

# AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard



AMS 3615E

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Superseding AMS 3615D

## Plastic Tubing Cotton Fabric Reinforced Phenol-Formaldehyde

### 1. SCOPE:

#### 1.1 Form:

This specification covers one type of cotton fabric impregnated with a phenolic resin and supplied in the form of tubing.

#### 1.2 Application:

This tubing has been used typically for electrical insulation at low voltages and for protection from galvanic corrosion, but usage is not limited to such applications. This tubing has good machining characteristics and good moisture resistance.

#### 1.2.1 This tubing is a fungus nutrient; cut or machined edges may require suitable protective treatment to prevent attack by fungi.

#### 1.3 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

### 2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The applicable issue of referenced publications shall be the issue in effect on the date of the purchase order.

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## 2.1 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 348 Testing Rigid Tubes Used for Electrical Insulation

## 2.2 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-2073-1 DOD Materiel, Procedures for Development and Application of Packaging Requirements

## 3. TECHNICAL REQUIREMENTS:

### 3.1 Material and Fabrication:

Tubing shall consist of laminations of fabric which have been impregnated with a thermosetting, phenol-formaldehyde resin, rolled on a mandrel between heated pressure rolls, and cured in an oven.

3.1.1 Fabric: Shall be fine weave cotton weighing not more than 4 ounces per square yard (136 g/m<sup>2</sup>). Thread counts, determined by inspection of finished tubing, shall be not less than 50 per inch (25 mm) in each direction (warp and fill) and not less than 140 total in both warp and fill directions.

3.1.2 Finish: Shall be buffed.

3.1.3 Color: Shall be natural, unless otherwise ordered. When colored tubing is ordered, color shall be substantially uniform throughout the tubing. Surfaces shall be substantially free from streaks and stains.

### 3.2 Properties:

Tubing shall conform to the requirements shown in Table 1, 3.2.5, 3.2.6, and 3.2.7; tests shall be conducted on the tubing supplied and in accordance with ASTM D 348, insofar as practicable.

TABLE 1 - Properties

Paragraph	Property		Requirement
3.2.1	Tensile Strength, minimum		6500 psi (44.8 MPa)
3.2.2	Compressive Strength, Axial, minimum		
	Nominal Wall Thickness Inch	Nominal Wall Thickness Millimeters	
	Up to 0.063, excl	Up to 1.60, excl	13.0 ksi ( 89.6 MPa)
	0.063 to 0.125, excl	1.60 to 3.18, excl	15.0 ksi (103 MPa)
	0.125 and over	3.18 and over	18.0 ksi (124 MPa)
3.2.3	Density, minimum		1.10 g/cm <sup>3</sup>
3.2.4	Water Absorption (24-hours Immersion), maximum		
	Nominal Wall Thickness Inch	Nominal Wall Thickness Millimeters	Nominal ID Up to 0.500 Inch (12.70 mm), excl
	Up to 0.063, incl	Up to 1.60, incl	8.0%
	Over 0.063 to 0.094, incl	Over 1.60 to 2.39, incl	6.5%
	Over 0.094 to 0.125, incl	Over 2.39 to 3.18, incl	5.5%
	Over 0.125 to 0.188, incl	Over 3.18 to 4.78, incl	3.5%
	Over 0.188 to 0.250, incl	Over 4.78 to 6.35, incl	3.5%
	Over 0.250 to 0.500, incl	Over 6.35 to 12.70, incl	2.1%
	Over 0.500	Over 12.70	1.9%
			1.7%
			1.6%
			1.6%
			1.5%
			1.5%

3.2.5 Machinability: Tubing shall not split, crack, chip, or delaminate when drilled, sawed, tapped, or machined in any direction.

3.2.6 Weather Resistance: Tubing shall have weather resistance acceptable to purchaser, determined by a procedure agreed upon by purchaser and vendor.

3.2.7 Corrosion: The product shall not have a corrosive effect on other materials when exposed to conditions normally encountered in service, determined by a procedure agreed upon by purchaser and vendor. Discoloration of metal shall not be considered objectionable.

### 3.3 Quality:

Tubing, as received by purchaser, shall be uniform in quality and condition, sound, and free from blisters, wrinkles, cracks, and crazing and reasonably free from other imperfections, such as scratches and dents, detrimental to usage of the tubing.

## 3.4 Tolerances:

Shall be as follows:

- 3.4.1 Diameter: Shall be as specified in Table 2. Diameter tolerance applies to ID or OD, as ordered, but not to both.

TABLE 2A - Diametral Tolerances, Inch/Pound Units

Nominal Diameter Inches	ID Tolerance Inch plus and minus	OD Tolerance Inch plus and minus
Up to 0.750, excl	0.003	0.005
0.750 to 2.000, excl	0.004	0.005
2.000 to 4.000, incl	0.008	0.008
Over 4.000 to 12.000, incl	0.010	0.025
Over 12.000 to 18.000, incl	0.030	0.030
Over 18.000 to 24.000, incl	0.040	0.035
Over 24.000 to 48.000, incl	0.060	0.040

TABLE 2B - Diametral Tolerances, SI Units

Nominal Diameter Millimeters	ID Tolerance Millimeters ID	OD Tolerance Millimeters OD
Up to 19.05, excl	0.08	0.13
19.05 to 50.80, excl	0.10	0.13
50.80 to 101.60, incl	0.20	0.20
Over 101.60 to 304.80, incl	0.25	0.64
Over 304.80 to 457.20, incl	0.76	0.76
Over 457.20 to 609.60, incl	1.02	0.89
Over 609.60 to 1219.20, incl	1.52	1.02

