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MILITARY SPECIFICATION

PLASTIC RODS AND TUBES, THERMOSETTING, LAMINATED

This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.

1. SCOPE

1.1 Scope. - This specification covers the basic characteristics required of laminated thermosetting rods and tubes, and the methods suited to their satisfactory determination. Rods and tubes machined from sheet stock, and other-than-round rods and tubes, are not covered by this specification.

1.2 Classification. - The laminated thermosetting rods and tubes shall be furnished in the following forms and types, as specified (see 6.2.):

- Form R - Rods, molded.
- Form T_r - Tubes, rolled.
- Form T_m - Tubes, molded.
- Type PBE - Paper-base, phenolic-resin.
- Type PBG - Paper-base, phenolic-resin.
- Type PBM - Paper-base, phenolic-resin, (form T_r only).
- Type FBE - Cotton-fabric-base, phenolic-resin.
- Type FBG - Cotton-fabric-base, phenolic-resin (forms T_m and R only).
- Type FEM - Cotton-fabric-base, phenolic-resin (form T_r only).
- Type GMG - Glass-fabric-base, melamine-resin (forms T_r and R only).

2. APPLICABLE DOCUMENTS

2.1 The following specifications and standards, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein:

SPECIFICATIONS

- FEDERAL
- L-P-406 - Plastics, Organic: General Specifications, Test Methods.
- PPP-B-566 - Boxes, Folding, Paperboard.
- PPP-B-585 - Boxes, Wood, Wirebound.
- PPP-B-591 - Boxes, Fiberboard, Wood-Cleated.
- PPP-B-601 - Boxes, Wood, Cleated Plywood.
- PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.

- PPP-B-636 - Boxes, Fiber.
- PPP-B-676 - Boxes, Set-up, Paperboard.
- PPP-T-60 - Tape; Pressure-Sensitive Adhesive, Waterproof-for Packaging and Sealing.
- PPP-T-76 - Tape, Pressure-Sensitive Adhesive, Paper, Water Resistant (For Carton Sealing).
- PPP-T-97 - Tape, Pressure-Sensitive Adhesive, Filament Reinforced.

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- MIL-P-116 - Preservation, Methods of.
- MIL-B-10377 - Boxes: Wood-Cleated, Veneer, Paper Overlaid.
- MIL-L-10547 - Liners, Case, Waterproof.

STANDARDS

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- 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 contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

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

OFFICIAL CLASSIFICATION COMMITTEE Uniform Freight Classification Rules.

(Application for copies should be addressed to the Official Classification Committee, 1 Park Avenue at 33rd St., New York 16, N. Y.)

AMERICAN SOCIETY FOR TESTING MATERIALS

- D-688 - Methods of Measuring Dimensions of Rigid Tubes Used for Electrical Insulation.

FSC 9330

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D-741 - Methods of Measuring Dimensions of Rigid Rods Used for Electrical Insulation.

(Application for copies should be addressed to American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION

Publication No. 45-107 - Recommended Practice for Fabricating Laminated Plastics.

(Application for copies should be addressed to the National Electrical Manufacturer's Association, 155 East 44th St., New York 17, N. Y.)

3. REQUIREMENTS

3.1 Material -

3.1.1 Construction - The material shall consist of a suitable base or filler, properly impregnated and bonded with a thermosetting-resin compound or binder, processed to conform to this specification.

3.1.1.1 Tubes are formed by rolling the impregnated sheet material upon mandrels between heated pressure rolls and then either oven-baking or pressing the material in a heated mold until the curing or setting of the resin into the infusible form is completed.

3.1.1.2 Molded rods are composed of laminations of impregnated sheet material which have been molded in cylindrical molds under high temperature and pressure and then ground to size.

3.1.2 Property values - The material shall conform to the property values shown in tables I to III, inclusive, when tested in accordance with section 4. These property values apply only to standard sizes of rods and tubes listed in table VI. Special sizes of rods and tubes are available as indicated in table VI. The property value requirements for special sizes of rods and tubes shall be as specified (see 6.2).

3.1.3 Machinability - The material shall be such that it can be drilled, tapped, sawed, and machined in accordance with NEMA Publication No. 45-107.

3.1.4 Surface defects - Laminated tubes shall be free from blisters, pronounced mandrel, scores, and loose layers, and reasonably free from resin pockets, voids and heat marks. Rolled tubes shall be free from wrinkles. Molded tubes shall be free from seam cracks. Rods shall be free from blisters and mold seam cracks and reasonably free from voids and resin pockets. Tubes with a wall

thickness greater than one half inch or rods with a diameter greater than 1 inch may show checks or cracks between the laminations on machined or sawed edges. Edges, drilled holes, and machined, milled, or ground faces of laminated rods and tubes shall be smooth and shall present a neat appearance.

