2.1.2	S-3	2.5
4.3.2.1.3	S-2	4.0

**4.4 End item testing.**

**4.4.1 Quality conformance testing.** Quality conformance testing of the end item shall be conducted in accordance with table V for the

characteristics as indicated herein for each lot submitted. The sample unit shall be one panel 12 by 12 inches by the thickness of the laminate. The warp and twist test, as applicable, shall be made on a full size sheet a portion of which may be used for destructive tests. The inspection level for determining the sample size shall be S-2 except that no less than two sample units shall be randomly selected throughout the lot. The acceptable quality level shall be 6.5 expressed as defects per 100 units. The lot size shall be expressed in units of sheets. These specimens shall then be drilled, tapped, sawed, and machined, in all directions, in accordance with the manufacturer's recommended technique, to determine conformance with 3.5.

TABLE V. Instructions for testing.

Characteristic	Specification reference		Rqmts. appl. to		Number determinations per sample unit	Results reported as	
	Requirement	Test method	Indiv. unit	Lot average		Pass or fail <sup>1</sup>	Numerically to nearest <sup>2</sup>
As received condition							
Dielectric breakdown (parallel to laminations) (applicable thickness range)	Table VI						
Short time	Table VI	4.7.2	X		1		KV
Step-by-step	Table VI	4.7.2	X		Avg of 4		KV
Flexural strength (applicable thickness range)							
Lengthwise	Table VI	4.7.4	X		Avg of 4		1000 psi
Crosswise	Table VI	4.7.4	X		Avg of 4		1000 psi
Bond strength (applicable to 1/2-3/4 inch thickness)	Table VI	4.7.5	X		Avg of 4		100 pounds
Warp and twist	3.2.5	4.7.13	X		Avg of 2		0.01 percent
Machinability	3.5	3.5	X		1	X	

<sup>1</sup> If failure is indicated report description of failure.

<sup>2</sup> Test reports shall include all values on which results are based.



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TABLE VI. Quality conformance tests for property values.

TABLE VI. Quality conformance tests for property													
Property to be tested	Test para-graph	Number of speci-men for each sample	Tests per specimen	Conditioning (see 4.6)	Unit of value	Values required for each sample thickness range: (inches)							
						0.031 to 0.032	0.032 to 0.044	0.044 to 0.096	0.096 to 0.125	0.125 to 0.250	0.251 to 0.499	0.500 to 1.000	1.001 to 2.500
Dielectric breakdown par-allel to lami-nations, step-by-step test Flexural strength, tested flatwise: Cut lengthwise Cut crosswise Bending strength	4.7.2	{ 1 4 }	1	D-48/50	Minimum kv.	60.0	60.0	60.0	60.0	60.0	55.0	45.0	40.0
	4.7.4	{ 4 4 }	{ 1 1 }	A	Minimum p. s. i.	{ 65,000 45,000 }	60,000	55,000	50,000	45,000	40,000	35,000	30,000
	4.7.5	{ 4 4 }	{ 1 1 }	A	Minimum pounds	{ 45,000 35,000 }	40,000	35,000	30,000	25,000	20,000	15,000	10,000

<sup>1</sup> Short time.<sup>2</sup> Step-by-step.<sup>3</sup> These ranges are for nominal thicknesses, subject to the tolerances specified in table III.<sup>4</sup> Not required.<sup>5</sup> Not required on thicknesses greater than 2 inches.

**MIL-P-15037E****4.5 Periodic control inspection.**

**4.5.1 Selection of samples and place of tests.** Periodic control tests and sample thicknesses of material required for the tests shall be as shown in table VII. Periodic control tests shall be conducted at intervals of 3 years after qualification tests have been completed. The tests shall be conducted on samples selected by the Government inspector. The material for test shall be taken either from production runs or from material manufactured by techniques representative of production runs. The material remaining after test, if satisfactory, may be applied to a contract or order.

**4.5.2 Reports of tests.** Five copies of the periodic control test report shall be forwarded to the Bureau of Ships (see 6.3) via the Government inspector, who shall certify that tests were conducted under his supervision and in accordance with the test procedures specified in this specification.

**4.5.3 Approval action on tests.** Upon receipt by the Bureau of Ships (see 6.3) of the

periodic control test report, action to maintain or withdraw the approval will be taken on the basis of the test results. If periodic control test results are not received by the Bureau of Ships at the expiration of the 3 year periods, the approval will automatically be withdrawn, and the product removed from the Military Qualified Products List.

