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AEROSPACE MATERIAL SPECIFICATION

SAE AMS-3636 REV G

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Submitted for recognition as an American National Standard

TUBING, PLASTIC, ELECTRICAL INSULATION
Irradiated Polyolefin, Pigmented, Flexible, Heat-Shrinkable
2 to 1 Shrink Ratio

1. SCOPE:

1.1 Form: This specification covers an irradiated, thermally stabilized, flame-resistant, modified polyolefin plastic in the form of flexible, thin-wall, heat-shrinkable tubing.

1.2 Application: Primarily as a flexible, electrical insulation tubing whose diameter can be reduced to a predetermined size by heating to 120°C(248°F) or higher. This tubing is stable under the following conditions:

-55° to +135°C (-67° to +275°F)	Continuous
-55° to +150°C (-67° to +302°F)	2000 hours
-55° to +175°C (-67° to +347°F)	336 hours
-55° to +200°C (-67° to +392°F)	48 hours
-55° to +250°C (-67° to +482°F)	8 hours
-55° to +300°C (-67° to +572°F)	2 hours

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.

2.1 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM D 471 - Rubber Property - Effect of Liquids
ASTM D 2671 - Testing Heat-Shrinkable Tubing for Electrical Use
ASTM G 21 - Determining Resistance of Synthetic Polymeric Materials to Fungi

2.2. U.S. Government Publications : Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.2.1 Military Specifications:

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

2.2.2 Military Standards:

MIL-STD-104 - Limit for Electrical Insulation Color
MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REOUIREMENTS:

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

3.2 Color: Shall be as ordered. Colors shall be in accordance with MIL-STD-104, Class I.

3.3 Properties: Tubing shall conform to the following requirements; reported values shall be the average of all specimens tested for each requirement. Except as otherwise specified, herein, tests shall be performed in accordance with ASTM D 2671, insofar as practicable.

3.3.1 Recovered Tubing: The following requirements apply to tubing after being shrunk by heating to 200°C± 5 (392°F ± 9) in a convection-current air oven with an air velocity of 100- 200 feet per minute (0.5- 1.0 m/second) past the tubing, holding at heat for not less than 3 minutes, removing from the oven, and conditioning for not less than 4 hours at 23°C± 2 (73°F ± 4) and 45 - 55% relative humidity,

3.3.1.1 Tensile Strength, minimum Jaw separation rate 20 inches per minute (8.5 mm/s)	1500 psi (10.3 MPa)	
3.3.1.2 Elongation, minimum	200%	
3.3.1.3 Dielectric Strength, minimum (Short Time Test)	500 volts per mil (19,685 V/mm)	4.5.1
3.3.1.4 Volume Resistivity, minimum	10^{14} ohm-cm	

3.3.1.5 Flammability, Procedure B (See 8.2)	Self extinguishing within 1 minute, 25% maximum flag burn	
3.3.1.6 Copper Stability 0 168 hours ± 2 at 160°C ± 3 (320°F ± 5)	No pitting or blackening of copper	
3.3.1.6.1 Elongation, minimum	200%	
3.3.1.7 Fungus Resistance	Rating of 1 or less	ASTM G 21
3.3.1.8 Low-Temperature Flexibility 4 hours ± 0.25 at -55°C ± 2 (-67°F ± 4)	No cracks	4.5.2
3.3.1.9 Heat Aging, 336 hours ± 2 at 175°C ± 3 (347°F ± 5)		
3.3.1.9.1 Elongation, minimum	150%	
3.3.1.10 Corrosion, Procedure A, After 16 hours ± 0.25 at 175°C ± 3 (347°F ± 5)	Pass	
3.3.1.11 Fluid Resistance		4.5.3
3.3.1.11.1 Tensile Strength, minimum	1000 psi (6.90 MPa)	
3.3.1.11.2 Dielectric Strength, minimum	400 volts per mil (15,748 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, maximum 0	-5%, +0%	

3.3.2 Expanded Tubing: The following requirements apply to tubing in the expanded (as-received) condition. Heating for the tests of 3.3.2.2 and 3.3.2.4 shall be performed in an oven as specified in 3.3.1.

3.3.2.1 Secant Modulus at 2% Strain, maximum	25,000 psi (172 MPa)
3.3.2.2 Heat Shock, 4 hours ± 0.25 at 250°C ± 5 (482°F ± 9)	No dripping, flowing, or cracking

3.3.2.2.1 Bending after Heat Shock	No cracks	4.5.4
3.3.2.3 Color Stability 48 hours ± 1 at 175°C ± 5 (347°F ± 9)	Meet limits of MIL-STD-104, Class 1	
3.3.2.4 Restricted Shrinkage, Procedure C, After 30 minutes ± 1 at 175°C ± 5 (347°F ± 9)	No cracks; withstand 2000 V for 1 minute	
3.3.2.5 Specific Gravity, maximum	1.35	
3.3.2.6 Water Absorption, maximum 24 hours ± 0.25 at 25°C ± 2 (77°F ± 4)	0.50%	

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. Markings, applied prior to shrinkage, shall not be distorted by non-concentric shrinkage.

