SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS3683 REV. A

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Superseding AMS3683

Tubing, Irradiated Modified Fluoropolymer Plastic, Electrical Insulation Flame Resistant, Flexible, Heat-Shrinkable, 2 to 1 Shrink Ratio

RATIONALE

AMS3683A has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 Form:

This specification covers a thermally-stabilized, irradiated, modified fluoropolymer in the form of very-thin-wall tubing.

1.2 Applications:

This tubing has been used typically as a flexible, electrical insulation tubing whose diameter can be reduced to a predetermined size by heating to 150 °C (302 °F) or higher, but usage is not limited to such applications.

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 910	Aviation Gasolines
ASTM D 2671	Heat-Shrinkable Tubing for Electrical Use
ASTM G 21	Determining Resistance of Synthetic Polymeric Materials to Fungi

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS3683A

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, Missile, and Ordnance
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-A-8243	Anti-Icing and Deicing-Defrosting Fluid
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-resistant, modified fluoropolymer.

3.2 Color:

Shall be black and white.

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.

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 an air velocity of 100 to 200 feet per 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 2.0 inches per minute (0.85 mm/s)	3500 psi (24.1 MPa)	
3.3.1.2	Elongation, minimum	300%	
3.3.1.3	Dielectric Strength (short time test), minimum	500 volts/mil (19.7 kV/mm)	
3.3.1.4	Volume Resistivity, minimum	10^{11} ohm-cm	
3.3.1.5	Flammability, Procedure A Burn time, maximum (See 8.2)	15 seconds	
3.3.1.6	Fungus Resistance	Rating of 1 or less	ASTM G 21
3.3.1.7	Heat Aging, 336 hours ± 2 at 225 °C ± 3 (437 °F ± 5)		
3.3.1.7.1	Elongation, minimum	250%	
3.3.1.8	Fluid Resistance, at 23 °C ± 3 (73 °F ± 5)		4.5.1
3.3.1.8.1	Tensile Strength, minimum	3500 psi (24.1 MPa)	
3.3.1.8.2	Dielectric Strength, minimum	400 Volts/mil (15.7 V/mm)	
3.3.1.9	Dimensional Change on Heating		
3.3.1.9.1	Diametral	In accordance with Table 3	
3.3.1.9.2	Longitudinal, maximum	-10%, +1%	

3.3.2 Expanded Tubing: The requirements shown in Table 2 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 2 - Expanded Tubing Properties

Paragraph	Property	Requirement	Test Method
3.3.2.1	Secant Modulus at 2% Strain, maximum	50 ksi (345 MPa)	
3.3.2.2	Heat Shock, After 4 hours ± 0.25 at 250 °C ± 5 (482 °F ± 9)	No dripping, flowing, or cracking	4.5.2
3.3.2.3	Restricted Shrinkage, Procedure C, after 30 minutes ± 1 at 200 °C ± 5 (392 °F ± 9)	No cracks; withstand 2000 volts for one minute	
3.3.2.4	Specific Gravity, maximum	1.85	
3.3.2.5	Low-Temperature Flexibility, after 4 hours ± 0.25 at -55 °C ± 2 (-67 °F ± 4)	No cracks	4.5.3
3.3.2.6	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 tubing 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 its use.

3.6 Standard Sizes and Tolerances:

Tubing shall be supplied on spools or in lengths agreed upon by purchaser and vendor, and in the standard sizes and to the tolerances shown in Table 3. Tolerances apply at 23 to 30 °C (73 to 86 °F). Measurements shall be made in accordance with ASTM D 2671.

TABLE 3A - Standard Sizes and Tolerances, Inch/Pound Units

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	0.009	0.003
1/16	0.063	0.031	0.009	0.003
3/32	0.093	0.046	0.009	0.003
1/8	0.125	0.062	0.009	0.003
3/16	0.187	0.093	0.009	0.003
1/4	0.250	0.125	0.011	0.004
3/8	0.375	0.187	0.011	0.004
1/2	0.500	0.250	0.011	0.004
3/4	0.750	0.375	0.016	0.004
1	1.000	0.500	0.018	0.004

TABLE 3B - Standard Sizes and Tolerances, SI Units

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	0.23	0.08
1/16	1.60	0.79	0.23	0.08
3/32	2.36	1.17	0.23	0.08
1/8	3.18	1.57	0.23	0.08
3/16	4.75	2.36	0.23	0.08
1/4	6.35	3.18	0.28	0.10
3/8	9.52	4.75	0.28	0.10
1/2	12.70	6.35	0.28	0.10
3/4	19.05	9.52	0.41	0.10
1	25.40	12.70	0.46	0.10

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 (3.3.1.9), 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), fungus resistance (3.3.1.6), heat aging (3.3.1.7), fluid resistance (3.3.1.8), restricted shrinkage (3.3.2.3), specific gravity (3.3.2.4), low-temperature flexibility (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:

4.3.1 For Acceptance Tests: Not less than 16 feet (4.9 m) of tubing taken at random 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 one production run presented for vendor's inspection at one time. A lot shall not exceed the quantities specified in Table 4.

TABLE 4 - Lot Size

Tubing Size	Lot Size Feet	Lot Size Meters
3/64 - 1/4, incl	1,000,000	304,800
3/8 - 1/2, incl	500,000	152,400
3/4 - 1, incl	50,000	15,240

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 48 feet (14.6 m) of tubing of each size or size range. Any size in the range may be used to demonstrate conformance of a range of sizes as shown in Table 5:

TABLE 5 - Range of Sizes

Representative Size	Range of Sizes
3/16	3/64 - 3/16, incl
1	1/4 - 1, incl

4.3.2.1 For the fungus requirement, any size may be used to qualify the tubing.

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 Fluid 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, MIL-H-5606 hydraulic oil, ASTM #3 oil, ASTM D 910 aviation gasoline Grade 100/130, MIL-A-8243 anti-icing fluid, and salt water (5% salt), using separate specimens for each fluid.

4.5.2 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 6. Any side-cracking, caused by flattening of the specimens on the mandrel, shall be disregarded.

TABLE 6 - Mandrel Diameters

Tubing Size	Mandrel Diameter Inch	Mandrel Diameter Millimeters
3/64 to 3/16, incl	5/16	7.9
1/4 to 1, incl	3/4	19.0

4.5.3 Low-Temperature Flexibility: For tubing of expanded size 1/4 or greater, three strip specimens 0.250 inch ± 0.010 (6.35 mm ± 0.25) wide and 12 inches (305 mm) long shall be cut from the expanded tubing. For tubing of expanded size less than 1/4, three tubular specimens 12 inches (305 mm) long shall be cut from the expanded tubing. The specimens shall be recovered in accordance with 3.3.1 and conditioned in accordance with 3.3.2.5. Mandrel diameter shall be ten times specimen thickness, ±10%. For tubular specimens, the specimen thickness shall be taken as the outside diameter. After the conditioning period, and while at the specified low temperature and without removing the specimens from the chamber, the tubing shall be wrapped around the mandrel for not less than one complete turn (360 degrees) at a uniform speed of about four seconds per turn. Any side cracking, caused by flattening of the specimens on the mandrel, shall be disregarded.

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 3683A, size, and quantity.