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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 3639E

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Superseding AMS 3639D

PLASTIC TUBING, ELECTRICAL INSULATION
Irradiated Polyolefin, Clear, Semi-Rigid, 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 semi-rigid, thin-wall, heat-shrinkable tubing.

1.2 Application: Primarily as a semi-rigid, electrical insulation tubing whose diameter can be reduced to a predetermined size by heating to 120°C (250°F) or higher. This tubing is stable under the following conditions:

-55° to +135°C (-65° to +275°F)	Continuous
-55° to +150°C (-65° to +300°F)	2000 hours
-55° to +175°C (-65° to +345°F)	336 hours
-55° to +200°C (-65° to +390°F)	48 hours
-55° to +250°C (-65° to +480°F)	8 hours
-55° to +300°C (-65° to +570°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 latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 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, Missile, 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.

3.2 Color: Shall be colorless and transparent. Tubing shall be sufficiently transparent to allow 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 3.3.1.

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 D2671 insofar as practicable.

3.3.1 Recovered Tubing: The following requirements apply to tubing after being shrunk by heating to 200°C ± 5 (390°F ± 10) in a convection-current air oven with an air velocity of 100 - 200 feet per minute (0.5 - 1.0 m/sec) 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 2 inches per minute (0.85 mm/sec)	2000 psi (14 MPa)
3.3.1.2	Elongation, minimum	200%

3.3.1.3 Ø Dielectric Strength, minimum (Short Time Test)	500 V per mil (19,700 V/mm)	
3.3.1.4 Volume Resistivity, minimum	10^{16} ohm-cm	
3.3.1.5 Ø Copper Stability, Procedure B	Pass	
3.3.1.5.1 Elongation, minimum	200%	
3.3.1.6 Fungus Resistance	Rating of 1 or less	ASTM G21
3.3.1.7 Low-Temperature Flexibility (4 hours ± 0.25 at -55°C ± 2 (-65°F ± 4))	No Cracks	4.5.1
3.3.1.8 Heat Aging, 168 hours ± 2 at 175°C ± 3 (345°F ± 5)		
3.3.1.8.1 Elongation, minimum	150%	
3.3.1.9 Corrosion, Procedure A, After 16 hours ± 0.25 at 150°C ± 3 (300°F ± 5)	Pass	
3.3.1.10 Solvent Resistance		4.5.2
3.3.1.10.1 Tensile Strength, minimum	1600 psi (11 MPa)	
3.3.1.10.2 Dielectric Strength, minimum	400 V per mil (15,750 V/mm)	
3.3.1.11 Dimensional Change on Heating		
3.3.1.11.1 Diametral	In accordance with Table I	
3.3.1.11.2 Longitudinal, maximum	-5%, +1%	

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 3.3.2.3 shall be performed in an oven as specified in 3.3.1.

3.3.2.1 Secant Modulus at 2% Strain, minimum	35,000 psi (240 MPa)	
3.3.2.2 Heat Shock, 4 hours ± 0.25 at 250°C ± 5 (480°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 (345°F ± 9)	No cracks; withstand 2000 V for 1 minute
3.3.2.4	Specific Gravity, maximum	1.0
3.3.2.5	Water Absorption, maximum Ø 24 hours + 1 at 23°C ± 2 (73°F ± 4)	0.2%

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 I. Tolerances apply at 23° - 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 reported to the purchaser as required by 4.6. 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 to determine conformance to requirements for tensile strength (3.3.1.1), elongation (3.3.1.2), dimensional change on heating (3.3.1.11), secant modulus (3.3.2.1), heat shock (3.3.2.2), 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 (3.3.1.3), volume resistivity (3.3.1.4), copper stability (3.3.1.5), fungus resistance (3.3.1.6), low-temperature flexibility (3.3.1.7), heat aging (3.3.1.8), corrosion (3.3.1.9), solvent resistance (3.3.1.10), restricted shrinkage (3.3.2.3), specific gravity (3.3.2.4), and water absorption (3.3.2.5) 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 prior to or on the initial shipment of tubing to a purchaser, when a change in material, processing, or both 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: Shall be in accordance with ASTM D2671 and the following:

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

4.3.1.1 A lot shall be all tubing of the same size from the same production run and presented for vendor's inspection at one time. An inspection lot shall not exceed 250,000 feet (75,000 m) but may be packaged in smaller quantities and delivered under the basic lot approval provided lot identification is maintained.

4.3.1.2 When a statistical sampling plan and acceptance quality level (AQL) have 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 4.6.1 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. Certain representative sizes may be used to demonstrate conformance of a range of sizes as follows:

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 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 material, processing, or both 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 D2671, 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	
	Inch	Millimetres
3/64 to 3/16, incl	5/16	8.0
1/4 to 1/2 , incl	3/8	9.5

4.5.2 Solvent Resistance: Shall be determined in accordance with ASTM D2671 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 D471), and water.

4.5.3 Bending after Heat Shock: Specimens from the heat shock test of 3.3.2.2 shall be bent 180 degrees 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 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 of this specification. This report shall include the purchase order number, AMS 3639E, 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 a report showing the purchase order number, AMS 3639E, 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 either a statement that the tubing conforms or 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.

5. PREPARATION FOR DELIVERY:

5.1 Identification: Each package shall be permanently and legibly marked with not less than AMS 3639E, size, quantity, purchase order number, manufacturer's identification, and date of manufacture.

5.2 Packaging:

5.2.1 Packaging shall be accomplished in such a manner as will ensure that the tubing, during shipment and storage, will not be permanently distorted and will be protected against damage from exposure to weather or any other normal hazard. Standard packages shall each contain the following quantities:

Size	Quantity	
	Feet	Metres
3/64, 1/16, 3/32, 1/8, 3/16, 1/4, 3/8	1000	305
1/2	800	244

5.2.1.1 Packaging of special sizes and lengths shall be as agreed upon by Ø purchaser and vendor.

5.2.2 Packages of tubing shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the tubing to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.2.3 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-794, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.2.1 and 5.2.2 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Tubing not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia: The phi (Ø) symbol is used to indicate technical changes from the previous issue of this specification.

8.2 Dimensions and properties in inch/pound units and the Celsius temperatures are primary; dimensions and properties in SI units and the Fahrenheit temperatures are shown as the approximate equivalents of the primary units and are presented only for information.