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

AEROSPACE MATERIAL SPECIFICATION

AMS 3634A
Superseding AMS 3634
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PLASTIC TUBING, ELECTRICAL INSULATION
Polyolefin, Selectively Crosslinked, Encapsulating, Semi-Rigid, Heat-Shrinkable

1. SCOPE:

1.1 Form: This specification covers an irradiated, selectively-crosslinked, thermally-stabilized, modified-polyolefin plastic in the form of semi-rigid, dual-wall, heat-shrinkable tubing.

1.2 Application: Primarily for use as a semi-rigid, electrical insulation tubing whose diameter can be reduced to a predetermined size by heating to temperatures higher than 135°C (275°F). Tubing is not flame-retardant and will burn slowly. This material is stable for continuous exposure at temperatures from -55°C (-67°F) to +110°C (+230°F).

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 Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania 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, Pennsylvania 19103.

ASTM D149 - Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies
ASTM D257 - D-C Resistance or Conductance of Insulating Materials
ASTM D471 - Change in Properties of Elastomeric Vulcanizates Resulting From Immersion in Liquids
ASTM D570 - Water Absorption of Plastics
ASTM D573 - Accelerated Aging of Vulcanized Rubber by the Oven Method
ASTM D638 - Tensile Properties of Plastics
ASTM D746 - Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D792 - Specific Gravity and Density of Plastics by Displacement
ASTM D876 - Testing Nonrigid Vinyl Chloride Polymer Tubing
ASTM G21 - Resistance of Synthetic Polymeric Materials to Fungi

2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 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

Printed in U.S.A.

3. TECHNICAL REQUIREMENTS:

3.1 Composition: The material shall be a thermally-stabilized, modified-polyolefin plastic, selectively cross-linked by irradiation to provide a non-meltable, shrinkable, outer wall and an inner wall capable of melting and adhering to itself.

Ø3.2 Color: Shall be black, unless otherwise ordered.

3.3 Properties: The product shall conform to the following requirements; tests shall be conducted in accordance with the specified methods, insofar as practicable. Unless otherwise specified, tubing shall be tested in the expanded form (as supplied).

3.3.1 Tensile Strength, min	1500 psi (10.3 MPa)	ASTM D638, Speed C (See 4.5.1)
3.3.2 Elongation, min	200%	ASTM D638, Speed C (See 4.5.1)
3.3.3 Flow of Inner Wall	Pass	4.5.2
3.3.4 Heat Shock	No dripping, flowing, or cracking of outer wall	4.5.3
3.3.5 Low-Temperature Brittleness at -55°C ± 2 (-67°F ± 3.6)	No cracking	ASTM D746
Ø3.3.6 Heat Aging	No dripping, flowing, or cracking	4.5.4
3.3.7 Corrosion	Pass	4.5.5
3.3.8 Solvent Resistance		4.5.6
3.3.8.1 Tensile Strength, min	1000 psi (6.90 MPa)	
Ø3.3.8.2 Dielectric Strength, min	400 V/mil (15,750 V/mm)	
Ø3.3.9 Fungus Resistance	Rating of 1 or less	4.5.7
3.3.10 Specific Gravity, max	0.99	ASTM D792, Method A
3.3.11 Water Absorption in 24 hr, max	0.10%	ASTM D570, Procedure A
3.3.12 Dielectric Strength, min	500 V/mil (19,680 V/mm)	4.5.8
3.3.13 Volume Resistivity, min	10^{15} ohm-cm	ASTM D257
3.3.14 Dimensional Change on Heating		ASTM D876 (See 4.5.9)
3.3.14.1 Diametral	In accordance with Table I	
3.3.14.2 Longitudinal, max	-10%, +1%	

3.4 Marking: Prior to and after shrinkage, tubing shall be suitable for numbers or characters printed on it with conventional tubing marking techniques.

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

3.6 Standard Sizes and Tolerances: Unless otherwise specified, tubing shall be supplied in lengths of 48 in., ø +1, -0 (1219 mm, +25, -0), and in the standard sizes and to the tolerances shown in Table I. Tolerances apply at 23° - 30°C (73.4° - 86°F). Measurements shall be made in accordance with ASTM D876.

