

AEROSPACE MATERIAL SPECIFICATIONS

AMS 3639

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc.

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Revised

PLASTIC TUBING, ELECTRICAL INSULATION Irradiated Polyolefin, Clear, Semi-Rigid, Heat Shrinkable 2 to 1 Shrink Ratio

1. **ACKNOWLEDGMENT:** A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.
2. **FORM:** Thin wall semi-rigid tubing.
3. **APPLICATION:** Primarily for use as a semi-rigid electrical insulation tubing whose diameter can be reduced to a predetermined size by heating. This material is stable under the following conditions:
 - 55 C (-67 F) to 135 C (275 F) Continuous
 - 55 C (-67 F) to 150 C (302 F) 1000 hr
 - 55 C (-67 F) to 175 C (347 F) 168 hr
 - 55 C (-67 F) to 200 C (392 F) 24 hr
 - 55 C (-67 F) to 250 C (482 F) 4 hr
 - 55 C (-67 F) to 300 C (572 F) 1 hr
4. **COMPOSITION:** The material shall be an irradiated thermally stabilized, non-flame-resistant, modified polyolefin.

5. **TECHNICAL REQUIREMENTS:**

- 5.1 **Appearance:** Unless otherwise specified, colorless transparent tubing shall be furnished. Tubing shall be sufficiently transparent to allow relatively undistorted visibility through two thicknesses produced by pressing the tubing flat upon itself. Typewritten letters shall be legible when viewed through these two thicknesses pressed onto the paper. Transparency shall apply to tubing in the expanded form (as supplied) and after tubing has been shrunk as specified in 5.2.
- 5.2 **Properties:** The product shall conform to the requirements of 5.2.1 thru 5.2.3 and shall be capable of meeting the requirements of 5.2.4 thru 5.2.13. Tests shall be performed in accordance with the issue of specified ASTM methods listed in the latest issue of AMS 2350, insofar as practicable. Unless otherwise specified, tubing shall be tested after being shrunk by heating for 3 min. at $200\text{ C} \pm 5$ ($392\text{ F} \pm 9$) and cooled by immersing in water for 30 seconds.

5.2.1 Tensile Strength, psi, min	2500	ASTM D638, Speed C, Note 1
5.2.2 Elongation, %, min	200	ASTM D638, Speed C, Note 1
5.2.3 Heat Shock	Pass	Note 2
5.2.4 Low Temperature Flexibility	Pass	Note 3
5.2.5 Heat Aging	Pass	Note 4
5.2.6 Corrosion	Pass	Note 5
5.2.7 Solvent Resistance	Pass	Note 6

5.2.8 Fungus Resistance	Pass	Note 7
5.2.9 Specific Gravity, max	1.00	ASTM D792, Method A
5.2.10 Water Absorption, 24 hr immersion, %, max	0.20	ASTM D570
5.2.11 Dielectric Strength, short time test, v per mil, min	500	ASTM D876
5.2.12 Volume Resistivity, ohm-cm, min	10^{16}	ASTM D257
5.2.13 Secant Modulus at 2% Strain, psi, min	4.5×10^4	ASTM D882, See Note 8

Note 1. The specimens shall be in accordance with ASTM D876.

Note 2. Three specimens in the expanded form (as supplied), each 4 in. in length, shall be conditioned for 4 hr in an oven which is at $250 \text{ C} \pm 5$ ($482 \text{ F} \pm 9$). After this conditioning, the specimens shall be visually examined. Tubing shall not drip, flow, or crack.

Note 3. Three specimens in the expanded form (as supplied), each 18 in. in length, shall be conditioned at $-55 \text{ C} \pm 2$ ($-67 \text{ F} \pm 3.6$) for 4 hours. A fixed steel mandrel, selected in accordance with Table I, shall be conditioned at this temperature. Upon completion of this conditioning and at this same temperature, the specimens shall be wrapped not less than 360 deg around the mandrel in approximately 2 seconds. The tubing shall be free from cracks.

