AEROSPACE
MATERIAL SPECIFICATIONS

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc. 485 Lexington Ave., New York, N.Y. 10017

AMS 3632B
Superseding AMS 3632A
Issued 2-15-65
Revised 11-1-67

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

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

2. FORM: Extra 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 to temperature higher than 175 C (347 F). This material is stable under the following conditions:

-55 C (-67 F) to 175 C (347 F)	Continuous
-55 C (-67 F) to 200 C (392 F)	15,000 hr
-55 C (-67 F) to 240 C (464 F)	1,000 hr
-55 C (-67 F) to 280 C (536 F)	110 hr
-55 C (-67 F) to 315 C (599 F)	24 hr
-55 C (-67 F) to 350 C (662 F)	5 hr

4. COMPOSITION: The material shall be an irradiated, thermally stabilized, flame-resistant, modified polyvinylidene fluoride.

5. TECHNICAL REQUIREMENTS:

5.1 Color: The tubing shall be furnished in a standard unpigmented state, transparent to translucent light tan in color.

5.2 Properties: The product shall conform to the requirements of 5.2.1 through 5.2.4 and shall be capable of meeting the requirements of 5.2.5 through 5.2.14. 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. in a mechanical convection oven which is at 200 C ± 5 (392 F ± 9), with an air velocity of 100 - 200 ft per min. past the tubing, removed from the oven, and cooled to room temperature.

5.2.1	Tensile Strength, psi, min	5000	ASTM D638, Speed C (See Note 1)
5.2.2	Elongation, %, min	150	ASTM D638, Speed C (See Note 1)
5.2.3	Secant Modulus at 2% Strain, psi, min	10×10^4	ASTM D882 (See Note 2)
5.2.4	Heat Shock	Pass	Note 3
5.2.5	Flammability	Self-extinguishing	ASTM D876
5.2.6	Low Temperature Flexibility	Pass	Note 4
5.2.7	Heat Aging	Pass	Note 5
5.2.8	Solvent Resistance	Pass	Note 6
5.2.9	Fungus Resistance	Pass	Note 7

5.2.10	Restricted Shrinkage	Pass	Note 8
5.2.11	Specific Gravity, max	1.80	ASTM D792, Method A
5.2.12	Water Absorption in 24 hr, %, max	0.50	ASTM D570
5.2.13	Dielectric Strength, short time test, v per mil, min		ASTM D876
	Sizes 3/64 to 1/2, incl	1000	
	Sizes 3/4 to 1 , incl	800	
5.2.14	Volume Resistivity, ohm-cm, min 10^{13}		ASTM D257

Note 1. Five specimens, each 4 in. long, shall be tested, using 1 in. bench marks and 1 in. initial jaw separation. The specimens shall be full sections of tubing for sizes 1/4 and smaller and strip specimens not less than 1/4 in. wide, cut longitudinally from sizes 3/8 and larger. No metal plugs are necessary when testing full sections of tubing. A specimen break at a bench mark or outside the gage length shall be cause for retest.

Note 2. 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 not less than 1/2 in. wide, 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.

Note 3. Three specimens in the expanded form (as supplied), each 6 in. in length, shall be conditioned for 4 hr in a mechanical convection oven which is at 300 C ± 5 (572 F ± 9), with an air velocity of 100 - 200 ft per min. past the specimens. After conditioning, the specimens shall be removed from the oven, cooled to room temperature, and visually examined. Tubing shall not drip, flow, or crack. Also, tubing shall be bent through 180 deg over a steel mandrel of the diameter shown in Table 1. The tubing shall remain free from cracks except that any side cracking caused by flattening of the specimen on the mandrel shall be disregarded.

TABLE I

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

Note 4. Three specimens, each 6 in. in length (x 1/4 in. wide strips cut from sizes 3/8 and larger), shall be conditioned at -55 C ± 2 (-67 F ± 3.6) for 4 hours. A fixed steel mandrel, selected in accordance with Table I above, shall be conditioned at this temperature. Upon completion of this conditioning and at the same temperature, the specimens shall be wrapped not less than 360 deg about the mandrel in approximately 2 seconds. The specimens shall be free from cracks.

Note 5. Specimens shall be prepared as in Note 1 and shall be conditioned for 168 hr in a mechanical convection oven which is at 250 C ± 5 (482 F ± 9), with an air velocity of 100 - 200 ft per min. past the specimens. After conditioning, the specimens shall be removed from the oven, cooled to room temperature, and tested for elongation. Specimens shall have elongation of not less than 50%.