**4.6 Conditioning.**

**4.6.1 Nomenclature.** The following letters shall be used to indicate the respective general conditioning procedures:

Condition A — As received; no special conditioning.

Condition C — Humidity conditioning.

Condition D — Immersion conditioning in distilled water.

Condition E — Temperature conditioning.

**Note.** Whenever a conditioning letter is followed by an inferior 1, as D<sub>1</sub>, a prior temperature conditioning has been carried out.

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TABLE VII. Periodic control tests for property values.

Property to be tested	Test paragraph	Number of specimens for each thickness	Tests per specimen	Conditioning (see 4.8)	Unit of value	Values required for each sample thickness		
						1/16 inch	1/8 inch	1/4 inch
Dielectric breakdown parallel to laminations, step-by-step test	4.7.2	{ 1 3 4 }	{ 1 1 }	D-333/50	Minimum kv.	50.0	50.0	45.0
Flexural strength, tested flatwise:								
	4.7.4	4	1	A	Minimum p. s. i.	{ 60,000 40,000 3	55,000	45,000
	4.7.5	4	1	A	Minimum pounds	0.80	0.70	30,000
	4.7.6	4	1	Precondition at E-1/105; condition at D <sub>1</sub> -24/23				1,700
Bonding strength								0.40
Water absorption								

1 Short time.  
2 Step-by-step  
3 Not required.

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**4.6.2 Designation.** Conditioning procedures shall be designated as follows:

- (a) A capital letter indicating the general condition of the specimen, that is, as received, humidity, immersion, or temperature conditioning.
- (b) A number indicating in hours the duration of the conditioning.
- (c) A number indicating in degrees centigrade the conditioning temperature.
- (d) A number indicating relative humidity whenever relative humidity is controlled.

The numbers shall be separated from each other by a slant mark, and from the capital

letter by a dash.

**Examples:**

Condition C-96/35/90 — Humidity condition, 96 hours at 35°C. and 90 percent relative humidity.

Condition D-48/50 — Immersion condition, 48 hours in distilled water at 50°C.

Condition E-48/50 — Temperature condition, 48 hours at 50°C.

**4.6.3 Time tolerances.** Oven conditioning shall be followed by a cooling to room temperature (23°C.) in a desiccator, and immersion conditioning shall be followed by cooling to room temperature in distilled water, as specified in table VIII.

TABLE VIII. Conditioning time tolerances.

Conditioning		Cooling		Comments
Condition	Time tolerance	Time	Time tolerance	
E-48/50 E-200/150	{ —0 hour } + 2 hours }	16 hours or more	—0 hour	{ Cool in desiccator. Start test within ½ hour after removing specimen from desiccator.
D-48/50 D-24/23 D-336/50	{ —0 hour } — ½ hour }	1 hour	{ —0 hour } + 2 hours }	{ Cool by immersion in a sufficient quantity of distilled water to reduce the temperature to 23°C. within 1 hour. Remove individually as needed, and wipe surface water off with a cloth. Start test within 1 minute after removing specimen from water.
E-1/105	{ —0 minute } — 5 minutes }	2 hours or more	—0 hour	See water-absorption test (see 4.7.5).
D <sub>1</sub> -24/23	{ —0 hour } — 2 hours }			See water-absorption test (see 4.7.6).
C-96/35/90	{ —0 hour } + 2 hours }			{ Tests after humidity conditioning shall be made on specimens in the humidity chamber (see 4.7.8). Forced air circulation shall be used in the humidity chamber.

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4.6.4 *Temperature tolerances.* The conditioning temperature tolerances shall be as follows:

Nominal temperature Degrees C.	Tolerance ( $\pm$ ) Degrees C.
23	2
35	1
50	2
105	2
150	2

4.6.5 *Humidity tolerance.* Tolerance on the nominal relative humidity of 90 percent shall be  $\pm 2$  percent.

#### 4.7 Test methods.

4.7.1 *Definitions.* In conducting tests, the term "lengthwise" shall be interpreted to mean that sheet direction known to be the stronger in flexure. "Crosswise" shall then be the sheet direction known to be the weaker in flexure.