3.1.5 Warp - The warp of material furnished in the rod or tube form, as delivered, shall not exceed the following (see 4.6.7):

<u>Outside diameter</u> <u>inch</u>	<u>Permissible warp,</u> <u>maximum percent</u>
1/8 to 1/4, inclusive	2.0
Over 1/4 to 3/4	1.0
Over 3/4	0.50

Note - Percentage of warp is specified in terms of a 36-inch length of material.

3.2 Color - The laminated rods and tubes shall be natural in color. Natural is the color produced by the natural, undyed paper or fabric and the resin used.

3.3 Dimensions and tolerances -3.3.1 Lengths -

3.3.1.1 Unless otherwise specified (see 6.2), rods and tubes shall be furnished in manufacturer's standard lengths, with a tolerance of ± 1 inch.

3.3.1.2 Tolerances on cut lengths -

3.3.1.2.1 Rods - When specified (see 6.2), rods shall be furnished cut to length within the tolerances shown in table IV.

3.3.1.2.3 Tubes - When specified (see 6.2), the tubes shall be furnished cut to length, circular-sawed, within the tolerances shown in table V.

3.3.2 Diameters and wall thicknesses -

3.3.2.1 Sizes - The diameter of molded rods and the inside diameter, outside diameter, and wall thickness of tubes shall be as specified (see 6.2). Standard sizes covered are shown in table VI and shall be specified unless otherwise required.

3.3.2.2 Tolerances on diameters and wall thicknesses -

Table I - Property values of form R.

Test	Unit	Condition (see 4.8)	Number of specimens per rod	Tests per specimen	Test procedure paragraph	Limit	Diameter range (Inches)	Type PBE	Type PFG	Type FBE	Type FPG	Type GMG
Water absorption	Percent	Precondition E-1/105 Condition D1-24/75	1	1	4.6.2	Maximum average	1/8 up to but not including 1/4 1/4 up to but not including 1/2 1/2 to 1, inclusive Over 1 to 3, inclusive	1.5 1.0 0.75 0.75	2.5 1.5 1.0 1.3	1/2.2 1.4 1.1 1.1	---	---
Compressive strength axially	P. S. I.	A	1	1	4.6.4	Minimum average	1/8 up to but not including 1/4 1/4 to 1, inclusive Over 1 to 3, inclusive	20,000 20,000 20,000	20,000 20,000 20,000	1/20,000 20,000 20,000	---	---
Flexural strength	P. S. I.	A	1	1	4.6.5	Minimum average	1/8 up to but not including 1/4 1/4 to 2, inclusive	13,000 13,000	15,000 15,000	1/12,000 12,000	---	---
Specific gravity	-----	A	1	1	4.6.6	Minimum average	1/8 to 3/16, inclusive 1/4 to 2, inclusive	1.25 1.25	1.20 1.20	1/1.20 1.20	---	---

1/ These values apply only to rods having diameters of three-sixteenths of an inch up to but not including one-quarter of an inch.

Table II - Proposed values of Figure 7.

