

**AEROSPACE
MATERIAL
SPECIFICATION**

AMS 3615D
Superseding AMS 3615C

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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:** Primarily for electrical insulation at low voltages and for protection from galvanic corrosion. This tubing has good machining qualities 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.

2. **APPLICABLE DOCUMENTS:** The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 **SAE Publications:** Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 **Aerospace Material Specifications:**

AMS 2350 - Standards and Test Methods

2.2 **ASTM Publications:** Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D348 - Testing Rigid Tubes Used for Electrical Insulation

2.3 **U.S. Government Publications:** Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 **Military Standards:**

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

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3. TECHNICAL REQUIREMENTS:

3.1 Material and Fabrication: Tubing shall consist of laminations of fabric which have been impregnated with a thermosetting, phenolic-type 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 oz per sq yd (135 g/m²). Thread counts, determined by inspection of finished tubing, shall be not less than 50 per in. (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 following requirements; tests shall be conducted on the tubing supplied and in accordance with ASTM D348, insofar as practicable, except that machinability, weather resistance, and corrosive effect shall be determined by procedures agreed upon by purchaser and vendor:

3.2.1 Tensile Strength, min 6,500 psi (45.0 MPa)

3.2.2 Compressive Strength, Axial, min

Nominal Wall Thickness		
Inch	Millimetres	
Up to 0.063, excl	Up to 1.58, excl	13,000 psi (90 MPa)
0.063 to 0.125, excl	1.58 to 3.12, excl	15,000 psi (105 MPa)
0.125 and over	3.12 and over	18,000 psi (125 MPa)

3.2.3 Density, min 1.10 g/cm³

3.2.4 Water Absorption (24 hr Immersion), %, max

Nominal Wall Thickness		Nominal ID	
Inch	Millimetres	Up to 0.500 in. (12.50 mm), excl	0.500 in. (12.50 mm) and over
Up to 0.063, incl	Up to 1.58, incl	8.0	6.5
Over 0.063 to 0.094, incl	Over 1.58 to 2.35, incl	5.5	3.5
Over 0.094 to 0.125, incl	Over 2.35 to 3.12, incl	3.5	2.2
Over 0.125 to 0.188, incl	Over 3.12 to 4.70, incl	2.1	1.8
Over 0.188 to 0.250, incl	Over 4.70 to 6.25, incl	1.9	1.7
Over 0.250 to 0.500, incl	Over 6.25 to 12.50, incl	1.6	1.6
Over 0.500	Over 12.50	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, clean, sound, and free from blisters, wrinkles, cracks, crazing, and surface roughness and reasonably free from other small imperfections such as scratches and dents detrimental to usage of the tubing.
- 3.4 Tolerances: Unless otherwise specified, the following tolerances shall apply:
- 3.4.1 Diameter: Shall be as specified in Table I. Diameter tolerance applies to ID or OD, as ordered, but not to both.

TABLE I

Nominal Diameter Inches	Diameter Tolerance, Inch plus and minus	
	ID	OD
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 I (SI)

Nominal Diameter Millimetres	Diameter Tolerance, Millimetres plus and minus	
	ID	OD
Up to 18.75, excl	0.08	0.12
18.75 to 50.00, excl	0.10	0.12
50.00 to 100.00, incl	0.20	0.20
Over 100.00 to 300.00, incl	0.25	0.62
Over 300.00 to 450.00, incl	0.75	0.75
Over 450.00 to 600.00, incl	1.00	0.88
Over 600.00 to 1200.00, incl	1.50	1.00

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

TABLE II

Nominal Wall Thickness Inch	Wall Thickness Tolerance, Inch plus and minus	
	ID Ranges, Inch	
	Up to 0.500, incl	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 II (SI)

Nominal Wall Thickness Millimetres	Wall Thickness Tolerance, Millimetres plus and minus	
	ID Ranges, Millimetres	
	Up to 12.50, incl	Over 12.50
Up to 1.58, excl	0.25	0.20
1.58 to 3.12, excl	0.28	0.23
3.12 to 6.25, excl	0.32	0.28
6.25 to 12.50, incl	0.38	0.33

3.4.3 Length: Shall be as specified in Table III.

TABLE III

Nominal Length Inches	Length Tolerance, Inch plus and minus		
	OD Ranges, Inches		
	Up to 2.000 incl	Over 2.000 to 4.000, incl	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 III (SI)

Nominal Length Millimetres	Length Tolerance, Millimetres plus and minus		
	OD Ranges, Millimetres		
	Up to 50.00 incl	Over 50.00 to 100.00, incl	Over 100.00
Up to 75.00, incl	0.25	0.25	0.75
Over 75.00 to 150.00, incl	0.25	0.38	0.75
Over 150.00 to 300.00, incl	0.38	0.50	0.75
Over 300.00 to 1200.00, incl	0.75	0.75	1.25

3.4.4 Straightness: Shall be as specified in Table IV.

TABLE IV

Nominal OD Inches	Maximum Curvature (Depth of Arc), Inch	
	36 Inch Lengths	Other Lengths, 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 IV (SI)

Nominal OD Millimetres	Maximum Curvature (Depth of Arc), Millimetres	
	1.0 Metre Lengths	Other Lengths, mm
Up to 6.25, incl	19.5	$0.00000195 \times (\text{length})^2$
Over 6.25 to 18.75, incl	9.8	$0.00000098 \times (\text{length})^2$
Over 18.75	5.0	$0.00000050 \times (\text{length})^2$

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. Results of such tests shall be reported to the purchaser as required by 4.5. 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 to determine conformance to requirements 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 classified as acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed prior to or on the initial shipment of tubing to a purchaser, when a change in material or processing, or both, 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, the contracting officer, or the request for procurement.

4.3 Sampling: 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 D348 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. An inspection lot shall not exceed 2000 yd (1830 m). A lot may be packaged in smaller quantities under the basic lot approval provided the lot identification is maintained.

4.3.1.2 When a statistical sampling plan and acceptance quality level (AQL) have 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 4.5.1 shall state that such plan was used.

4.3.2 For Preproduction Tests: Shall be 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 material or processing, or both, and, when requested, sample tubing. Production tubing made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Reports: