

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 ± 3°C (347 ± 5°F). Prior to all testing, condition the test specimens (and measurement gauges, when applicable) for 3 hours at 23 ± 3°C (73 ± 5°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]
 L_0 = Length Before Conditioning [Inches (*mm*)]
 L_1 = 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 |

*Trademark of the Monsanto Company.



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