Test	Year	Condition (see 4.1)	Number of specimens per side	Years per specimen	Test volume per specimen	Limit	Dist. (see 4.1)	Type 200		Type 200		Type 200		Type 200		Type 200		Type 200		
								1/4 up to 1/2 1/2 inch	1/2 to 3/4 3/4 inch	3/4 to 1 1 inch	1 to 1 1/4 1 1/4 inch	1 1/4 to 1 1/2 1 1/2 inch	1 1/2 to 1 3/4 1 3/4 inch	1 3/4 to 2 2 inch	2 to 2 1/4 2 1/4 inch	2 1/4 to 2 1/2 2 1/2 inch	2 1/2 to 2 3/4 2 3/4 inch	2 3/4 to 3 3 inch	3 to 3 1/4 3 1/4 inch	3 1/4 to 3 1/2 3 1/2 inch
Water absorption	Percent	Present - Item 5.1/100 Cont'd - Item 5.1/200	1	1	4.6.2	Maximum average	1/20 up to 1/16, including 1/16 in. Over 1/16 to 1/8, including 1/8 in. Over 1/8 to 1/4, including 1/4 in. Over 1/4 to 1/2, including 1/2 in. Over 1/2 to 3/4, including 3/4 to 1, including 1.	3/4 to 1	1 to 1 1/4	1 1/4 to 1 1/2	1 1/2 to 1 3/4	1 3/4 to 2	2 to 2 1/4	2 1/4 to 2 1/2	2 1/2 to 2 3/4	2 3/4 to 3	3 to 3 1/4	3 1/4 to 3 1/2	3 1/2 to 3 3/4	3 3/4 to 4
								100	100	100	100	100	100	100	100	100	100	100	100	100
Disturbance strength per cubic inch	Yield per cubic inch	A	1	1	4.6.3	Maximum average	1/20 up to 1/16, including 1/16 in. Over 1/16 to 1/8, including 1/8 in. Over 1/8 to 1/4, including 1/4 in. Over 1/4 to 1/2, including 1/2 in. Over 1/2 to 3/4, including 3/4 to 1, including 1.	3/4 to 1	1 to 1 1/4	1 1/4 to 1 1/2	1 1/2 to 1 3/4	1 3/4 to 2	2 to 2 1/4	2 1/4 to 2 1/2	2 1/2 to 2 3/4	2 3/4 to 3	3 to 3 1/4	3 1/4 to 3 1/2	3 1/2 to 3 3/4	3 3/4 to 4
								100	100	100	100	100	100	100	100	100	100	100	100	100
Compressive strength	P.S.I.	A	1	1	4.6.4	Minimum average	1/20 up to 1/16, including 1/16 in. Over 1/16 to 1/8, including 1/8 in. Over 1/8 to 1/4, including 1/4 in. Over 1/4 to 1/2, including 1/2 in. Over 1/2 to 3/4, including 3/4 to 1, including 1.	3/4 to 1	1 to 1 1/4	1 1/4 to 1 1/2	1 1/2 to 1 3/4	1 3/4 to 2	2 to 2 1/4	2 1/4 to 2 1/2	2 1/2 to 2 3/4	2 3/4 to 3	3 to 3 1/4	3 1/4 to 3 1/2	3 1/2 to 3 3/4	3 3/4 to 4
								100	100	100	100	100	100	100	100	100	100	100	100	100
Specific gravity	A	A	1	1	4.6.5	Maximum average	1/20 up to 1/16, including 1/16 in. Over 1/16 to 1/8, including 1/8 in. Over 1/8 to 1/4, including 1/4 in. Over 1/4 to 1/2, including 1/2 in. Over 1/2 to 3/4, including 3/4 to 1, including 1.	3/4 to 1	1 to 1 1/4	1 1/4 to 1 1/2	1 1/2 to 1 3/4	1 3/4 to 2	2 to 2 1/4	2 1/4 to 2 1/2	2 1/2 to 2 3/4	2 3/4 to 3	3 to 3 1/4	3 1/4 to 3 1/2	3 1/2 to 3 3/4	3 3/4 to 4
								100	100	100	100	100	100	100	100	100	100	100	100	100

1. This test is limited to using 1/4 inch and greater in length diameter and 8 inches and less in outside diameter.
 2. For use in concrete, the test is not applicable.
 3. For use in concrete with inside diameter of 1/8 to 3/16 inch, including 1/8 inch.
 4. Applies only to those over 3/4 inch to 1 1/2 inch, including 3/4 inch.

Table III - Property values of form T_m

Test	Unit	Condition (see 4.5)	Number of specimens per tube	Tests per specimen	Test procedure paragraph	Limit	Wall thickness range $\frac{2}{3}$ (inch)	Type PEIE	Type PBG	Type FBE	Type FBG
Water absorption	Percent	Precondition E-1/105 Condition D ₁ -24/23	1	1	4.6.2	Maximum average	1/32 up to 1/16	-----	-----	4.5	3.0
							1/16 up to 3/32	1.4	2.0	2.2	3.0
							3/32 up to 1/8	1.2	1.8	1.8	2.2
							1/8 up to 3/16	1.1	1.6	1.5	2.0
							3/16 up to 1/4	1.0	1.3	1.3	1.8
Dielectric strength perpendicular to laminae	Volts per mil	A	1	1	4.6.3	Minimum average	1/4 up to 1/2	0.9	1.2	1.2	1.6
							1/2 up to 1	0.8	1.0	1.0	1.2
							1	0.7	0.9	0.9	1.1
							1/16	300	300	150	175
							Over 1/16 to 1/8, inclusive	230	230	175	175
Compressive strength axially	P. S. I.	A	1	1	4.6.4	Minimum average	Over 1/8 to 1/4, inclusive	150	150	135	125
							Over 1/4 to 1/2, inclusive	110	110	90	90
							1/16 and greater $\frac{2}{3}$	20,000	19,000	19,000	19,000
Specific gravity	-----	A	1	1	4.6.6	Minimum average	All sizes	1.22	1.25	1.25	1.25

1/ Test is limited to tubes 2 inches and less in outside diameter.

2/ The term "up to" means "up to but not including."

3/ Applies only to tubes 1/4 inch I. D. and greater.

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3.3.2.2.1 Tolerances on diameters of rods. - Unless otherwise specified (see 6.2), the tolerances shown in table VII shall apply.

3.3.2.2.2 Tolerances on diameters and wall thicknesses of tubes -

3.3.2.2.2.1 Inside and outside diameters. - Unless otherwise specified (see 6.2), tubes in either the rolled or molded construction shall conform to the specified dimensions for nominal inside and outside diameters, within the tolerances shown in table VIII.

