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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 3634D

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Submitted for recognition as an American National Standard

Superseding AMS 3634C

TUBING, POLYOLEFIN PLASTIC, ELECTRICAL INSULATION
Selectively Crosslinked, Semi-Rigid, Heat-Shrinkable

1. SCOPE:

1.1 Form:

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

1.2 Applications:

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 temperatures higher than 135 °C (275 °F), but usage is not limited to such applications. Tubing is not flame-retardant and will burn slowly. This tubing is stable for continuous exposure from -55 to +110 °C (-67 to +230 °F).

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 and 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 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.

3.2 Color:

Shall be black, unless otherwise ordered.

3.3 Properties:

Tubing shall conform to the requirements shown in Table 1; 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. Tubing shall be tested in the expanded form (as supplied), unless otherwise specified herein.

TABLE 1 - Properties

Paragraph	Property	Requirement	Test Method
3.3.1	Tensile Strength, minimum Jaw separation rate 2 inches per minute(0.85 mm/s)	1500 psi) (10.3 MPa)	
3.3.2	Elongation, minimum	200%	
3.3.3	Flow and Sealing of Inner Wall	Pass	4.5.1
3.3.4	Heat Shock, after 4 hours ± 0.2 at 250 °C ± 5 (482 °F ± 9)	No dripping, flowing, or cracking of outer wall	
3.3.5	Low-Temperature Flexibility, Procedure B, after 4 hours ± 0.25 at -55 °C ± 2 (-67 °F ±4)	No Failure	
3.3.6	Heat Aging, after 168 hours ± 2 at 175 °C ± 3 (347 °F ± 5)	No dripping, flowing, or cracking of outer wall	4.5.2
3.3.7	Corrosion, Procedure A, after 16 hours ± 0.25 at 120 °C ± 3 (248 °F ± 5)	Area of transparency not more than 5% of total area	
3.3.8	Fluid Resistance		4.5.3
3.3.8.1	Tensile Strength, minimum	1000 psi (6.89 MPa)	
3.3.8.2	Dielectric Strength, minimum	400 volts per mil (15.7 kV/mm)	4.5.4
3.3.9	Fungus Resistance	Rating of 1 or less	ASTM G 21
3.3.10	Specific Gravity, maximum	0.99	
3.3.11	Water Absorption, maximum, after 24 hours ± 0.25 at 25 °C ± 2 (77 °F ± 4)	0.10%	
3.3.12	Dielectric Strength, minimum(short-time test)	500 volts per mil (19.7 kV/mm)	4.5.4

TABLE 1 - Properties (Continued)

Paragraph	Property	Requirement	Test Method
3.3.13	Volume Resistivity, minimum	10^{15} ohm-cm	
3.3.14	Dimensions and Dimensional Change on Heating		4.5.5
3.3.14.1	Dimensions and Diametral	In accordance with Table 2	
3.3.14.2	Longitudinal, maximum	-10%, +1%	4.5.5.1

3.4 Marking:

(R)

Tubing, prior to and after shrinkage, shall be suitable for having numbers or characters printed on it with conventional tube marking techniques. Marking 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 2. Tolerances apply at 23 to 30 °C (73 to 86 °F). Measurements shall be made in accordance with ASTM D 2671.

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

Size	Expanded (As Supplied) ID, Inches minimum	Expanded (As Supplied) ID, Inch maximum	Recovered Dimensions (After Heating) Nominal Total Wall Thickness Inch	Recovered Dimensions (After Heating) Total Wall Thickness Tolerance, Inch plus and minus	Recovered Dimensions (After Heating) 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 (See 8.2)	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 2B - Standard Sizes and Tolerances, SI Units

Size	Expanded (As Supplied) ID, Millimeters minimum	Expanded (As Supplied) ID, Millimeters maximum	Recovered Dimensions (After Heating) Nominal Total Wall Thickness Millimeters	Recovered Dimensions (After Heating) Total Wall Thickness Tolerance Millimeters plus and minus	Recovered Dimensions (After Heating) Nominal Meltable Wall Millimeters
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 (See 8.2)	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:

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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), elongation (3.3.2), flow and sealing of inner wall (3.3.3), heat shock (3.3.4), dimensional change on heating (3.3.14), and sizes and tolerances (3.6) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests for low-temperature flexibility (3.3.5), heat aging (3.3.6), corrosion (3.3.7), fluid resistance (3.3.8), fungus resistance (3.3.9), specific gravity (3.3.10), water absorption (3.3.11), dielectric strength (3.3.12), volume resistivity (3.3.13), 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:

(R) Shall be in accordance with ASTM D 2671 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. 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 (4.9 m) of tubing from each lot.

