



RT-1145

**Tyco Fluoroelastomer Tubing -- Heavy Wall
Flexible, Fluid Resistant, Heat-Shrinkable**

SCOPE:

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

Approved Signatories*

TE Connectivity :

Approved electronically via DMTech

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1. Revision History

Revision Number	Change Request	Date	Incorporated by
5		Oct 2005	
6	RTS 1317397.1	Jun 2017	N. Nagar
7	RTS 1317397.2	Jun 2018	N. Nagar

2. Applicable Documents

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

2.1 Government Furnished Documents

Military

MIL-PRF-5606 Hydraulic Fluid, Petroleum Base, Aircraft, Missile & Ordnance

MIL-PRF-7808 Lubricating Oil, Aircraft Turbine Engine, Synthetic Base

MIL-DTL-83133 Turbine Fuels, Aviation, Kerosene Types, Nato F-34 (JP-8), Nato F-35 and P-8+100

2.2 Other Publications

American Society for Testing & Materials (ASTM)

D 910 Standard Specification for Aviation Gasolines

D 412 Test Methods for Rubber Properties in Tension

D 570 Test Method for Water Absorption of Plastics

D 792 Test Methods for Specific Gravity and Density of Plastics by Displacement

D 876 Methods of Testing Nonrigid Vinyl Chloride Polymer Tubing Used for Electrical Insulation

D 2240 Test Method for Rubber Property -- Durometer Hardness

D 2671 Method of Testing Heat-Shrinkable Tubing for Electrical Use

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

3.0 Requirements

3.1 Material

The tubing shall be fabricated from a crosslinked, thermally stabilized, modified fluoroelastomer composition. It shall be homogeneous and essentially free from flaws, defects, pinholes, bubbles, seams, cracks and inclusions.

3.2 Color

The tubing shall be black.

3.3 Properties
The tubing shall meet the requirements of Table 3.

4.0 **Quality Assurance Provisions**

4.1 Classification of Tests

4.1.1 Qualification Tests

Qualification tests are those performed on samples submitted for qualification as satisfactory products 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
Tensile Stress
Ultimate Elongation
Heat Shock
Hardness

4.2 Sampling Instructions

4.2.1 Qualification Test Samples

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

Range of Sizes

1/4 through 3/4

7/8 through 2

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, perform tests on specimens which have been fully recovered by conditioning in accordance with 4.3.1. 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 (*152 mm*) specimens of tubing, as supplied, for length $\pm 1/32$ inch (± 1 mm) and inside diameter in accordance with ASTM D 2671. Condition these specimens for 10 minutes in a $200 \pm 5^\circ\text{C}$ ($392 \pm 9^\circ\text{F}$) oven or equivalent, cool to $23 \pm 3^\circ\text{C}$ ($73 \pm 5^\circ\text{F}$) and then remeasure. Calculate 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 and Elongation

Test three specimens of tubing for tensile strength and elongation in accordance with ASTM D 2671. 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 D 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 (*51 mm*) for die-cut specimens. The rate of jaw separation shall be 20 ± 2 inches (508 ± 51 mm) per minute.

4.3.3 Low Temperature Flexibility

Condition three specimens, each 12 inches (*305 mm*) in length, and a mandrel selected in accordance with Table 2, at $-40 \pm 3^\circ\text{C}$ ($-40 \pm 5^\circ\text{F}$) for 4 hours. For tubing sizes 3/4 or less, the specimens shall be whole sections of tubing. For tubing sizes larger than 3/4, the specimens shall be 1/4 inch (*6.4 mm*) wide strips cut from tubing which has been recovered in accordance with 4.3.1. After 4 hours conditioning, while still at the conditioning temperature, wrap the specimens around the mandrel for not less than 360 degrees in 10 ± 2 seconds then visually examine specimens for evidence of cracking.

4.3.4 Heat Shock

Condition three 6 inch (*152 mm*) specimens of tubing for 4 hours in a $300 \pm 5^\circ\text{C}$ ($572 \pm 9^\circ\text{F}$) oven. After conditioning, remove the specimens from the oven, cool to room temperature and bend through 180 degrees in 2 to 4 seconds over a mandrel selected in accordance with Table 2. Visually examine the specimens for evidence of dripping, flowing or cracking. Any side-cracking caused by flattening of the specimen on the mandrel shall not constitute failure.

4.3.5 Heat Resistance

Condition three 6 inch (*152 mm*) specimens of tubing, prepared in accordance with 4.3.1, for 168 hours in a $250 \pm 3^\circ\text{C}$ ($482 \pm 5^\circ\text{F}$) oven. After conditioning, remove the specimens from the oven, cool to room temperature and test for ultimate elongation in accordance with 4.3.2.

4.3.6 Corrosive Effect

4.3.6.1 Copper Mirror Corrosion

The tubing shall be tested for copper mirror corrosion in accordance with ASTM D 2671, Procedure A, for 16 hours at $200 \pm 3^{\circ}\text{C}$ ($392 \pm 5^{\circ}\text{F}$). For tubing sizes 1/8 and larger, specimens shall consist of 1/4 x 1 inch ($6 \times 25 \text{ mm}$) strips cut longitudinally. Evidence of corrosion shall be the removal of copper from a mirror, leaving an area of transparency greater than 5 percent of its total area.