Table IV - Tolerances on length of cut rods.

Rod length:	Tolerances (\pm) ^{1/}	
	Diameter	
	1/8 to 1-15/16 inches, inclusive	2 to 4 inches inclusive
Inches	Inch	Inch
0 to less than 3	0.010	0.010
3 to less than 6	.010	.015
6 to less than 12	.015	.030
12 and over	.030	1/32

^{1/} Measure dimensions in accordance with ASTM D-741.

Table V - Tolerances on lengths of cut tubes.

Tube length	Tolerances (\pm) ^{1/}		
	Outside diameter of tubes		
	3/16 to 2 inches, inclusive	Over 2 to 4 inches, inclusive	Over 4 inches
Inches	Inch	Inch	Inch
0 to 3, inclusive	0.010	0.010	0.030
Over 3 to 6	.010	.015	.030
Over 6 to 12	.015	.030	.030
Over 12 to 48	1/32	1/32	3/64

^{1/} Measure dimensions in accordance with ASTM D-688.

3.3.2.2.2.2 Wall thicknesses. - Unless otherwise specified (see 6.2), tubes shall conform to the specified dimensions for nominal inside and outside diameters, within variations in wall thickness not exceeding the tolerances shown in table IX.

3.4 Surface finish. - Laminated rods or tubes shall be furnished in the following finishes, as specified (see 6.3):

3.4.1 Ground. - Ground finish is that finish which is applied by a fine grinding wheel or belt and is free from any pronounced scratches.

3.4.2 Buffed. - Buffed finish is somewhat more glossy than the ground finish and is obtained by buffing the tube or rod immediately after grinding, using a touch of shellac or other polishing compound on the buffer. The finish is not to be applied to type GMG tubes or rods.

3.4.3 Varnished. - Varnished finish is obtained by coating the rod or tube with varnish and then air-drying or baking (see 6.3).

3.5 Marking. - Each bundle of rods or tubes shall be identified with the laminator's name or trademark, and the specified type.

3.6 Workmanship. - Laminated rods and tubes shall be manufactured and processed in a careful and workmanlike manner, in accordance with sound practice.

4. QUALITY ASSURANCE PROVISIONS

4.1 The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. 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 shall be classified as follows:

- (a) Examination.
- (b) Acceptance tests.

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Table VI - Standard and special sizes of rods and tubes

Form	Type	Standard Sizes				Special sizes				Steps in outside diameter of tubes		Steps in inside diameter of tubes					
		Inside diameter		Outside diameter		Wall thickness		Rate of wall thickness to ID		Rate of wall thickness to OD		By steps of	By steps of				
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.						
Standard rods, R	FRS, PFR	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2
	FRS	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2
	FRS	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2
	FRS	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2
Standard tubes, T ₁	FRS	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2
	PFR	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2
	FRS	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2
	FRS	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2
Special tubes, T ₂	FRS	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2
	PFR	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2
	FRS	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2
	FRS	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2	1/8	1/4	3/8	1/2

1. Type PFR rod is 1/8 inch diameter is available as a special size.
 2. The wall thickness shall be greater than 1/8 inch can show choice or criteria between the numbers on marked or unmarked rods.
 3. The wall thickness shall be greater than 1/8 inch in all cases, the standard wall thickness shall not be greater than 1.40 x ID of the I.D., whichever value applies.
 4. In the range from 8 to 24 inches I.D., standard steps of 1/8 inch are indicated in this table. In other cases, these I.D.'s can only be obtained by the use of special equipment.

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4.3 Sampling for inspection. -

4.3.1 Lot. - For inspection purposes, a lot shall consist of laminated thermosetting plastic material which is of the same form, type, range of size (as covered in table X, and brand, and which meets one or both of the following conditions, as agreed on between the laminator and the Government.

- (a) Laminated in one continuous period of time not to exceed one month.
 (b) Offered for delivery at the same time.

Table VII - Tolerances on diameters of molded rods.

Nominal diameter	Tolerances (\pm)
Inches	Inch
1/8 to 1-15/16, inclusive	0.005
2 to 4, inclusive	.008

Table VIII - Tolerances on diameters of tubes.

Nominal diameters	Tolerances (\pm) ^{3/}		
	Inside diameter		Outside diameter
	Steel mandrel ^{1/}	Built-up mandrel ^{2/}	Ground, buffed or varnished finish
Inches	Inch	Inch	Inch
1/8 to 23/32, inclusive	0.003	-----	0.005
3/4 to 1-15/16, inclusive	.004	-----	.005
2 to 4, inclusive	.008	-----	.008
<u>Rolled only</u>			
4-1/8 to 12, inclusive	.010	-----	.025
			<u>Turned</u>
12-1/8 to 18, inclusive	.030	0.060	0.030
18-1/8 to 24, inclusive	.040	.075	.035
24-1/8 to 48, inclusive	.060	.090	.040

^{1/} Type GMG tubes are made on steel mandrels only.