Note 6. Tubing shall have tensile strength not lower than 5000 psi and dielectric strength not lower than 900 v per mil for sizes 3/64 - 1/2, and not less than 700 v per mil for sizes 3/4 - 1, after being immersed for 24 hr ± 2 at 23 C ± 3 (73.4 F ± 5.4) in JP-4 fuel, SAE phosphate ester fluid No. 1, hydraulic oil, aviation gasoline 100/130, salt water (5% salt), anti-icing fluid, and ASTM Service Fluid No. 101 (ASTM D471). Six specimens (a total of 42), 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 each group of 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 flavius, Penicillium luteum, and Trichoderma T-1. At the end of the incubation period, not more than traces of growth on the specimens are permissible. Three specimens, each 3 in. long, shall be used for each organism.

Note 8. A specimen in the expanded form (as supplied) shall be shrunk onto a clean metallic mandrel of the configuration and size shown in Fig. 1. The tubing on the mandrel then shall be conditioned for 30 min. in an oven which is at 200 C ± 5 (392 F ± 9), in accordance with ASTM D573. When cooled to room temperature, the tubing shall be visually examined and then shall be subjected to the following voltage withØ stand test. The tubing shall snugly fit the mandrel and shall not be cracked. The test potential shall be applied between the mandrel and a metal foil electrode wrapped around the largest diameter of the tubing in accordance with ASTM D876. The test potential then shall be applied in accordance with the short-time test of ASTM D149 using a 500 v per sec rate of rise. The specimen shall withstand 2000 v for 1 minute.

5.3 Dimensions After Shrinkage:

5.3.1 Diametral: Three specimens in the expanded form (as supplied), each 6 in. in length, shall be measured for length and inside diameter. The specimens shall be conditioned for 3 min. in a mechanical convection oven which is at 200 C ± 5 (392 F ± 9), with an air velocity of 100 - 200 ft per min. past the specimens. After conditioning, the specimens shall be removed from the oven, cooled to room temperature, and then remeasured. Longer heating at such temperature shall cause no additional shrinkage. Prior to and after conditioning, the dimensions of the tubing shall be in accordance with Table II. Measurements shall be made in accordance with ASTM D876.

5.3.2 Longitudinal: In reaching its recovered dimensions, the tubing shall not exhibit a longitudinal change greater than +1%, - 10%, computed as follows:

$$\% \text{ change} = \frac{\text{Length after heating - Length before heating}}{\text{Length before heating}} \times 100$$

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, and in the standard sizes and tolerances shown in Table II. Tolerances apply at 23 - 30 C (73.4 - 86 F).

TABLE II

Expanded (As Supplied)		Recovered Dimensions (After Heating)		
Size	ID, Inch min	ID, Inch max	Nominal Wall Thickness, Inch	Wall Thickness Tolerance, Inch plus and minus
3/64	0.046	0.023	0.010	0.002
1/16	0.063	0.031	0.010	0.002
3/32	0.093	0.046	0.010	0.002
1/8	0.125	0.062	0.010	0.002
3/16	0.187	0.093	0.010	0.002
1/4	0.250	0.125	0.012	0.003
3/8	0.375	0.187	0.012	0.003
1/2	0.500	0.250	0.012	0.003
3/4	0.750	0.375	0.017	0.003
1	1.000	0.500	0.019	0.003

8. REPORTS:

8.1 Unless otherwise specified, the vendor of the product shall furnish with each shipment three copies of a report stating that the product conforms to the requirements of this specification. This report shall include the purchase order number, material specification number, vendor's compound number, size, and quantity.

8.2 Unless otherwise specified, the vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number, contractor or other direct supplier of material, supplier's compound number, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification, and shall include in the report a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

9. PACKAGING:

9.1 Packaging shall be accomplished in such a manner as to ensure that the product, during shipment and storage, will not be permanently distorted and will be protected against damage from exposure to weather or any normal hazard. Unless otherwise specified, standard packages shall contain the following quantities:

Size	Quantity, ft
3/64, 1/16, 3/32, 1/8	200
3/16, 1/4, 3/8	100
1/2	48
3/4, 1	24

9.2 Each package shall be permanently and legibly marked with the AMS number, size, quantity, purchase order number, manufacturer's identification, and date of manufacture.

10. APPROVAL:

10.1 To assure adequate performance characteristics, compounds shall be approved by purchaser before material for production use is supplied, unless such approval be waived. Results of tests on production material shall be essentially equivalent to those on the approved sample.