4.7.2 *Dielectric breakdown parallel to laminations step-by-step.*

4.7.2.1 *Specimens.* The test specimens shall be 2 by 3 inches in the thickness of the sheet. American Standard tapered pins having a taper of one-quarter inch per foot shall be used. For test specimens having a thickness up to one-half inch, inclusive, No. 3 American Standard tapered pins  $\frac{3}{16}$  inches long and having a diameter at the large end of seven-thirty-seconds of an inch shall be used. Drill two  $\frac{3}{16}$ -inch-diameter holes, centrally located, 1 inch apart, center to center, and perpendicular to the faces of the specimen. Using standard tapered pin reamer, ream holes to a sufficient depth to allow the pins to extend approximately  $1\frac{1}{2}$  inches from the small end of the hole. For test specimens having a thickness over  $\frac{1}{2}$  up to 2 inches inclusive, No. 4 American Standard tapered pins 4 inches long and having a diameter at the large end of one-quarter inch shall be used. Drill two  $\frac{3}{16}$ -inch-diameter holes, cen-

trally located, 1 inch apart, center to center, and perpendicular to the faces of the specimen. Using standard tapered pin reamer, ream holes to a sufficient depth to allow the pins to extend approximately 1 inch from the small end of the hole. The electrodes shall be inserted after the conditioning of the test specimen. Spheres having a  $\frac{1}{2}$ -inch diameter, when placed on the extremities of the tapered pins, will decrease the tendency to flashover.

4.7.2.2 *Procedure.* All tests shall be made under oil, at commercial power frequency of 60 cycles. One specimen only shall be tested by the short-time method for the purpose of providing a basis for the initial voltage applied to the step-by-step test. In the short-time test, starting at zero, the testing voltage shall be increased as uniformly as possible at a rate of 500 volts per second. On the remaining specimens, the step-by-step method shall be used. The initial voltage applied in the step-by-step tests, determined as specified above, shall be applied for 1 minute and the voltage shall then be increased in increments as follows, holding the voltage at each step for 1 minute:

Breakdown voltage by short-time method	Increment of increase in step-by-step method
Kv.	Kv.
12.5 or less	0.5
Over 12.5 to 25, inclusive	1.0
Over 25 to 50, inclusive	2.5
Over 50 to 100, inclusive	5.0

4.7.2.3 *Report.* The breakdown voltage shall be reported in kilovolts and the time required to break each specimen shall be reported in seconds.

4.7.3 *Impact strength (tested edgewise).*

4.7.3.1 *Specimens.* Specimens of sheets in thicknesses of  $\frac{1}{8}$  to  $\frac{1}{2}$  inch, inclusive, shall

\* For information on tapered pins, see Kents Mechanical Engineers Handbook, 12th Edition, Design and Production, page 15-14.

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be tested in sizes  $2\frac{1}{2}$  inches by  $\frac{1}{2}$  inch by thickness without build-up. Each specimen shall be notched in one edge (side). The notch shall be centrally located with respect to the ends of the specimen. The angle of the notch shall be 45 degrees and the depth under the notch shall be  $0.400 \pm 0.005$  inch with a curvature at the bottom of the notch of  $0.010 \pm 0.002$  inch radius. Different sets of specimens shall be cut lengthwise and crosswise of the sheet.

**4.7.3.2 Procedure.** After the conditioning of the specimen, the impact strength shall be determined on a pendulum type Izod impact machine. Accurate corrections shall be made for friction and windage losses. The specimen shall be located in the machine by means of a jig, with center line of notch on the level of the top of the clamping surface. In the striking position, the striking edge of the pendulum shall be 0.866 inch from the edge of the specimen clamp. The pendulum shall be released from such a position that the linear velocity of the striking edge at the instant of impact shall be approximately 11 feet per second, which is the linear velocity corresponding to an initial elevation of the striking edge of 2 feet. The blow shall be

struck on the notched side. The pointer setting shall be recorded and corresponding correction shall be obtained from a chart. This chart shall be constructed by measuring the friction and windage losses, using the proportionate amount of these losses as the correction factor.

**4.7.3.3 Calculations.** The impact strength shall be taken as the energy absorbed in breaking the specimen. It shall equal the difference between the energy remaining after breaking the specimens and the pendulum's initial energy, and shall be expressed in foot-pounds per inch of notch.

**4.7.4 Flexural strength (tested flatwise).**

**4.7.4.1 Specimens.** Specimens of sheet in thicknesses of  $\frac{1}{32}$  to  $3\frac{1}{2}$  inches, inclusive, shall be tested flatwise in accordance with method 1031 of FED-STD-406, except that the dimensions and speed of test shown in table IX shall be used and that specimens over  $\frac{1}{2}$  inch in nominal thickness shall be machined on both surfaces to a specimen thickness of  $\frac{1}{2}$  inch. Different sets of specimens shall be cut lengthwise and crosswise of the sheet.