^{2/} In the absence of a mandrel of the precise size required, tubes of that size can sometimes be made on a built-up mandrel. In such cases, this is accomplished by winding a phenolic laminate rolled tube on the next smaller size steel mandrel and then curling and grinding the tube to the desired size.

^{3/} When tolerances different from those specified in table VIII are required for type GMG rolled tubes, they shall be as specified (see 6.2).

Table IX - Tolerances on wall thickness of tubes.

Thickness tolerances (±) from average wall thickness of individual tube									
Wall thickness ^{1/}	Rolled tubes, form T _r					Molded tubes, form T _m			
	Types PBE, PBG, and PBM	Type FBE		Type FBM	Type GMG	Types PBE, PBG, FBE			Type FBG
		Inside diameter	Over 1/2 inch			Inside diameter	Over 1/4 to 1/2 inch inclusive	Over 1/2 inch	
Inch	Inch	3/16 to 1/2 inch inclusive	Inch	Inch	Inch	1/8 to 1/4 inch inclusive	Over 1/4 to 1/2 inch inclusive	Over 1/2 inch	Inch
0.010 up to 1/64	0.003	-----	-----	-----	-----	-----	-----	-----	-----
1/64 up to 1/32	.005	-----	-----	-----	0.006	-----	-----	-----	-----
1/32 up to 1/16	.006	0.010	-----	-----	.008	-----	-----	-----	-----
1/16 up to 1/8	.007	.011	0.015	-----	.009	-----	-----	-----	-----
1/8 up to 1/4	.009	.013	.020	-----	.011	-----	-----	-----	-----
1/4 up to 1/2	.011	.015	.020	-----	.013	-----	-----	-----	-----
1/32 up to 1/16	-----	-----	-----	-----	-----	0.008	0.008	0.008	0.015
1/16 to 1/8, inclusive	-----	-----	-----	-----	-----	.011	.011	.011	.015
Over 1/8 to 1/4, inclusive	-----	-----	-----	-----	-----	-----	.015	.011	.030
Over 1/4 to 1/2, inclusive	-----	-----	-----	-----	-----	-----	-----	.013	.020

^{1/} The term "up to" means "up to but not including".

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Table X - Range of sizes for lot inspection.

Rods	Up to and including 1 inch diameter Over 1 inch diameter.
Rolled tubes	1/8 up to but not including 1/2 inch ID: 1/32 up to but not including 1/16 inch wall thickness 1/16 up to but not including 1/4 inch wall thickness
	1/2 to 2 inches ID: 1/32 up to but not including 1/16 inch wall thickness 1/16 up to and including 1/4 inch wall thickness Over 1/4 up to and including 1 inch wall thickness
	Over 2 up to and including 8 inches ID: 1/16 up to and including 1/4 inch wall thickness Over 1/4 inch wall thickness
Molded tubes	1/16 up to and including 1/8 inch wall thickness Over 1/8 inch wall thickness

4.3.2 Sampling for examination. - A sample of rods or tubes shall be selected at random from each lot of material offered for examination of visual and dimensional characteristics, with lot acceptance based on the following sampling inspection requirements shown in table XI in accordance with Standard MIL-STD-105:

Table XI - Sampling for examination, AQL (approx.) = 1.5 percent defective.

Number of rods or tubes in lot	Number of rods or tubes in sample	Defective rods and tubes	
		Acceptance number	rejection number
15 and under	10	0	1
16 to 40	15	0	1
41 to 110	25	1	2
111 to 300	35	1	2
301 to 500	50	2	3
501 to 800	75	3	4
801 to 1300	110	4	5
1301 and over	150	5	6

4.3.3 Sampling for acceptance tests. - If the lot consists of 100 or less lengths of rods or tubes, the number of samples shall consist of 10 percent of the lot, but in no case less than one or more than three lengths. If the lot consists of 101 or more lengths of rods or tubes the number of samples shall be as shown in table XII.

4.4 Inspection. -

4.4.1 Examination. - Each of the sample rods or tubes selected in accordance with table XI shall be

examined to verify compliance with the requirements of this specification. Any rod or tube in the sample containing one or more defects shall be rejected, and if the number of defective rods or tubes in any sample exceeds the acceptance number for that sample, the lot represented by the sample shall be rejected.

Table XII - Sampling for acceptance tests.