3.4.2 Wall Thickness: Shall be as specified in Table 3.

TABLE 3A - Wall Thickness Tolerance in ID Ranges Shown, Inch/Pound Units

Nominal Wall Thickness Thickness Inch	Tolerance, Inch plus and minus Up to 0.500, incl	Tolerance, Inch plus and minus Over 0.500
Up to 0.063, excl	0.010	0.008
0.063 to 0.125, excl	0.011	0.009
0.125 to 0.250, excl	0.013	0.011
0.250 to 0.500, incl	0.015	0.013

TABLE 3B - Wall Thickness Tolerance in ID Ranges Shown, SI Units

Nominal Wall Thickness Millimeters	Tolerance, Millimeter plus and minus Up to 12.70, incl	Tolerance, Millimeter plus and minus Over 12.70
Up to 1.60, excl	0.25	0.20
1.60 to 3.18, excl	0.28	0.23
3.18 to 6.35, excl	0.33	0.28
6.35 to 12.70, incl	0.38	0.33

3.4.3 Length: Shall be as specified in Table 4.

TABLE 4A - Length Tolerance for OD Ranges Shown, Inch/Pound Units

Nominal Length Inches	Tolerance, Inch plus and minus Up to 2.000, incl	Tolerance, Inch plus and minus Over 2.000, to 4.000, incl	Tolerance, Inch plus and minus Over 4.000
Up to 3.000, incl	0.010	0.010	0.030
Over 3.000 to 6.000, incl	0.010	0.015	0.030
Over 6.000 to 12.000, incl	0.015	0.020	0.030
Over 12.000 to 48.000, incl	0.030	0.030	0.050

TABLE 4B - Length Tolerance for OD Ranges Shown, SI Units

Nominal Length Millimeters	Tolerance Millimeter plus and minus Up to 50.80, incl	Tolerance Millimeter plus and minus Over 50.80 to 101.60, incl	Tolerance Millimeter plus and minus Over 101.60
Up to 76.20, incl	0.25	0.25	0.76
Over 76.20 to 152.40, incl	0.25	0.38	0.76
Over 152.40 to 304.80, incl	0.38	0.51	0.76
Over 304.80 to 1219.20, incl	0.76	0.76	1.27

3.4.4 Straightness: Shall be as specified in Table 5.

TABLE 5A - Maximum Warp (Curvature, Depth of Arc) in Lengths Shown, Inch/Pound Units

Nominal OD Inch	Maximum Warp, Inch For 36 Inch Length	Maximum Warp, Inch For Other Lengths in Inches
Up to 0.250, incl	0.72	$0.000555 \times (\text{length})^2$
Over 0.250 to 0.750, incl	0.36	$0.000277 \times (\text{length})^2$
Over 0.750	0.18	$0.000138 \times (\text{length})^2$

TABLE 5B - Maximum Warp (Curvature, Depth of Arc) in Lengths Shown, SI Units

Nominal OD Millimeters	Maximum Warp, mm For 1 Meter Lengths	Maximum Warp, mm For Other Lengths in Meters
Up to 6.35, incl	21.8	$21.8 \times (\text{length})^2$
Over 6.35 to 19.05, incl	10.9	$10.9 \times (\text{length})^2$
Over 19.05	5.4	$5.4 \times (\text{length})^2$

#### 4. QUALITY ASSURANCE PROVISIONS:

##### 4.1 Responsibility for Inspection:

The vendor of tubing shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the tubing conforms to the requirements of this specification.

#### 4.2 Classification of Tests:

- 4.2.1 Acceptance Tests: Tests for material and fabrication (3.1), tensile strength (3.2.1), compressive strength (3.2.2), density (3.2.3), water absorption (3.2.4), and tolerances (3.4) are acceptance tests and shall be performed on each lot.
- 4.2.2 Preproduction Tests: Tests for all technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of tubing to a purchaser, when a change in ingredients and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.
- 4.2.2.1 For direct U. S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

#### 4.3 Sampling and Testing:

Shall be as follows:

- 4.3.1 For Acceptance Tests: Each lot of tubing shall be 100% visually examined for quality (3.3) and sampled at random for all other tests; the number of determinations for each requirement shall be as specified in ASTM D 348 or, if not specified therein, not less than three.
- 4.3.1.1 A lot shall be all tubing of one size produced in a single production run under the same fixed conditions and presented for vendor's inspection at one time. A lot shall not exceed 2000 yards (1828 m).
- 4.3.1.2 When a statistical sampling plan has been agreed upon by purchaser and vendor, sampling shall be in accordance with such plan in lieu of sampling as in 4.3.1 and the report of 4.5 shall state that such plan was used.
- 4.3.2 For Preproduction Tests: As agreed upon by purchaser and vendor.

#### 4.4 Approval:

- 4.4.1 Sample tubing shall be approved by purchaser before tubing for production use is supplied, unless such approval be waived by purchaser. Results of tests on production tubing shall be essentially equivalent to those on the approved sample.
- 4.4.2 Vendor shall use ingredients, manufacturing procedures, processes, and methods of inspection on production tubing which are essentially the same as those used on the approved sample tubing. If necessary to make any change in ingredients, in type of equipment for processing, or in manufacturing procedures, vendor shall submit for reapproval a statement of the proposed changes in ingredients and/or processing and, when requested, sample tubing. Production tubing made by the revised procedure shall not be shipped prior to receipt of reapproval.