TABLE I

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Size	Expanded (As Supplied) ID, Inches min	Recovered Dimensions (After Heating) ID, Inches max	Nominal Total Wall Thickness Inch	Total Wall Thickness Tolerance, Inch plus and minus	Nominal Meltable Wall Inch
1/8	0.125	0.023	0.038	0.006	0.020
3/16	0.187	0.060	0.043	0.006	0.025
1/4	0.250	0.080	0.047	0.006	0.027
300	0.300	0.050	0.100	0.008	0.065
3/8	0.375	0.135	0.050	0.007	0.030
1/2	0.500	0.195	0.055	0.007	0.035
3/4	0.750	0.313	0.065	0.007	0.040
1	1.000	0.400	0.075	0.007	0.040

TABLE I (SI)

Size	Expanded (As Supplied) ID, Millimetres min	Recovered Dimensions (After Heating) ID, Millimetres max	Nominal Total Wall Thickness Millimetres	Total Wall Thickness Tolerance Millimetre plus and minus	Nominal Meltable Wall Millimetres
1/8	3.18	0.58	0.97	0.15	0.51
3/16	4.75	1.52	1.09	0.15	0.64
1/4	6.35	2.03	1.19	0.15	0.69
300	7.62	1.27	2.54	0.20	1.65
3/8	9.52	3.43	1.27	0.18	0.76
1/2	12.70	4.95	1.40	0.18	0.89
3/4	19.05	7.95	1.65	0.18	1.02
1	25.40	10.16	1.90	0.18	1.02

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of tubing shall supply all samples and shall be responsible for ø performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.6. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to assure 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 tensile strength (3.3.1), elongation (3.3.2), flow of inner wall (3.3.3), heat shock (3.3.4), dimensional change on heating (3.3.14), and size and tolerance (3.6) requirements are classified as acceptance or routine control tests.

4.2.2 Qualification Tests: Tests to determine conformance to low-temperature brittleness (3.3.5), heat aging (3.3.6), corrosion (3.3.7), solvent resistance (3.3.8), fungus resistance (3.3.9), specific gravity (3.3.10), water absorption (3.3.11), dielectric strength (3.3.12) and volume resistivity (3.3.13) requirements are classified as qualification or periodic control tests.

4.3 Sampling: Shall be in accordance with the following; a lot shall be all tubing of the same size from the same production run offered for inspection at the same time.

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

4.3.2 Qualification Tests: Not less than 50 ft (15.25 m) of tubing of each size or size range. Certain sizes will qualify additional sizes, as shown below:

Range of Sizes	Qualification Size
1/8 - 1/4, incl	1/4
300 - 1, incl	1

4.4 Approval:

4.4.1 Sample tubing shall be approved by purchaser before tubing for production use is supplied, unless such approval is 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 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 revised tubing. No tubing made by the revised procedure shall be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Tensile Strength and Elongation: Five specimens, each approximately 4 in. (102 mm) long, shall be tested using 1-in. (25-mm) bench marks and 1 in. (25 mm) initial jaw separation. The specimens shall be full sections of tubing for sizes 1/4 and smaller and strip specimens, not less than 1/4 in. (6.4 mm) wide, cut longitudinally from sizes 3/8 and larger. Tubular specimens shall be measured in accordance with ASTM D876. Metal plugs are not necessary when testing full sections of tubing. A specimen break at a bench mark or outside the gage length shall be cause for retest, but such breaks shall not be considered failure to meet requirements in determining the need for retesting as in 4.7.

4.5.2 Flow of Inner Wall: Three specimens, each approximately 6 in. (152 mm) long, shall be conditioned for 3 min. ± 0.2 in a mechanical convection oven which is at 200°C ± 5 (392°F ± 9) with an air velocity of 100 - 200 ft. per min. (508 - 1016 mm/s) past the specimens. Within 5 sec after conditioning, approximately 1/4 in. (6.4 mm) of one end shall be lightly pressed together with needle nose pliers. The specimens shall be removed from the pliers and cooled to room temperature. The specimens shall be replaced for 5 min. ± 0.2 in the mechanical convection oven at 200°C ± 5 (392°F ± 9). After heating, the specimen shall be removed, cooled to room temperature, and examined to assure that there are no openings through the pressed portion.