Number of lengths in lot	Number of sample lengths
101 to 180, inclusive	4
181 to 300, inclusive	5
301 to 500, inclusive	7
501 to 1,300, inclusive	10
1,301 or more	15

4.4.2 Acceptance tests. - The samples selected in accordance with 4.3.3 shall be subjected to acceptance tests. The number of specimens per sample to be tested and the number of tests per specimen shall be as specified in tables I to III, inclusive. If the lot contains five or less standard lengths of tubes or rods, only water absorption and specific gravity tests need be conducted. If any of the samples tested fails any of these tests, the lot shall be rejected.

4.5 Conditioning. -

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

Condition A - As received, no special conditioning.

Condition D - Immersion conditioning in distilled water on samples as received.

Condition E - Temperature conditioning in an oven on samples as received.

NOTE: Whenever a conditioning letter is followed by an inferior i, as D₁, a prior temperature conditioning has been carried out.

4.5.2 Designation. - Conditioning procedures shall be designated as follows:

- A capital letter indicating the general condition of the specimen, i.e., as received, immersion, and temperature conditioning.
- A number indicating in hours the duration of the conditioning.
- A number indicating in degrees centigrade the conditioning temperature.

The numbers shall be separated from each other by slant marks, and from the capital letter by a hyphen.

4.5.3 Time tolerances. - Oven conditioning shall be followed by 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 XIII.

4.5.4 Temperature tolerances. - The conditioning temperature tolerances shall be as follows:

Nominal temperature, degrees C.	Tolerance (±) degrees C.
23	2
35	1
50	2
105	2

4.6 Test methods. -

4.6.1 Measurements. - Specimens shall be examined, and dimensions required to be recorded shall be measured to the nearest 0.001 inch by using a suitable micrometer or vernier caliper. All other dimensions shall be measured to the nearest one-thirty-second inch. Such measurements shall be made before conditioning in each case and after completion of the test wherever required.

4.6.2 Water absorption. -

4.6.2.1 Specimens. -

4.6.2.1.1 Rods. - The test specimen for rods shall be 1 inch in length for rods 1 inch in diameter or under, and one-half inch in length for larger diameter rods. The diameter of the specimen shall be the diameter of the finished rod.

4.6.2.1.2 Tubes. - The test specimen for tubes less than 3 inches in outside diameter shall be the full section of the tube and 1 inch in length. For tubes 3 inches or more in outside diameter, a rectangular specimen shall be cut 3 inches in length in the circumferential direction of the tube and 1 inch in width lengthwise of the tube.

4.6.2.2 Procedure. - The specimens shall be weighed individually and then subjected to 105 ± 2°C. for 1 hour (-0+6 minutes), cooled in a desiccator for at least 2 hours, and reweighed (W_1). The specimens shall then be immersed in distilled water for 24 hours (-0+1/2 hour) at 23 ± 2°C. They shall be removed individually as needed, all surfaces wiped off with a dry cloth, and then reweighed (W_2). The test shall begin not more than 1 minute after removal of the specimens from the water and shall be completed as rapidly as consistent with accuracy. No correction shall be made for water-soluble matter

Table XIII - Conditioning time tolerances.

Conditioning		Cooling		Comments
Condition	Time tolerance	Time	Time tolerance	
D-48/50 D-24/23	-0 hours +1/2 hour	1 hour	-0 hours +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 minutes +6 minutes	2 hours or more	-0 hours	See water-absorption test (4.6.2)
D ₁ -24/23	-0 hours +3 hours	-----	-----	See water-absorption test (4.6.2)

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4.6.2.3 Calculations. - The percentage of water absorption shall be calculated as follows:

$$\text{Percentage of water absorption in 24 hours} = \frac{W_2 - W_1}{W_1} \times 100$$

4.6.3 Dielectric strength perpendicular to laminations (short-time). - The dielectric strength perpendicular to laminations shall be determined by the short-time test specified in method 4031 of Specification L-P-406, using specimens 12 inches long. The tests shall be made under oil at a frequency not exceeding 100 cycles per second. The voltage in the short-time test shall be increased, uniformly at the rate of 500 volts per second. The test electrodes shall be as specified in table XIV.

Table XIV - Electrodes.

Inside diameter of tubing (inches)	Inner electrode	Other electrode
1.5 or less	Mercury or brass rod, 3 inches long, with edges rounded to a 1/4-inch radius and of such diameter that it fits snugly in the tube.	Metal foil
Greater than 1.5	Mercury or metal foil	Metal foil

The electrodes shall be of the same length, accurately centered with respect to the specimen. A very thin coating of petrolatum shall be used as an adhesive for foil electrodes. A cork or wax plug shall be used to hold the mercury in the tube.

4.6.4 Compressive strength (axially). - The axial compressive strength shall be determined by method 1021 of Specification L-P-406, except that the specimen length shall be as shown in table XV.

Table XV - Specimen lengths for compressive strength tests.

