SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS3638 REV. G

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Superseding AMS3638F

Tubing, Irradiated Polyolefin Plastic, Electrical Insulation Pigmented, Semi-Rigid, Heat Shrinkable, 2 to 1 Shrink Ratio

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

STABILIZED NOTICE

This document has been declared "Stabilized" by SAE AMS P, Polymeric Materials Committee, and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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1. SCOPE:

1.1 Form:

This specification covers an irradiated, thermally-stabilized, flame-retardant, modified polyolefin plastic in the form of thin-wall tubing.

1.2 Application:

This tubing has been used typically as a semi-rigid, electrical insulation tubing whose diameter can be reduced to a predetermined size by heating to a temperature higher than 120 °C (248 °F), but usage is not limited to such applications. This tubing is stable, after being heat shrunk, 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 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 DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-H-5606 Hydraulic Fluid, Petroleum Base, Aircraft, Missiles and Ordnance
MIL-T-5624 Turbine Fuel, Aviation, Grades Jp-4, Jp-5 and Jp-5/Jp-8 St
MIL-STD-2073-1 DOD Materiel, Procedures for Development and Application of Packaging Requirements

3. TECHNICAL REQUIREMENTS:

3.1 Material:

Shall be an irradiated, thermally-stabilized, flame-retardant modified polyolefin plastic.

3.2 Color:

Shall be black.

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 requirements shown in Table 1 apply to tubing after being shrunk by heating to 200 °C ± 5 (392 °F ± 9) in a convection-current air oven with air velocity of 100 to 200 feet/minute (0.5 to 1.0 m/s) past the tubing, holding at heat for not less than three minutes, removing from the oven, and conditioning for not less than four hours at 23 °C ± 2 (73 °F ± 4) and 45 to 55% relative humidity.

TABLE 1 - Recovered Tubing Properties

Paragraph	Property	Requirement	Test Method
3.3.1.1	Tensile strength, minimum Jaw separation rate 2 inches/minute (0.85 mm/s)	2000 psi (13.8 MPa)	

TABLE 1 - Recovered Tubing Properties (Continued)

Paragraph	Property	Requirement	Test Method
3.3.1.2	Elongation, minimum	200%	
3.3.1.3	Dielectric Strength, minimum	500 volts per mil (19.7 kV/mm)	
3.3.1.4	Volume Resistivity, minimum	10^{14} ohm-cm	
3.3.1.5	Flammability, Procedure B	Self-extinguishing within one minute; no more than 25% of charred; no falling, burning particles	
3.3.1.6	Copper Stability	Pass	
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 after 4 hours ± 0.25 at -55 °C ± 2 (-67 °F ± 4)	No cracks	4.5.1
3.3.1.9	Heat Aging, after 168 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 150 °C ± 3 (302 °F ± 5)	Pass	
3.3.1.11	Solvent Resistance		4.5.2
3.3.1.11.1	Tensile Strength, minimum	1600 psi (11.0 MPa)	
3.3.1.11.2	Dielectric Strength, minimum	400 volts/mil (15.7 kV/mm)	
3.3.1.12	Dimensional Change on Heating		
3.3.1.12.1	Diametral	In accordance with Table 2	
3.3.1.12.2	Longitudinal, maximum	-5%, +1%	

TABLE 2A - Standard Sizes and Tolerances, Inch/Pound Units

Tubing Size	Expanded (As Supplied) ID, Inch minimum	Recovered Dimensions (After Heating ID, Inch maximum	Recovered Dimensions (After Heating) Nominal Wall Thickness Inch	Recovered Dimensions (After Heating) Wall Thickness Tolerance Inch plus and minus
3/64	0.046	0.023	0.020	0.003
1/16	0.063	0.031	0.020	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	0.025	0.003
1/4	0.250	0.125	0.025	0.003
3/8	0.375	0.187	0.030	0.003
1/2	0.500	0.250	0.030	0.003

TABLE 2B - Standard Sizes and Tolerances, SI Units

Tubing Size	Expanded (As Supplied) ID, millimeters minimum	Recovered Dimensions (After Heating) ID, Millimeters maximum	Recovered Dimensions (After Heating) Nominal Wall Thickness Millimeter	Recovered Dimensions (After Heating) Wall Thickness Tolerance Millimeter plus and minus
3/64	1.17	0.58	0.51	0.08
1/16	1.60	0.79	0.51	0.08
3/32	2.36	1.17	0.51	0.08
1/8	3.18	1.57	0.51	0.08
3/16	4.75	2.36	0.64	0.08
1/4	6.35	3.18	0.64	0.08
3/8	9.52	4.75	0.76	0.08
1/2	12.70	6.35	0.76	0.08

3.3.2 Expanded Tubing: Requirements shown in Table 3 apply to tubing in the expanded (as-received) condition. Heating for the tests of 3.3.2.2 and 3.3.2.3 shall be performed in an oven as specified in 3.3.1.

TABLE 3 - Expanded Tubing Properties

Paragraph	Property	Requirement	Test Method
3.3.2.1	Secant Modulus at 2% Strain, minimum	35.0 ksi (241 MPa)	
3.3.2.2	Heat Shock, after 4 hours at ±0.25 250 °C ± 5 (482 °F ± 9)	No dripping flowing, or cracking	
3.3.2.2.1	Bending after Heat Shock	No cracks	4.5.3
3.3.2.3	Restricted Shrinkage, Procedure C, After 30 minutes ± 1 at 175 °C ± 5 (347 °F ± 9)	No cracks; withstand 2000 volts for one minute	
3.3.2.4	Specific Gravity, maximum	1.35	
3.3.2.5	Water Absorption, maximum After 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.

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 2. Tolerances apply at 23 to 30 °C (73 to 86 °F). Measurements shall be made in accordance with ASTM D 2671.

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 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), solvent resistance (3.3.1.11), restricted shrinkage (3.3.2.3), specific gravity (3.3.2.4), water absorption (3.3.2.5), 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:

4.3.1 For Acceptance Tests: Not less than 16 feet (4.9 m) of tubing from each lot; 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.

4.3.1.1 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 shall not exceed 500,000 feet (152,400 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 4.6 shall state that such plan was used.

4.3.2 For Periodic Tests: Not less than 50 feet (15.2 m) of tubing of each size or size range. Certain representative sizes may be used to demonstrate conformance of a range of sizes as shown in Table 4.

TABLE 4 - Sizes

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

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. 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 Low-Temperature Flexibility: Shall be determined in accordance with ASTM D 2671, Procedure C, bending the specimen around the applicable mandrel of Table 5. Any side-cracking, caused by flattening of the specimen on the mandrel, shall be disregarded.

TABLE 5 - Mandrel Diameters

Tubing Size	Mandrel Diameter Inch	Mandrel Diameter Millimeters
3/64 to 3/16, incl	5/16	7.9
1/4 to 1/2, incl	3/8	9.5

4.5.2 Solvent Resistance: Shall be determined in accordance with ASTM D 2671 on specimens immersed for 24 hours ± 2 at 23 °C ± 3 (73 °F ± 5) in MIL-T-5624 JP-4 Fuel, SAE phosphate ester test fluid No. 1A, MIL-H-5606 hydraulic oil, ASTM Fuel B (See ASTM D 471), and water.