

THERMOFIT[®] SRFR TUBING
Silicone Rubber, Flame-Resistant, Heat-Shrinkable

1. SCOPE

This specification covers requirements for a type of highly flexible, electrical insulating, extruded tubing whose diameter will reduce to a predetermined size upon the application of heat in excess of 135°C (275°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 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2240 Standard Method of Test for Indentation Hardness of Rubber and Plastics by Means of a Durometer

ASTM D 2671 Standard Methods of Testing Heat Shrinkable Tubing for Electrical Use

(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-resistant, modified silicone rubber 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 grey.

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 dimensions. Longitudinal Change shall be tested every 5th lot. Tensile Strength, Ultimate Elongation, Specific Gravity, Heat Shock, Hardness and Flammability shall be tested every 10th lot.

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

2.9/1.7 through 21/13

29/20 through 51/33

4.2.2 Acceptance Test Samples

Acceptance test samples shall consist of not less than 16 feet (5 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, tests shall be performed on specimens that have been recovered by conditioning in accordance with 4.3.1. Prior to all testing, the test specimens (and measurement gauges, when applicable) shall be conditioned 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

Three 6-inch (150-mm) specimens of tubing, as supplied, shall be measured for length to an accuracy of $\pm 1/32$ inch (± 1 mm), and inside diameter in accordance with ASTM D 2671. The specimens then shall be conditioned for 5 minutes in a $175 \pm 2^\circ\text{C}$ ($347 \pm 4^\circ\text{F}$) oven, removed from the oven, cooled to $23 \pm 3^\circ\text{C}$ ($73 \pm 5^\circ\text{F}$), remeasured for length and inside diameter, and inspected for wall thickness in accordance with ASTM D 2671. The longitudinal change shall be calculated 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 and Ultimate Elongation

Three specimens shall be tested for tensile strength and ultimate elongation in accordance with ASTM D 2671 using 1-inch (25-mm) bench marks and a jaw separation speed of 20 ± 2 inches (500 ± 50 mm) per minute. For sizes 10/6 and smaller, the specimens shall be full sections of tubing and the initial jaw separation shall be 1 inch (25 mm). For sizes larger than 10/6, the specimens shall be 1/8-inch (3.2-mm) wide strips cut from the tubing and the initial jaw separation shall be 2 inches (50 mm). The specimens shall be obtained by cutting the tubing wall along its entire length, flattening the piece, and applying the strip die with its long dimension parallel to the longitudinal axis of the tubing.

4.3.3 Low-Temperature Flexibility

Three 12-inch (300-mm) specimens of tubing and a mandrel selected in accordance with Table 2 shall be conditioned for 4 hours at $-75 \pm 2^\circ\text{C}$ ($-103 \pm 4^\circ\text{F}$). While at this same temperature, the specimens then shall be wrapped around the mandrel for not less than 360 degrees in approximately 2 seconds. The specimens then shall be visually examined for evidence of cracking.

4.3.4 Corrosion

Three specimens shall be tested in accordance with ASTM D 2671, Procedure B. The specimens shall be slid over a straight, clean, unplated, uninsulated, solid copper conductor. For sizes 10/6 and smaller, a single copper conductor shall be used; for sizes 15/9 and larger, several copper conductors shall be used, each conductor being AWG 18 [0.0403 in. (1.024 mm)] or smaller. The specimens, on conductors, shall be conditioned for not less than 24 hours in a humidity chamber at 90 to 95 percent relative humidity and $25 \pm 3^\circ\text{C}$ ($77 \pm 5^\circ\text{F}$) oven, cooled to room temperature, visually examined, and tested for elongation. The tubing shall not be brittle, glazed, cracked, severely discolored, or otherwise deteriorated by direct contact with copper. The copper shall not be pitted or blackened. Darkening of the copper due to normal air oxidation shall be disregarded.

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 action taken to correct the defect shall be furnished to the inspector.

5. PREPARATION FOR DELIVERY

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

5.1 MARKING

Each container of tubing shall be permanently and legibly marked with the size, quantity, manufacturer's identification, specification number and lot number.

**TABLE 1
Tubing Dimensions**

Product Number	As Supplied		As Recovered							
	Inside Diameter Minimum		Inside Diameter Maximum		Wall Thickness					
					Minimum		Maximum		Nominal	
	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
2.9/1.7	.114	2.89	.067	1.70	.019	0.48	.059	1.49	.039	0.99
4.0/2.9	.157	4.00	.114	2.89	.019	0.48	.059	1.49	.039	0.99
7.8/4.6	.307	7.79	.181	4.59	.019	0.48	.059	1.49	.039	0.99
10/6.5	.394	10.00	.256	6.49	.039	0.99	.079	2.00	.059	1.49
15/9.6	.591	15.01	.378	9.59	.039	0.99	.079	2.00	.059	1.49
21/13	.827	21.00	.511	12.99	.049	1.24	.109	2.76	.079	2.00
29/20	1.141	28.99	.787	19.99	.049	1.24	.109	2.76	.079	2.00
41/27	1.614	40.99	1.063	26.99	.079	2.00	.157	3.98	.118	2.99
51/33	2.007	50.99	1.299	32.99	.079	2.00	.157	3.98	.118	2.99

**TABLE 2
Mandrel Dimensions for Bend Testing**

Product Number	Mandrel Dimensions	
	in.	mm.
2.9/1.7 through 7.8/4.6	3/8	9.5
10/6.5 through 21/13	5/8	15.9
29/20 through 51/33	7/8	22.2

TABLE 3
Requirements

PROPERTY	UNIT	REQUIREMENTS	TEST METHOD
PHYSICAL			
Dimensions	Inches	In accordance with Table 1	Section 4.3.1
Longitudinal Change	Percent	15 maximum	ASTM D 2671
Tensile Strength	psi	600 minimum	Section 4.3.2
Ultimate Elongation	Percent	250 minimum	ASTM D 2671
Secant Modulus	psi	2.1×10^3 maximum	ASTM D 2671
Specific Gravity	---	1.25 maximum	ASTM D 2671
Hardness	Durometer A	60 ± 8	ASTM D 2240
Low Temperature Flexibility 4 hours at -75°C (-103°F)	---	No cracking	Section 4.3.3 ASTM D 2671
Heat Shock 4 hours at 300°C (572°F)	---	No dripping, flowing or cracking	ASTM D 2671
Heat Resistance 168 hours at 200°C (392°F) Followed by tests for:	---	---	ASTM D 2671
Tensile Strength	psi	500 minimum	Section 4.3.2
Ultimate Elongation	Percent	150 minimum	
ELECTRICAL			
Dielectric Strength	Volts/mil	200 minimum	NOTE 1 ASTM D 2671
Volume Resistivity	ohm-cm	10^{12} minimum	ASTM D 2671
CHEMICAL			
Copper Contact Corrosion 168 hours at 175°C (347°F)	---	No pitting or blackening of copper	ASTM D 2671 Procedure B
Copper Stability 168 hours at 175°C (347°F) Followed by test for:	---	No brittleness, glazing, cracking, or severe discoloration of tubing	
Ultimate Elongation	Percent	200 minimum	
Flammability	---	Self-extinguishing within 1 minute, 25% maximum flag burn	ASTM D 2671 Procedure B

NOTE 1: Recover specimens by heating for 10 minutes at 175°C .

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