TABLE IX. Dimensions of specimen and speed of test.

Nominal specimen thickness	Width of specimen	Length of specimen	Span	Speed of test per minute
<i>Inch</i>	<i>Inch</i>	<i>Inches</i>	<i>Inches</i>	<i>Inch</i>
$\frac{1}{32}$	1	$2\frac{1}{2}$	$\frac{3}{4}$ <sup>1</sup>	0.025
$\frac{1}{16}$	1	3	1	.026
$\frac{3}{42}$	1	$3\frac{1}{2}$	$1\frac{1}{2}$	.040
$\frac{1}{8}$	1	4	2	.063
$\frac{3}{16}$	$\frac{1}{2}$	5	3	.080
$\frac{1}{4}$	$\frac{1}{2}$	6	4	.106
$\frac{3}{8}$	$\frac{1}{2}$	8	6	.160
$\frac{1}{2}$	$\frac{1}{2}$	10	8	.218

<sup>1</sup> This span depth ratio is greater than 16 to 1 in order to give clearance between moving head and specimen supports.

**4.7.4.2 Procedure.** Specimens shall be tested in accordance with method 1031 of FED-STD-406, except that the speed shown in table IX shall be used. No modulus data

need be taken.

**4.7.4.3 Calculations.** The calculations shall be made in accordance with method 1031 of

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## FED-STD-406.

**4.7.5 Bonding strength.** The test for bonding strength shall be conducted in accordance with method 1111 of FED-STD-406.

**4.7.6 Water absorption.** The water absorption test shall be conducted in accordance with method 7031 of FED-STD-406 with 24-hour immersion.

**4.7.7 Dielectric constant and dissipation factor (at 1 megacycle).**

**4.7.7.1 Specimens.** The specimens for dielectric constant and dissipation factor tests at 1 megacycle frequency, perpendicular to laminations, shall be 4-inch diameter disks or 4-inch squares cut from sheets  $\frac{1}{8}$  inch in thickness.

**4.7.7.2 Procedure.** After the conditioning of the specimens, the electrical measurements shall be made by using a suitable bridge method, a twin-T impedance-measuring circuit, or a resonant-circuit substitution method. The method used shall have an accuracy of determination of dielectric constant of  $\pm 5$  percent and an accuracy of determination of dissipation factor of  $\pm 5$  percent but in no case closer than 0.0001. The specimens shall have been covered on both sides with metal foil using a thin layer of petrolatum as an adhesive, or with conductive silver paint electrodes. The dissipation factor shall be directly computed from the instrument readings and shall be considered nominally equivalent to the power factor.

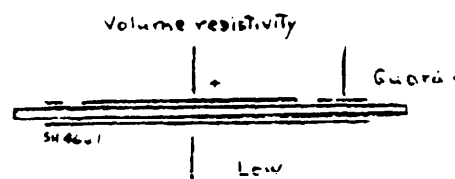
*Note.* For a complete discussion of theory, apparatus, electrodes, and calculation, refer to ASTM D-150.

**4.7.8 Volume resistivity and surface resistance.**

**4.7.8.1 Specimens.** The specimens for volume-resistivity and surface-resistance tests shall be 4 by 4 inches by thickness.

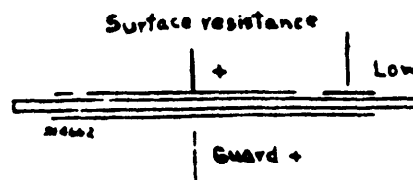
**4.7.8.2 Procedure.**

**4.7.8.2.1 Volume resistivity.** The test electrodes shall be made of conductive silver paint sprayed or brushed on the surfaces of the specimen. The upper electrode shall be in the shape of a circle 2 inches in diameter. A guard ring  $\frac{1}{4}$  inch wide shall be located concentrically with respect to the upper electrode and shall be spaced  $\frac{1}{4}$  inch from it. The bottom electrode shall be in the shape of a circle 3 inches in diameter. The centers of the upper and lower electrodes shall be centered as accurately as possible so that they are on the same axis. The potentials applied shall be as follows:



The volume resistance shall be measured by means of a 500-volt megohm bridge exactly 1 minute after the current is applied. Tests following the humidity conditioning shall be made on specimens in the humidity chamber.