4.5.3 Heat Shock: Three specimens in the expanded form (as supplied), each approximately 6 in. (152 mm) long, shall be conditioned for 4 hr ± 0.2 in a mechanical convection oven which is at 250°C ± 5 (482°F ± 9) with an air velocity of 100 - 200 ft per min. (508 - 1016 mm/s) past the specimens. After conditioning, the specimens shall be removed from the oven, cooled to room temperature, and examined visually.

4.5.4 Heat Aging: Three specimens, approximately 6 in. (152 mm) long, shall be conditioned on aluminum foil for 168 hr ± 2 in an oven which is at 175°C ± 2 (347°F ± 3.6). After conditioning, the specimens ø shall be removed from the oven, cooled to 23°C ± 3 (73.4°F ± 5.4), and bent through 180 deg (3.14 rad) over a mandrel selected in accordance with Table II. The specimens shall be examined visually for evidence of dripping, flowing, or cracking of the outer wall. Any side cracking caused by flattening of the specimen on the mandrel shall not constitute failure.

TABLE II

Size	Diameter of Mandrel	
	Inch	Millimetres
1/8 - 1/4, incl	7/16	(11.1)
300 - 3/4, incl	1/2	(12.7)
1	9/16	(14.3)

4.5.5 Corrosion: A specimen, approximately 1 in. (25 mm) long, shall be placed in the bottom of each of two clean 1/2 x 12 in. (12.7 x 305 mm) test tubes. The specimens shall be full sections of tubing for sizes smaller than 1/4. For sizes 1/4 and larger, strips approximately 1/4 in. (6.4 mm) in width shall be cut from the tubing. A third tube shall be used for control. A copper-glass mirror about 1/4 in. (6.4 mm) wide x 1 in. (25 mm) long shall be suspended 6 - 7 in. (152 - 178 mm) above the bottom of each tube by fine copper wire attached to a silicone rubber stopper wrapped in aluminum foil. The mirrors shall be vacuum-deposited copper, on one side only, with a thickness equal to 10% ± 5 transmission of normal incident light of 5000 angstroms. The coated mirrors shall be stored in vacuum and may be used for test only if no oxide film is present and the copper is not visibly damaged. The three test tubes shall be tightly sealed. The lower 2 in. (51 mm) of each tube shall be placed in an oven or oil bath at 121°C ± 3 or 347°F ± 5 for 16 hr ± 0.5. After cooling, the mirrors shall be examined in a good light against a white background. The copper shall not have been removed from a mirror leaving an area of transparency greater than 5% of the total area, disregarding the bottom 1/16 in. (1.6 mm) of the mirror. Discoloration of the copper film shall not be considered corrosion.

4.5.6 Solvent Resistance: Tubing shall be immersed for 24 hr ± 2 at 23°C ± 3 (73.4°F ± 5.4) 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 as in ASTM D471, and water. Six specimens (a total of 30), each approximately 6 in. (152 mm) long, shall be immersed in each of the fluids. The volume of fluid shall be not less than 20 times that of the specimens. After immersion, the specimens shall be lightly wiped and air dried for 30 - 60 min. at room temperature. After drying, three of each group of six specimens shall be tested in accordance with ASTM D638 for tensile strength; the other three shall have inner electrodes inserted as specified in ASTM D876 and shall be tested in accordance with ASTM D149 for dielectric strength.

4.5.7 Fungus Resistance: Shall be determined in accordance with ASTM G21 except that the incubation period ø shall be 28 days ± 0.5 and the test organisms shall be Aspergillus niger, Aspergillus flavus, Penicillium funiculosum and Trichoderma sp. Three specimens, each approximately 3 in. (76 mm) long, shall be used for each organism.