4.3.6.2 Corrosion in Contact with Copper

The tubing shall be tested for corrosion in contact with copper for 16 hours at $200 \pm 3^{\circ}\text{C}$ ($392 \pm 5^{\circ}\text{F}$) in accordance with ASTM D 2671, Procedure B.

4.3.7 Fluid Resistance

Completely immerse three specimens of tubing, prepared and measured in accordance with 4.3.1, in each listed solvent for 24 ± 2 hours at the temperatures specified in Table 3. The volume of the fluid shall be not less than 20 times that of the specimens. After immersion, lightly wipe the specimens and air-dry for 45 ± 15 minutes at room temperature, then test specimens for tensile strength and ultimate elongation in accordance with 4.3.2.

4.4 Rejection And Retest

Failure of any sample of tubing to conform to 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 the inspector.

5.0 Preparation for Delivery

5.1 Packaging

The tubing shall be packaged in accordance with good commercial practice unless otherwise specified. Individual sizes shall be neatly bundled or boxed. The exterior shipping container shall not be less than 125-pound-test fiberboard.

5.2 Marking

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

TABLE 1
Inside Diameters and Wall Thicknesses of Tubing

Size	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.
1/4	0.250	6.35	0.125	3.18	0.020	0.51	0.040	1.02	0.030	0.76
3/8	0.375	9.53	0.187	4.75	0.025	0.64	0.045	1.14	0.035	0.89
1/2	0.500	12.70	0.250	6.35	0.033	0.84	0.053	1.35	0.043	1.09
5/8	0.625	15.87	0.312	7.92	0.035	0.89	0.059	1.50	0.047	1.19
3/4	0.750	19.05	0.375	9.53	0.037	0.94	0.067	1.70	0.052	1.32
7/8	0.875	22.22	0.437	11.09	0.045	1.14	0.075	1.91	0.060	1.52
1	1.000	25.40	0.500	12.70	0.050	1.27	0.080	2.03	0.065	1.65
1-1/4	1.250	31.75	0.625	15.87	0.050	1.27	0.090	2.29	0.070	1.78
1-1/2	1.500	38.10	0.750	19.05	0.055	1.40	0.095	2.41	0.075	1.91
2	2.000	50.80	1.000	25.40	0.090	2.29	0.130	3.30	0.110	2.79

TABLE 2
Mandrel Dimensions

Tubing Size	Mandrel Diameter	
	in.	mm.
1/4 to 3/8 inclusive	3/8	9.5
1/2 to 2 inclusive	7/16	11.1

TABLE 3

Requirements

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
PHYSICAL			
Dimensions	inches (<i>mm</i>)	In accordance with Table 1	ASTM D 2671
Longitudinal Change	percent	-15 to +0	Section 4.3.1
Tensile Strength	psi (<i>MPa</i>)	1800 (<i>12.4</i>) minimum	Section 4.3.2
Tensile Stress at 200% elongation	psi (<i>MPa</i>)	2000 (<i>13.8</i>) maximum	ASTM D 2671
Ultimate Elongation	percent	250 minimum	
Specific Gravity	---	2.0 maximum	ASTM D 792
Hardness	Shore A	80 ± 10	ASTM D 2240
Low Temperature Flexibility 4 hours at -40 ± 3°C (-40 ± 5°F)	---	No cracking	Section 4.3.3 ASTM D 2671
Heat Shock 4 hours at 300 ± 5°C (572 ± 9°F)	---	No dripping, flowing or cracking	Section 4.3.4 ASTM D 2671
Heat Resistance 168 hours at 250 ± 3°C (482 ± 5°F) Followed by test for: Ultimate Elongation	percent	200 minimum	Section 4.3.5 ASTM D 2671 Section 4.3.2 ASTM D 2671
ELECTRICAL			
Dielectric Strength	Volts/mil (<i>Volts/mm</i>)	150 (<i>5,900</i>) minimum	ASTM D 2671
Volume Resistivity	ohm-cm	10 ¹⁰ minimum	ASTM D 2671
CHEMICAL			
Corrosive Effect	---	Noncorrosive	Section 4.3.6 ASTM D 2671
Copper Mirror Corrosion 16 hours at 200 ± 3°C (392 ± 5°F)	---	Copper Removal 5%, maximum	Section 4.3.6.1 ASTM D 2671 Procedure A
Copper Contact Corrosion 16 hours at 200 ± 3°C (392 ± 5°F)	---	No blackening or pitting of copper	Section 4.3.6.2 ASTM D 2671 Procedure B
Flammability	seconds	Self-extinguishing within 15 seconds; no dripping or flowing; no burning or charring of indicator	ASTM D 876
Water Absorption 24 hours at 23°C (73°F)	percent	0.5 maximum	ASTM D 570 Procedure A
Fluid Resistance 24 hours at 23 ± 3°C (73 ± 5°F) in: Aviation Gasoline (100/130) (ASTM D 910) 24 hours at 93 ± 3°C (200 ± 5°F) in: JP-8 Fuel (MIL-DTL-83133) Lubricating Oil (MIL-PRF-7808) Hydraulic Fluid (MIL-PRF-5606) Water Followed by tests for: Tensile Strength Ultimate Elongation	psi (<i>MPa</i>) percent	1600 (<i>11.0</i>) minimum 250 minimum	Section 4.3.6 Section 4.3.2