

THERMOFIT[®] SFR TUBING
Modified Silicone Elastomer, Flame-Retarded, Heat-Shrinkable

1. SCOPE

This specification covers the requirements for a type of highly flexible, electrically insulating, extruded tubing whose diameter will reduce to a predetermined size upon the application of heat in excess of 175°C (347°F).

2. APPLICABLE DOCUMENTS

This specification takes precedence over documents referenced herein. Unless otherwise specified, the latest issue of referenced documents applies. The following documents form a part of this specification to the extent specified herein.

2.1 GOVERNMENT-FURNISHED DOCUMENTS

Military

MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-G-5572	Gasoline, Aviation, Grades 80/87, 100/130 and 115/145
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5

2.2 OTHER PUBLICATIONS

American Society for Testing and Materials (ASTM)

D 412	Standard Method of Tension Testing of Vulcanized Rubber
D 2240	Standard Method of Test for Indentation Hardness of Rubber and Plastics by Means of a Durometer
D 2671	Standard Methods of Testing Heat-Shrinkable Tubing
G 21	Recommended Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

(Copies of ASTM publications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

3. REQUIREMENTS

3.1 MATERIAL

The tubing shall be fabricated from a stabilized, flame-retarded, modified silicone elastomer and shall be crosslinked. It shall be homogeneous and essentially free from flaws, defects, pinholes, bubbles, seams, cracks, and inclusions.

3.2 COLOR

Unless otherwise specified, the tubing shall be black.

3.3 PROPERTIES

The tubing shall meet the requirements of Table 3.

4. QUALITY ASSURANCE PROVISIONS

4.1 CLASSIFICATION OF TESTS

4.1.1 Qualification Tests

Qualification tests are those performed on tubing submitted for qualification as a satisfactory product and shall consist of all tests listed in this specification.

4.1.2 Acceptance Tests

Acceptance tests are those performed on tubing submitted for acceptance under contract. Acceptance tests shall consist of the following:

Dimensions
Longitudinal Change
Tensile Strength
Ultimate Elongation
Flammability
Heat Shock

4.2 SAMPLING INSTRUCTIONS

4.2.1 Qualification Test Samples

Qualification test samples shall consist of 50 feet (*15 m*) of tubing of each size. Qualification of any size within each size range specified below will qualify all sizes in the same range.

Size Range
1/4 through 7/8
1 through 2

4.2.2 Acceptance Test Samples

Acceptance test samples shall consist of not less than 16 feet (*6 m*) of tubing selected at random from each lot. A lot shall consist of all tubing of the same size, from the same production run, and offered for inspection at the same time.

4.3 TEST PROCEDURES

Unless otherwise specified, perform the tests on specimens that have been recovered by conditioning for 10 minutes at $175 \pm 3^{\circ}\text{C}$ ($347 \pm 5^{\circ}\text{F}$). Prior to all testing, condition the test specimens (and measurement gauges, when applicable) for 3 hours at $23 \pm 3^{\circ}\text{C}$ ($73 \pm 5^{\circ}\text{F}$) and 50 ± 5 percent relative humidity. All ovens shall be of the mechanical-convection type in which air passes the specimens at a velocity of 100 to 200 feet (*30 to 60 m*) per minute.

4.3.1 Dimensions and Longitudinal Change

Measure three 6-inch (150 mm) specimens of tubing, as supplied, for length $\pm 1/32$ inch (± 1 mm), and inside diameter in accordance with ASTM D 2671. Condition the specimens for 10 minutes in a $175 \pm 5^\circ\text{C}$ ($347 \pm 9^\circ\text{F}$) oven, cool to $23 \pm 3^\circ\text{C}$ ($73 \pm 5^\circ\text{F}$) and remeasure. Prior to and after conditioning, the dimensions of the tubing shall be in accordance with Table 1 and the longitudinal change shall be in accordance with Table 3. Calculate the longitudinal change as follows:

$$C = \frac{L_1 - L_0}{L_0} \times 100$$

Where: C = Longitudinal Change [Percent]
L₀ = Length Before Conditioning [Inches (mm)]
L₁ = Length After Conditioning [Inches (mm)]

4.3.2 Tensile Strength, Tensile Stress and Ultimate Elongation

Test three specimens of tubing for tensile strength and ultimate elongation in accordance with ASTM D 2671, and for tensile stress in accordance with ASTM D 412. For tubing sizes 3/8 and smaller, the specimens shall be full sections of tubing; for sizes 1/2 and larger, the specimens shall be cut with die C of ASTM D 412. The specimens shall have 1-inch (25-mm) bench marks, centrally located. The testing machine shall have an initial jaw separation of 1 inch (25 mm) for full sections of tubing and 2 inches (50 mm) for die-cut specimens. The rate of jaw separation shall be 20 ± 2 inches (500 \pm 5 mm) per minute.