Outside diameter of tube or rod	Length of specimen
Inches	Inches
Rods:	
1/8 to 1/4, inclusive	1/2
Above 1/4 to 1/2, inclusive	1
Above 1/2 to 1, inclusive	2
Above 1 to 2, inclusive	4
Tubes:	
Up to 2, inclusive	1

4.6.5 Flexural strength (rods only). -

4.6.5.1 Specimens. - The test specimen shall have a diameter equal to the diameter of the rod and a span-depth ratio of eight to one shall be used.

For rods over one-half inch in diameter, specimens shall be machined to a diameter of one-half inch and specimens 5 inches long shall be cut.

4.6.5.2 Apparatus. - Any standard testing machine may be used provided it is accurate to within 1 percent for the lowest load for which it is used. The specimen shall be tested as a simple beam loaded at the center. The supports shall have contact edges rounded to a radius of one-eighth inch. The distance between supports shall be eight times the diameter of the rod. Where necessary, the load shall be applied through a steel block having a semicircular contact edge of the same radius as the rod with edges rounded to a radius of one-eighth inch. The cross-head speed of the testing machine shall be such that the load can be accurately weighed, but shall not exceed 0.050 inch per minute when the machine is running idle.

4.6.5.3 Procedure. - Specimens shall be measured to the nearest 0.001 inch, inserted into the machine and broken.

4.6.5.4 Report. - The flexural, or fiber stress in p. s. i. shall be calculated from the formula:

$$\text{Flexural strength, } S = \frac{6 Fl}{\pi d^3}$$

Where

- P = The breaking load applied in pounds.
- L = The span or distance between supports.
- d = The machined diameter in inches.

4.6.6 Specific gravity. - The specific gravity shall be determined by method 5011 or 5012 of Specification L-P-406.

4.6.7 Warpage. -

4.6.7.1 Apparatus. - A horizontal flat surface and a rigid bar with a vertically plane surface firmly fixed at right angles to the flat surface, both at least as long as the specimen, shall be used. The height of the bar shall exceed half the outside diameter of the tube or rod. Feeler gages of suitable thicknesses will also be required.

4.6.7.2 Procedure. - The specimen shall be placed on the horizontal flat surface and rotated against the vertically plane surface of the rigid bar. The bar shall be firmly fastened to the horizontal flat surface. With the aid of feeler gages, the maximum distance between the tube or rod and the vertically plane surface shall be measured to the nearest 0.001 inch.

4.6.7.3 Report and calculation. - Warp or lack of straightness shall be reported as the maximum

distance or any part of the tube or rod from a straight edge which connects the ends of the specimen. The minimum length tested for warpage shall be 24 inches. The warpage shall then be calculated as follows:

$$W_{36} = \frac{36 D X 100}{L^2}$$

Where:

W_{36} = Percentage of warp, calculated to a 36-inch length.

D = Maximum deviation of tube or rod from straight edge in inches.

L = Length of tube or rod in inches.

4.7 Inspection of preparation for delivery. - Sample packages and packs shall be selected and inspected in accordance with Specification MIL-P-116 to verify conformance to the requirements of Section 5 herein.

5. PREPARATION FOR DELIVERY

5.1 Packaging. -

5.1.1 Level A. - Laminated rods or tubes, or parts fabricated therefrom, shall be packaged for physical and mechanical protection in accordance with method D1 of Specification MIL-P-116, either individually, in bundles, or in cartons as required. Containers shall conform to Specification PPP-B-566, PPP-B-676, or PPP-B-636. Container closure shall be as specified in the applicable box specification or appendix thereto. The gross weight of fiber containers shall not exceed 20 pounds, paperboard containers 10 pounds.

5.1.2 Level C. - Laminated rods or tubes, or parts fabricated therefrom, shall be packaged in accordance with the supplier's commercial practice.

5.2 Packing. -

5.2.1 Level A. - Unless otherwise specified, laminated rods and tubes, or parts fabricated therefrom, packaged as specified (see 6.2), shall be packed in overseas type, wood-cleated fiberboard, nailed wood, fiber, wirebound wood, wood-cleated veneer paper overlaid, or wood-cleated plywood boxes conforming to Specification PPP-B-591, PPP-B-631 (class 2), PPP-B-636 (class 2), PPP-B-585 (class 3), MIL-B-10377 or PPP-B-601, respectively, at the option of the contractor. Shipping containers shall have caseliners conforming to Specification MIL-L-10547. Caseliners shall be closed and sealed in accordance with the appendix to Specification MIL-L-10547. Caseliners for boxes conforming to Specification PPP-B-636 may be omitted provided all joints and corners of the boxes are sealed with minimum 1-1/2 inch wide tape

conforming to Specification PPP-T-76 or PPP-T-60. Boxes shall be closed and strapped in accordance with the applicable box specification or appendix thereto, except fiber boxes shall be banded with tape as specified in the appendix to Specification PPP-T-636. The gross weight of wood or wood-cleated boxes shall not exceed 200 pounds.