**4.7.8.2.2 Surface resistance.** Surface resistance measurements shall be made on the same specimens as those used for volume resistivity. The test procedure shall be similar to that specified for volume resistivity, except that the potentials of the guard and bottom electrodes shall be interchanged as follows:



The surface resistance shall be measured by means of a 500-volt megohm bridge exactly



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1 minute after the current is applied. Tests following the humidity conditioning shall be made on specimens in the humidity chamber.

4.7.8.3 *Calculations.* The volume resistivity shall be calculated as follows:

$$r = \frac{RA}{L}$$

Where:

$r$  = volume resistivity in megohm-centimeters.

$R$  = measured volume resistance in megohms.

$A$  = area of guarded electrode in square centimeters.

$L$  = average thickness of specimen in centimeters.

Surface resistance shall be reported in megohms.

4.7.9 *Arc resistance.* The arc resistance test shall be performed in accordance with ASTM D-495. Tungsten rod electrodes shall be used.

4.7.10 *Dielectric strength perpendicular to laminations, step-by-step test.*

4.7.10.1 *Specimens.* The test specimens shall be of  $\frac{1}{16}$  inch thickness and of sufficient length and width to prevent flashover when tested in air. (Specimens 12 inches by 12 inches by  $\frac{1}{16}$  inch are suggested)

4.7.10.2 *Procedure.* All tests shall be made in air, at commercial power frequency of 60 cycles, in accordance with method 4031 of FED-STD-406 using electrodes 2 inches in diameter and 1 inch in length with the edges rounded to a radius of  $\frac{1}{4}$  inch. One specimen only shall be tested by the short-time method for the purpose of providing a basis for the initial voltage applied in the step-by-step test. In the short-time test, starting at zero, the testing voltage shall be increased as uni-

formly as possible at a rate of 500 volts per second. On the remaining specimens, the step-by-step method shall be used. The initial voltage applied in the step-by-step test shall be 50 percent of the short-time breakdown voltage. The initial voltage in the step-by-step tests, determined as specified above, shall be applied for 1 minute and the voltage shall then be increased in increments as follows, holding the voltage at each step for 1 minute:

<i>Breakdown voltage by short-time method</i>	<i>Increment of increase in step-by-step method</i>
<i>Kv.</i>	<i>Kv.</i>
12.5 or less	0.5
Over 12.5 to 25, inclusive	1.0
Over 25 to 50, inclusive	2.5
Over 50 to 100, inclusive	5.0

4.7.10.3 *Report.* The time to break each specimen shall be reported in seconds. The dielectric strength in volts per mil.

4.7.11 *Flame resistance.* Flame resistance shall be determined in accordance with method II of ASTM D229 with the following exceptions:

- (a) Determination of weight and weight loss, such as in definitions, apparatus, procedures, calculations and report sections, are not applicable.
- (b) *Flame cabinet.* The  $\frac{3}{16}$ -inch slot at bottom of the flame cabinet shall be on all 4 sides. The door shall be provided with a  $1\frac{1}{4}$  inch diameter peep hole located directly opposite the heater coil when the door is closed. The hole shall be kept closed during testing by means of a cover.
- (c) *Pyrometer.* The means of correction from black-body radiation to actual conditions of this test shall be delineated as follows:
  - (1) When a pyrometer calibrated for black body emission is used,



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6° C. shall be added to the pyrometer reading to obtain the true temperature of the Nichrome V coil.

(d) *Specimens.* Test specimens shall be as follows:

(1) Specimens shall be  $\frac{1}{2} \pm 0.036$  inch thick machined to  $\frac{1}{2} \pm 0.01$  inch wide and  $10 \pm \frac{1}{16}$  inch long.

(2) The test sample shall consist of 5 samples.

(e) *Calibration.* In the calibration of this equipment adjust the heater current to obtain an equilibrium temperature of  $860 \pm 2^\circ \text{C}$ .

(f) *Calculation of burning time.* Arrange the 5 values of burning time in increasing order of magnitude, as  $T_1, T_2, T_3, T_4$ , and  $T_5$ . Compute the following ratios:

$$\frac{T_2 - T_1}{T_5 - T_1} \text{ and } \frac{T_4 - T_1}{T_5 - T_1}$$

If either of these ratios exceeds 0.642 then  $T_1$  or  $T_5$  is judged to be abnormal and is eliminated. The burning time reported shall be the average of the remaining four values.

(g) *Average ignition time.* The average ignition time is calculated as the arithmetic mean of the five specimens.