4.4 REJECTION AND RETEST

Failure of any sample of tubing to comply with any one of the requirements of this specification shall be cause for rejection of the lot represented. Tubing which has been rejected may be replaced or reworked to correct the defect and then resubmitted for acceptance. Before resubmitting, full particulars concerning the rejection and the action taken to correct the defect shall be furnished to the inspector.

5. PREPARATION FOR DELIVERY

5.1 PACKAGING

Packaging shall be in accordance with good commercial practice. The shipping container shall be not less than 125-pound-test fiberboard.

5.2 MARKING

Each container of tubing shall be permanently and legibly marked with the size, quantity, manufacturer's name, part number, specification number, lot number, date of manufacture and expiration date.

**TABLE 1
Tubing Dimensions**

Size	As Recovered		As Supplied							
	Inside Diameter Minimum		Inside Diameter Maximum		Wall Thickness					
					Minimum		Maximum		Nominal	
	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
1/4	.250	6.35	.143	3.63	.025	0.63	.045	1.14	.035	0.88
3/8	.375	9.52	.214	5.43	.030	0.76	.050	1.27	.040	1.01
1/2	.500	12.70	.286	7.25	.033	0.83	.063	1.60	.048	1.21
5/8	.625	15.87	.357	9.06	.037	0.93	.067	1.70	.052	1.32
3/4	.750	19.05	.428	10.87	.042	1.06	.072	1.82	.057	1.44
7/8	.875	22.22	.500	12.70	.050	1.27	.080	2.03	.065	1.65
1	1.000	25.40	.570	14.47	.050	1.27	.090	2.28	.070	1.77
1-1/4	1.250	31.75	.714	18.13	.067	1.70	.107	2.71	.087	2.20
1-1/2	1.500	38.10	.857	21.76	.075	1.90	.115	2.92	.095	2.41
1-3/4	1.750	44.45	1.000	25.40	.087	2.20	.127	3.22	.107	2.71
2	2.000	50.80	1.140	28.95	.090	2.28	.130	3.30	.110	2.79

**TABLE 2
Mandrel Dimensions**

Tubing Size	Mandrel Diameter	
	in.	mm.
1/4 through 3/8	3/8	9.5
1/2 through 1-3/4	7/16	11.1
2	7/8	22.2

TABLE 3
Requirements

PROPERTY	UNIT	REQUIREMENTS	TEST METHOD
PHYSICAL Dimensions	inches	In accordance with Table 1	Section 4.3.1 ASTM 2671
Longitudinal Change	percent	+3 -10 maximum	
Tensile Strength	psi (MPa)	600 minimum (4.1)	Section 4.3.2
Ultimate Elongation	percent	200 minimum	ASTM D 2671
Tensile Stress at 100% elongation	psi (MPa)	1000 maximum (6.8)	Section 4.3.2 ASTM D 412
Specific Gravity	---	1.35 maximum	ASTM D 2671
Hardness (Sizes 1/2" or larger)	Shore A	60 ± 5	ASTM D 2240
Low Temperature Flexibility 4 hours at -75 ± 2°C (-103 ± 4°F)	---	No cracking	ASTM D 2671 Procedure C Table 2
Heat Shock 4 hours at 300 ± 3°C (572 ± 5°F)	---	No dripping, flowing or cracking of suspended specimens	ASTM D 2671
Heat Resistance 168 hours at 200 ± 3°C (392 ± 5°F) Followed by tests for:	---	---	ASTM D 2671
Tensile Strength	psi (MPa)	450 minimum (3.1)	Section 4.3.2
Ultimate Elongation	percent	100 minimum	
ELECTRICAL Dielectric Strength	volts/mil (v/mm)	350 minimum (13,800)	ASTM D 2671
Volume Resistivity	ohm-cm	10 ¹¹ minimum	ASTM D 2671
CHEMICAL Corrosive Effect 16 hours at 175 ± 2°C (347 ± 4°F)	---	Noncorrosive	ASTM D 2671 Procedure A
Flammability Time of burning	seconds	60 maximum	ASTM D 2671
Flag burn	percent	25% maximum	Procedure B
Fungus Resistance	---	Rating of 1 or less	ASTM G 21
Water Absorption 24 hours at 23 ± 3°C (73 ± 5°F)	percent	1.0 maximum	ASTM D 2671
Fluid Resistance 24 hours at 23 ± 3°C (73 ± 5°F) JP-4 Fuel (MIL-T-5624) Skydrol* 500 Hydraulic Fluid (MIL-H-5606) Aviation Gasoline (100/130) (MIL-G-5572) Lubricating Oil (MIL-L-7808) Water Followed by tests for:	---	---	ASTM D 2671
Tensile Strength	psi (MPa)	250 minimum (1.7)	Section 4.3.2
Ultimate Elongation	percent	100 minimum	ASTM D 2671

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