Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 3588A
Superseding AMS 3588
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PLASTIC TUBING, ELECTRICAL INSULATION
Irradiated Polyolefin, Clear, Very Flexible, Heat Shrinkable
2 to 1 Shrink Ratio

1. SCOPE:

1.1 Form: This specification covers an irradiated, thermally-stabilized, modified polyolefin plastic in the form of very flexible, thin-wall, heat-shrinkable tubing with a low recovery temperature.

1.2 Application: Primarily for use as a very flexible, electrical insulation tubing whose diameter can be reduced to a predetermined size by heating to 100°C (210°F) or higher. This tubing is stable for continuous exposure from -55°C (-65°F) to +135°C (+275°F).

1.2.1 For flame-retardant, opaque tubing, refer to AMS 3587.

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 specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 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 D471 - Rubber Property - Effect of Liquids
ASTM D2671 - Testing Heat-Shrinkable Tubing for Electrical Use
ASTM G21 - Determining Resistance of Synthetic Polymeric Materials to Fungi

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 Specifications:

MIL-H-5606 - Hydraulic Fluid, Petroleum Base, Aircraft, Missiles and Ordnance
MIL-T-5624 - Turbine Fuel, Aviation, Grades JP-4 and JP-5

2.3.2 Military Standards:

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

3. TECHNICAL REQUIREMENTS:

3.1 Material: Shall be an irradiated, thermally-stabilized, modified polyolefin plastic.

3.2 Color: Shall be colorless and transparent, unless otherwise specified. Tubing shall be sufficiently transparent to allow relatively undistorted visibility through one wall thickness. Typewritten letters shall be legible when viewed through one wall thickness pressed onto the typewritten paper. Transparency shall apply to tubing in the expanded form (as supplied) and after tubing has been shrunk as specified in 3.3.

3.3 Properties: Tubing shall conform to the following requirements; reported values shall be the Ø average of all specimens tested for each requirement. Except as otherwise specified, tests shall be performed in accordance with ASTM D2671 insofar as practicable.

3.3.1 Recovered Tubing: The following requirements apply to tubing after being shrunk by heating to 125°C ± 3 (257°F ± 5) in a convection-current air oven with an air velocity of 100 - 200 ft Ø per min. (0.5 - 1.0 m/sec) past the tubing, holding at heat for not less than 3 min., removing from the oven, and conditioning for not less than 4 hr at 23°C ± 2 (73°F ± 4) and 45 - 55% relative humidity.

3.3.1.1 Tensile Strength, min Jaw separation rate 20 in. per min. (8.5 mm/sec)	1500 psi (10.3 MPa)	
3.3.1.2 Elongation, min	200%	
3.3.1.3 Secant Modulus at 2% Strain, max	12,000 psi (82.7 MPa)	
3.3.1.4 Dielectric Strength	500 V per mil (19,680 V/mm)	4.5.1
3.3.1.5 Volume Resistivity, min	10^{14} ohm-cm	
3.3.1.6 Copper Stability	Pass	4.5.2
3.3.1.7 Fungus Resistance	Rating of 1 or less	ASTM G21
3.3.1.8 Low-Temperature Flexibility At -55°C ± 2 (-67°F ± 4)	No cracks	4.5.3
3.3.1.9 Heat Aging, 168 hr ± 2 at 175°C ± 3 (347°F ± 5)		
3.3.1.9.1 Elongation, min	200%	
3.3.1.10 Corrosion, Method A, After 16 hr ±0.25 at 175°C ± 3 (347°F ± 5)	Pass	
3.3.1.11 Solvent Resistance		4.5.4
3.3.1.11.1 Tensile Strength, min	750 psi (5.1 MPa)	
3.3.1.11.2 Dielectric Strength, min	400 V per mil (15,750 V/mm)	
3.3.1.12 Dimensional Change on Heating		
3.3.1.12.1 Diametral	In accordance with Table I	
3.3.1.12.2 Longitudinal, max	-5%, +3%	

3.3.2 Expanded Tubing: The following requirements apply to tubing in the expanded (as-received) condition. Heating for the tests of 3.3.2.1 and 3.3.2.2 shall be performed in an oven as specified in 3.3.1.

3.3.2.1 Heat Shock at 250°C ± 5 (482°F ± 9)	No dripping, flowing, or cracking	
3.3.2.1.1 Bending after Heat Shock	No cracks	4.5.5
3.3.2.2 Restricted Shrinkage, Procedure C After 30 min. ± 1 at 150°C ± 5 (302°F ± 9)	No cracks; withstand 2000 V for 1 min.	
3.3.2.3 Specific Gravity, max	1.00	
3.3.2.4 Water Absorption, max 24 hr ± 0.25 at 25°C ± 2 (77°F ± 4)	0.20%	

3.4 Marking: Tubing, prior to and after shrinkage, shall be suitable for having numbers or characters printed on it with conventional tube marking techniques.

3.5 Quality: Tubing shall be uniform in quality and condition, clean, smooth, and free from foreign materials and from internal and external imperfections detrimental to fabrication, appearance, or performance of parts.

3.6 Standard Sizes and Tolerances: Tubing shall be supplied in lengths of 48 in., +1, -0 (1219 mm, +25, -0) and in the standard sizes and to the tolerances shown in Table I, unless otherwise specified. Tolerances apply at 23°C - 30°C (73° - 86°F). Measurements shall be made in accordance with ASTM D2671.