4.3.1.1 When a statistical sampling plan has been agreed upon by purchaser and
(R) 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 3.

TABLE 3 - Sizes

Representative Size	Range of Sizes
1/4	1/8 to 1/4, incl
1	300 to 1, incl

4.3.3 For Preproduction Tests: As agreed upon by purchaser and vendor.

4.4 Approval:

4.4.1 Sample tubingtubing 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 Flow and Sealing of Inner Wall: Three specimens, each approximately 6 inches (152 mm) long, shall be conditioned for 3 minutes ± 0.2 in a mechanical convection oven which is at 200 °C ± 5 (392 °F ± 9) with an air velocity of 100 to 200 feet per minute (508 to 1016 mm/s) past the specimens. Within five seconds after conditioning, approximately 1/4 inch (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 minutes ± 0.2 in the mechanical convection oven at 200 °C ± 5 (392 °F ± 9). After heating, the specimens shall be removed, cooled to room temperature, and examined to ensure that there are no openings through the pressed portion.

4.5.2 Heat Aging: Three specimens, approximately 6 inches (152 mm) long, shall be conditioned on aluminum foil for 168 hours ± 2 in an oven which is at 175 °C ± 2 (347 °F ± 4). After conditioning, the specimens shall be removed from the oven, cooled to 23 °C ± 3 (73 °F ± 5), and bent through 180 degrees over a mandrel selected in accordance with Table 4. 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 be disregarded.

TABLE 4 - Mandrel Diameter

Size	Mandrel Diameter Inch	Mandrel Diameter Millimeters
1/8 to 1/4, incl	7/16	11.1
300 to 3/4, incl	1/2	12.7
1	9/16	14.3

4.5.3 Fluid Resistance: Shall be determined in accordance with ASTM B 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.

4.5.4 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.

4.5.5 Dimensions and Dimensional Change on Heating and Diametral Change: Three 6 inch (152 mm) specimens of tubing shall be measured for inside diameter in accordance with ASTM D 2671. The specimens then shall be placed on mandrels and conditioned for 10 minutes in an oven at 200 °C ± 3 (392 °F ± 5). The diameter of the mandrels shall equal the maximum inside diameter of the recovered tubing as specified in Table 2, plus 0.000, minus 0.002 inch (0.051 mm) or 2%, whichever is greater. After conditioning, the specimens, while still on the mandrels, shall be removed from the oven, cooled for at least 30 seconds in water at less than 35 °C (95 °F), and inspected for wall thickness in accordance with ASTM D 2671. If air space is visible between the specimen and the mandrel, the specimen shall be removed from the mandrel, measured for inside diameter and inspected for wall thickness in accordance with ASTM D 2671.

4.5.5.1 Longitudinal Change: Three 6 inch (152 mm) specimens of tubing shall be measured for length to an accuracy of ±1/32 inch (±0.8 mm). The specimens shall be conditioned on aluminum foil for three minutes in an oven at 200 °C ± 3 (392 °F ± 5). After conditioning, the specimens shall be removed from the oven, cooled to 23 °C ± 3 (73 °F ± 5), and remeasured. The longitudinal change shall be calculated using Equation 1.

$$\% \text{ Change} = \frac{\text{Length after Heating} - \text{Length before Heating}}{\text{Length before Heating}} \times 100 \qquad \text{(Eq.1)}$$

4.6 Reports:

The vendor of tubing shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements and, when performed, to the periodic test requirements, and stating that the tubing conforms to the other technical requirements. This report shall include the purchase order number, lot number, AMS 3634D, vendor's compound number, size, and quantity.

4.7 Resampling and Retesting:

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If the average results of specimens tested for any requirement fails 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. Results of all tests shall be reported.