4.7.12 *Analysis of pyrolysis products.* The method described in U. S. Testing Company's Report #83413 shall be used. Specimens  $\frac{1}{2}$  inch by 5 inches shall be cut from a  $\frac{1}{2}$  inch sheet for testing.

4.7.13 *Warp and twist.* The warp and twist test shall conform to method 6051 of FED-STD-401 (see 3.2.5).

## 5. PREPARATION FOR DELIVERY

5.1 *Packaging.* Packaging shall be level A or C, as specified (see 6.2).

5.1.1 *Level A.* Unless otherwise specified, laminated sheets shall be wrapped individually, or interleaved to protect them from abrasion, using kraft paper conforming to UU-P-268 or equivalent commercial quality.

5.1.2 *Level C.* Packaging shall be sufficient to accord adequate protection against deterioration and physical damage during shipment from the supply source to the first receiving activity for immediate use. This level may conform to the supplier's commercial practice when such meets the requirements of this level.

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

5.2.1 *Level A.* Laminated sheets, packaged as specified (see 6.2), shall be packed in containers conforming to class weather-resistant of PPP-B-636. Shipping containers shall have case liners conforming to MIL-L-10547. Case liners shall be closed and sealed in accordance with the appendix to MIL-L-10547. Case liners may be omitted provided all joints and corners of the boxes are sealed with minimum  $1\frac{1}{2}$  inch wide tape conforming to PPP-T-76. Shipping containers shall be closed, strapped or banded in accordance with the box specification or appendix thereto. Fiberboard boxes shall not exceed the weight limitations of PPP-B-636.

5.2.2 *Level B.* Laminated sheets, packaged as specified (see 6.2), shall be packed in containers conforming to class domestic of PPP-B-636. Shipping containers shall be closed in accordance with the box specification of appendix thereto. Fiberboard boxes shall not exceed the weight limitations of PPP-B-636.

5.2.3 *Level C.* Laminated sheets, packaged as specified (see 6.2), shall be packed in con-

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tainers, at the lowest rates, in a manner which will insure acceptance by common carrier and will afford protection against physical or mechanical damage during direct shipment from the supply source to the first receiving activity for immediate use. This level in general shall conform to the Uniform Freight Classification Rules and Regulations or other carrier regulations as applicable to the mode of transportation and may be the supplier's commercial practice when such meets the requirements of this level.

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

**6. NOTES**

**6.1 Intended use.** The plastic sheet covered by this specification is an electrical type designed specially for service under moisture conditions and is used primarily for electrical insulating purposes.

**6.2 Ordering data.** Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Sheet size and thickness required (see 3.3).
- (c) Whether sheets, smaller in dimension than specified in the procurement document due to cutting specimens for lot acceptance tests are acceptable (see 3.3.1).
- (d) Levels of packaging and packing required (see 5.1 and 5.2).
- (e) Special marking required (see 5.3).

**6.3** With respect to products requiring qualification, awards will be made for such products as have, prior to the time set for opening of bids, been tested and approved

for inclusion in Qualified Products List QPL-15037, whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification, in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the qualified products list is the Chief of the Bureau of Ships, Department of the Navy, Washington, D.C. 20360, and information pertaining to qualification of products may be obtained from that activity. Application for Qualification tests shall be made in accordance with "Provisions Governing Qualification" (see 6.4).

**6.4** Copies of "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

**6.5 Fabricated parts or equipment.** Requirements applicable to fabricated parts or equipment incorporating glass-cloth, melamine-resin, laminated materials should be specified in separate specifications or as part of contracts or orders.

**6.6** Certain provisions of this specification are the subject of international standardization agreement Navy-ABC-STD-17. When amendment, revision, or cancellation of this specification is proposed, the departmental custodians will inform their respective Departmental Standardization Officers so that appropriate action may be taken respecting the international agreement concerned.

**6.7 CHANGES FROM PREVIOUS ISSUE.** THE EXTENT OF CHANGES (DELETIONS, ADDITIONS, ETC.) PRECLUDE THE ANNOTATION OF THE INDIVIDUAL CHANGES FROM THE PREVIOUS ISSUE OF THIS DOCUMENT.

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**Custodians:**

**Army—EL**

**Navy—SH**

**Air Force—11**

**Preparing activity:**

**Navy—SH**

**(Project 9330-0100)**

**International interest (see section 6)**

**Reviewer:**

**Army—EL, MI, MR, MU**

**Navy—SH**

**Air Force—11, 17, 69**

**User:**

**Army—GL**

**Navy—WP**



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