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 reØ ported to the purchaser as required by 4.6. Purchaser reserves the right to sample and to perform such confirmatory testing as he deems 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 tensile strength (3.3.1.1), elongation (3.3.1.2), secant modulus (3.3.1.3), dimensional change on heating (3.3.1.12), heat shock (3.3.2.1), and sizes and tolerances (3.6) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for dielectric strength (3.3.1.4), volume resistivity (3.3.1.5), copper stability (3.3.1.6), fungus resistance (3.3.1.7), low-temperature flexibility (3.3.1.8), heat aging (3.3.1.9), corrosion (3.3.1.10), solvent resistance (3.3.1.11), restricted shrinkage (3.3.2.2), specific gravity (3.3.2.3), water absorption (3.3.2.4), and marking (3.4) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed on the initial shipment of tubing to a purchaser, when a change in material or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.3.1 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 in accordance with ASTM D2671 and the following; a lot shall be all tubing of the same size from the same production run presented for vendor's inspection at one time.

Ø The number of specimens for each test shall be as specified in the applicable test procedure or, if not specified therein, not less than three. A lot may be packaged in small quantities as noted in 5.2.1 under a basic lot approval as long as lot identification is maintained.

Ø 4.3.1 For Acceptance Tests: Not less than 16 ft (4.88 m) of tubing from each lot.

4.3.1.1 When a statistical sampling plan and acceptance quality level (AQL) have been agreed upon

Ø 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 4.6.1 shall state that such plan was used.

4.3.2 For Periodic Tests: Not less than 50 ft (18.3 m) of tubing of each size or size range. Certain representative sizes may be used to demonstrate conformance of a range of sizes as follows:

Ø

Representative Size	Range of Sizes
1/4	3/64 - 1/4, incl
1	3/8 - 1, incl
4	1-1/2 - 4, incl

Ø 4.3.3 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. 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

Ø tubing. If any change is necessary 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 and processing and, when requested, sample tubing. Tubing made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Dielectric Strength: Shall be determined by dividing the dielectric breakdown voltage,

Ø determined in accordance with ASTM D2671, by the wall thickness, measured at the point of electrical rupture.

4.5.2 Copper Stability: Specimens of tubing, approximately 6 in. (150 mm) long, shall be slid over straight, clean, unplated, uninsulated, solid, copper conductors. For size 1/4 and smaller, a single copper conductor shall be used; for sizes 3/8 and larger, several copper conductors shall be used, each conductor being AWG 18 (0.0403 in.) (1.024 mm) or smaller. The specimens, on horizontally suspended conductors, shall be conditioned for not less than 24 hr in a humidity chamber at 90 - 95% relative humidity and 25°C ± 3 (77°F ± 5). The specimens, on horizontally suspended conductors, shall then be conditioned for 168 hr ± 2 in an oven which is at 160°C ± 3 (320°F ± 5), cooled to room temperature, visually examined, and tested for elongation in accordance with 3.3.1.2. The tubing shall not be brittle, glazed, cracked, severly discolored, or otherwise deteriorated by direct contact with copper. The copper shall not be pitted or blackened. Darkening of the copper due to normal air oxidation shall be disregarded.

4.5.3 Low-Temperature Flexibility: Shall be determined in accordance with ASTM D2671, Procedure C, bending the specimen around the applicable mandrel of Table II. Any side-cracking, caused by flattening of the specimen on the madrel, shall be disregarded.

TABLE II

Size	Mandrel Diameter Inch	(Millimetres)
3/64 to 1/4, incl	5/16	(7.9)
3/8 to 1/2, incl	3/8	(9.5)
3/4 to 2, incl	7/16	(11.1)
3 to 4, incl	7/8	(22.2)

4.5.4 Solvent Resistance: Shall be determined in accordance with ASTM D2671 on specimens immersed for 24 hr ± 2 at 23°C ± 3 (73°F ± 5) in MIL-T-5624 JP-4 Fuel, SAE phosphate ester test fluid No. 1A (See 8.2), MIL-H-5606 hydraulic oil, ASTM Fuel B (See ASTM D471), and water.

4.5.5 Bending after Heat Shock: Specimens from the heat shock test of 3.3.2.1 shall be bent 180 deg around the applicable mandrel of Table II. Any side-cracking, caused by flattening of the specimen on the mandrel, shall be disregarded.

4.6 Reports:

4.6.1 The vendor of tubing shall furnish with each shipment three copies of a report showing the results of tests to determine conformance to the acceptance test requirements and stating that the tubing conforms to the other technical requirements of this specification. This report shall include the purchase order number, AMS 3588A, vendor's compound number, lot number, size, and quantity.

4.6.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, AMS 3588A, contractor or other direct supplier of tubing, supplier's compound number, part number, and quantity. When tubing for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of tubing to determine conformance to the requirements of this specification, and shall include in the report a statement that the tubing conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

4.7 Resampling and Retesting: If the average results of the specimens tested for any requirement fail to meet the specified value, disposition of the tubing may be based on the results of testing three additional specimens for each original specimen failing to meet the specified average requirement. Failure of the average of the original specimens plus the retest specimens to meet any specified requirement shall be cause for rejection of the tubing represented and no additional testing shall be permitted. Results of all tests shall be reported.