TABLE I

Size	Diameter of Mandrel, Inch
$3/64$ to $3/16$, incl	$5/16$
$1/4$ to $1/2$, incl	$3/8$

Note 4. Three specimens, each 6 in. in length, shall be conditioned for 168 hr in a gravity convection or mechanical convection oven which is at $175 \text{ C} \pm 3$ ($347 \text{ F} \pm 5.4$), with an air velocity of from 100 to 200 ft per min. past the specimens. After conditioning, the specimens shall be removed from the oven, cooled to room temperature, and bent through 180 deg over a steel mandrel of the diameter shown in Table I. The tubing shall remain free from cracks except that any side cracking caused by flattening of the specimen on the mandrel shall be disregarded.

Note 5. Two specimens, each 1 in. in length, shall be placed in the bottoms of two clean $1/2$ in. x 12 in. test tubes. A third test tube shall be used for control. A copper-glass mirror about $1/4$ in. wide x 1 in. long shall be suspended 6 - 7 in. above the bottom of each tube by fine copper wire attached to a silicone rubber stopper wrapped in aluminum foil. The mirrors shall be vacuum-deposited copper, on one side only, with a thickness equal to $10\% \pm 5$ transmission of normal incident light of 5000 Angstroms. The coated mirrors shall be stored in vacuum and may be used for test only if no oxide film is present and the copper is not visibly damaged. The three test tubes shall be tightly sealed. The lower 2 in. of each tube shall be placed in an oven or oil bath at $120 \text{ C} \pm 2$ ($248 \text{ F} \pm 3.6$) for 16 hours. After cooling, the mirrors shall be examined in a good light against a white background. Evidence of corrosion shall be areas of transparency larger than pinholes in a mirror. Discoloration of copper film shall not be considered corrosion.

- Note 6. Tubing shall have tensile strength not lower than 1600 psi and a dielectric strength not lower than 400 v per mil after being immersed for 24 hr $\pm$ 2 at 23 C $\pm$ 3 (73.4 F $\pm$ 5.4) in JP-4 fuel, SAE phosphate ester test fluid No. 1, hydraulic oil, aviation gasoline 100/130, and water. Six specimens (a total of 30), each 6 in. in length, shall be immersed in each of the fluids. The volume of the fluid shall be not less than 20 times that of the specimens. After immersion, the specimens shall be lightly wiped, air dried for 30 - 60 min. at room temperature, and subjected to the tensile strength and dielectric strength tests; three of the six specimens shall be tested for tensile strength and the other three for dielectric strength.
- Note 7. Fungus resistance shall be determined in accordance with ASTM D1924, except that the incubation period shall be 28 days and the test organisms shall be *Aspergillus niger*, *Aspergillus flavus*, *Penicillium luteum*, and *Trichoderma T-1*. At the end of the incubation period, not more than traces of growth on the specimen are permissible. Three specimens, each 3 in. long, shall be used for each organism.
- Note 8. Five specimens in the expanded form (as supplied), each 12 in. long, shall be tested. The specimens shall be full sections of tubing for sizes 1/4 and smaller and strip specimens cut longitudinally from sizes 3/8 and larger. No metal plugs are necessary when testing full sections of tubing. Initial strain rate shall be 0.1 in. per in. per minute.
- 5.3 Dimensions After Shrinkage:
- 5.3.1 Diametral: The dimensions of the tubing in its expanded form (as supplied) and after recovery subsequent to the application of heat at any temperature in the range of 135 to 205 C (275 to 401 F) for 1 min. shall be in accordance with Table II. Longer heating at such temperature shall cause no additional shrinkage. Unless otherwise specified, measurements shall be made in accordance with the issue of ASTM D876 listed in the latest issue of AMS 2350.
- 5.3.2 Longitudinal: In reaching its recovered dimensions, the tubing shall not exhibit a longitudinal change greater than +1% or -5%.
- 5.4 Marking: Prior to or after shrinkage, tubing shall be capable of having numbers or characters printed on it with conventional tubing marking techniques.
6. QUALITY: The product shall be uniform in quality and condition, clean, smooth, and free from foreign materials and from imperfections detrimental to fabrication, appearance, or performance of parts.
7. STANDARD SIZES AND TOLERANCES: Unless otherwise specified, tubing shall be supplied in lengths of 48 in., +1, -0. The sizes shown in Table II are standard and the tolerances apply in the range 23 - 30 C (73.4 - 86 F).

TABLE II

<u>Expanded (As Supplied)</u>		<u>Recovered Dimensions (After Heating)</u>		
Size	ID, Inch min	ID, Inch max	Nominal Wall Thickness, Inch	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