5.2.2 Level B. - Laminated rods and tubes, or parts fabricated therefrom, packaged as specified (see 6.2), shall be packed in domestic type wood-cleated fiberboard, nailed wood, wirebound wood, cleated plywood or wood-cleated veneer paper overlaid boxes or class 2 fiber boxes conforming to Specification PPP-B-591, PPP-B-621 (class 1), PPP-B-585 (class 1 or 2 use), PPP-B-601, MIL-B-10377 or PPP-B-636, respectively, at the option of the contractor. Box closure shall be as specified in the applicable box specification or appendix thereto. The gross weight of wood or wood cleated boxes shall not exceed 200 pounds.

5.2.3 Level C. - Laminated rods and tubes, or parts fabricated therefrom, packaged as specified (see 6.2), shall be packed in containers which will insure acceptance by common carrier and safe delivery at destination. Shipping containers shall comply to the Uniform Freight Classification Rules or other regulations as applicable to the mode of transportation.

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

6. NOTES

6.1 Intended use. -

6.1.1 Forms. -

6.1.1.1 Molded rods. - Molded rods are intended for a variety of applications such as insulating screws, bolts, and small bushings or spacers where electrical stress is not severe. The material is nearly as dense as the comparable grade of sheets, and the electrical properties are of approximately the same order.

6.1.1.2 Rolled tubes. - Rolled tubes are intended for application in coil forms, insulating bushings, bearing retainers, etc., where excellent concentricity and good physical and electrical characteristics are required.

6.1.1.3 Molded tubes. - Molded tubes are intended for application in coil forms, insulating bushings, bearing retainers, etc., where higher density, lower water absorption, and better dimensional stability are required. Molded tubes are less concentric and do not show as good electrical and

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mechanical properties at the mold parting line where the excess material has been removed.

6.1.2 Types. -

6.1.2.1 Type PBE. - Type PBE is intended for applications similar to those for type PBG, except that under adverse conditions of temperature and humidity PBE possesses high dielectric strength and relatively low dielectric losses.

6.1.2.2 Type PBG. - Type PBG is a general purpose material combining fairly good mechanical and electrical properties.

6.1.2.3 Type PBM. - Type PBM is intended for a variety of applications where the electrical properties are subordinate to the required mechanical properties; that is, for use in solely mechanical equipment or for use as mechanical members of electrical equipment where a dielectric material is required, but where the use of a high order of dielectric properties with a corresponding sacrifice of mechanical properties would not be warranted. It is intended for structural and electrical applications where no moisture is present. Special precautions must be taken if the material is to be tapped or machined parallel to the laminations without cracking.

6.1.2.4 Type FBE. - Type FBE is intended for applications similar to those of type FBG, except that it possesses better electrical properties though with some sacrifice of toughness. It is suitable for fine machining operations.

6.1.2.5 Type FBG. - Type FBG is intended for electrical applications that require fairly good dielectric properties, medium dielectric loss, and at the same time a good degree of mechanical strength, particularly toughness.

6.1.2.6 Type FBM. - Type FBM is intended for structural, not electrical, applications and for use where the electrical properties have been greatly subordinated to the required mechanical properties.

6.1.2.7 Type GMG. - Type GMG is intended for mechanical applications requiring good resistance to heat and to flame as well as to arcing conditions.

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

- (a) Title, number, and date of this specification.
- (b) Form required (see 1.2).
- (c) Type required (see 1.2).

Custodians:

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- (d) Property value requirements for special sizes of rods and tubes (see 3.1.2).
- (e) Tolerances on diameters of type GMG rolled tubes, if required (see 3.3.2.2.1 and note 3 of table VIII).
- (f) Dimensions required (see 3.3).
- (g) Finish required (see 3.4).
- (h) Requirements and/or drawings for parts.
- (i) Levels of packaging and packing required (see 5.1 and 5.2).
- (j) Special marking required (see 5.3).

6.3 Varnished finish. - A varnished finish requires operations which may greatly change the properties of the material. All values are based on unvarnished rods, tubes, or parts fabricated therefrom. Adjustment of properties of materials occasioned by varnished finish should be handled by negotiation between the bureau or agency concerned and the bidder, prior to award of contract.

6.4 Cross-reference list of designations. - Because of past practices of several Government agencies and industry, the cross-references shown in table XVI are provided for equivalent designations of laminated rods and tubes.

Table XVI - Equivalent designations for laminated rods and tubes.

Type	Equivalent designations	
PBE	LTS-E-4	XXX
PBG	LTS-E-3	XX
PBM	LTS-M-1	X
FBE	LTS-EM-2	LE
FBE	LTS-M-3	FBI
FBG	LTS-EM-1	CE
FBM	LTS-M-4	C
GMG	LTS-MG-1	G-5

Notice. - When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

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