3.5 Quality: Tubing, as received by purchaser, shall be uniform in quality and condition, smooth, and free from foreign materials and from imperfections detrimental to usage of the tubing.

3.6 Standard Sizes and Tolerances: Tubing shall be supplied in lengths of 48 inches, +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° - 86°F). Measurements shall be made in accordance with ASTM D 2671.

TABLE I

Size	Expanded (As Supplied) ID, Inches min	Recovered Dimensions (After Heating) ID, Inches max	Nominal Wall Thickness Inch	Wall Thickness Tolerance, Inch plus and minus
3/64	0.046	0.023	0.016	0.003
1/16	0.063	0.031	0.017	0.003
3/32	0.093	0.046	0.020	0.003
1/8	0.125	0.062	0.020	0.003
3/16	0.187	0.093	0.020	0.003
1/4	0.250	0.125	0.025	0.003
3/8	0.375	0.187	0.025	0.003
1/2	0.500	0.250	0.025	0.003
3/4	0.750	0.375	0.030	0.003
1	1.000	0.500	0.035	0.005
1-1/2	1.500	0.750	0.040	0.006
2	2.000	1.000	0.045	0.007
3	3.000	1.500	0.050	0.008
4	4.000	2.000	0.055	0.009

TABLE I (SI)

Size	Expanded (As Supplied) ID Millimetres min	Recovered Dimensions (After Heating) ID Millimetres max	Wall Thickness Millimetres	Wall Thickness Tolerance Millimetre plus and minus
3/64	1.17	0.58	0.41	0.08
1/16	1.60	0.79	0.43	0.08
3/32	2.36	1.17	0.51	0.08
1/8	3.18	1.58	0.51	0.08
3/16	4.75	2.36	0.51	0.08
1/4	6.35	3.18	0.64	0.08
3/8	9.52	4.75	0.64	0.08
1/2	12.70	6.35	0.64	0.08
3/4	19.05	9.52	0.76	0.08
1	25.40	12.70	0.89	0.13
1-1/2	38.10	19.05	1.02	0.15
2	50.80	25.40	1.14	0.18
3	76.20	38.10	1.27	0.20
4	101.60	50.80	1.40	0.23

3.6.1 Dimensional requirements (length, inside diameters, wall thicknesses, tolerances, and longitudinal change) of short lengths of tubing ordered specifically for identification purposes shall be as agreed upon by purchaser and vendor.

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 color (3.2), tensile strength (3.3.1.1), elongation (3.3.1.2), flammability (3.3.1.5), dimensional change on heating (3.3.1.12), secant modulus (3.3.2.1), heat shock (3.3.2.2), and sizes and tolerances (3.6) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests for dielectric strength (3.3.1.3), volume resistivity (3.3.1.4), 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), fluid resistance (3.3.1.11), color stability (3.3.2.3), restricted shrinkage (3.3.2.4), specific gravity (3.3.2.5), water absorption (3.3.2.6), and marking (3.4) are 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 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.

4.2.3.1 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, contracting officer, or request for procurement.

4.3 Sampling and Testing: Shall be in accordance with ASTM D 2671 and the following; the number of determinations for each requirement shall be as specified in the applicable test procedure or, if not specified therein, not less than three.

4.3.1 For Acceptance Tests: Not less than 16 feet (5 m) of tubing from each lot.

4.3.1.1 A lot shall be all tubing of the same size from the same production run presented for vendor's inspection at one time. A lot may be packaged in small quantities and delivered under the basic lot approval provided lot identification is maintained.

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 4.6 shall state that such plan was used.

4.3.2 For Periodic Tests: Not less than 50 feet (15 m) of tubing of each size or size range. Any size within a size range may be chosen to demonstrate conformance to that size range.

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

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 by purchaser. Results of tests on production tubing shall be essentially equivalent to those on the approved sample tubing.

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. 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, determined in accordance with ASTM D 2671, by the wall thickness, measured adjacent to the point of electrical rupture.

4.5.2 Low-Temperature Flexibility: Shall be determined in accordance with ASTM D 2671, Procedure C, bending the specimen around the applicable mandrel of Table II. Any side-cracking, caused by flattening of the specimen on the mandrel, shall be disregarded.

TABLE II

Size	Mandrel Diameter	
	Inches	Millimetres
3/64 to 1/4, incl	5/16	8.0
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