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**Raychem
Tubing**

Specification
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RW-1200
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THERMOFIT® HT-200 TUBING
Clear Fluoropolymer, Very Flexible, Flame-Resistant, Fluid-Resistant, Heat-Shrinkable

1. SCOPE

This specification covers the requirements for one type of flexible, electrical insulating, extruded tubing whose diameter will reduce to a predetermined size upon the application of heat in excess of 130°C (266°F). The tubing shall be flame-resistant and the standard color shall be clear.

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

Federal

A-A-694 Sodium Chloride, Technical

Military

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

MIL-DTL-83133 Turbine Fuel, Aviation, Kerosene Type, JP-8 (NATO F-34), NATO F-35, and JP-8+100 (NATO F-37)

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

MIL-PRF-23699 Lubricating Oil, Aircraft Turbine Engines, Synthetic Base, NATO Code Number 0-156

2.2 OTHER PUBLICATIONS

American Society for Testing and Materials (ASTM)

D412	Test Methods for Rubber Properties in Tension
D2671	Standard Methods of Testing Heat-Shrinkable Tubing for Electrical Use
G21	Standard 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 or via the ASTM website at <http://www.astm.org>).

SAE International

AMS 1424	Deicing/Anti-Icing Fluid, Aircraft, SAE Type 1
AMS-DTL-23053	Insulating Sleeving, Electrical, Heat Shrinkable, General Specification for

(Copies of SAE publications may be obtained from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or via the SAE website at <http://www.sae.org>.)

3. REQUIREMENTS

3.1 MATERIALS

The tubing shall be fabricated from thermally stabilized, modified fluoropolymer and shall be crosslinked by irradiation. It shall be homogeneous and essentially free from flaws, defects, pinholes, bubbles, seams, cracks, and contaminants.

3.2 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 be:

Dimensions
 Longitudinal Change
 Concentricity
 Tensile Strength
 Ultimate Elongation
 Secant Modulus
 Low Temperature Flexibility
 Flammability
 Heat Shock
 Clarity Stability (Clear only)

Statistical process control data may be used to demonstrate conformance for dimensions.

4.2 SAMPLING INSTRUCTIONS

4.2.1 Qualification Test Samples

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

Range of Sizes
 3/64 through 1/8
 3/16 through 1-inch

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 compound batch or the first sleeving production lot of the batch compound. Physical property tests performed at this time qualify subsequent sleeving lots produced from the same compound batch.

4.2.3 Lot Formation

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 for 3 minutes in a $200 \pm 5^\circ\text{C}$ ($392 \pm 9^\circ\text{F}$) oven. 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 prior to all testing. Use mechanical convection type ovens in which air passes the specimens at a velocity of 100 to 200 feet (30 to 60 m) per minute.

4.3.1 Tensile Strength and Elongation

Test three specimens of tubing for tensile strength and elongation in accordance with ASTM D2671. 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 D412. The specimens shall have 1 inch (25 mm) bench marks, centrally located. The testing machine shall have an initial jaw separation of 2 inches (51 mm) for full sections of tubing and 2 inches (51 mm) for die-cut specimens. The rate of jaw separation shall be 2 ± 0.22 inches (51 ± 5.1 mm) per minute.

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 defects and resubmitted for acceptance. Before resubmitting, full particulars concerning previous rejection and action taken to correct the defects shall be furnished to the inspector.

5. PREPARATION FOR DELIVERY

5.1 FORM

The tubing shall be supplied on spools, unless otherwise specified.

5.2 PACKAGING

Packaging shall be in accordance with good commercial practice.

5.3 MARKING

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

**TABLE 1
Tubing Dimensions**

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.
3/64	.046	1.17	.023	0.58	.008	0.20	.012	0.30	.010	0.25
1/16	.063	1.60	.031	0.79	.008	0.20	.012	0.30	.010	0.25
3/32	.093	2.36	.046	1.17	.008	0.20	.012	0.30	.010	0.25
1/8	.125	3.17	.062	1.57	.008	0.20	.012	0.30	.010	0.25
3/16	.187	4.74	.093	2.36	.008	0.20	.012	0.30	.010	0.25
1/4	.250	6.35	.125	3.17	.009	0.23	.015	0.38	.012	0.30
3/8	.375	9.50	.187	4.74	.009	0.23	.015	0.38	.012	0.30
1/2	.500	12.70	.250	6.35	.009	0.23	.015	0.38	.012	0.30
3/4	.750	19.05	.375	9.50	.014	0.36	.020	0.51	.017	0.43
1	1.000	25.40	.500	12.70	.016	0.41	.022	0.56	.019	0.48

**TABLE 2
Mandrel Dimensions for Bend Testing**

Tubing Size	Mandrel Diameter	
	in.	mm.
3/64 to 1/4 inclusive	5/16 ± 0.002	7.9 ± 0.05
3/8 to 1/2 inclusive	3/8 ± 0.003	9.5 ± 0.08
3/4 to 1 inclusive	7/16 ± 0.004	11.1 ± 0.10

TABLE 3
Requirements

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
PHYSICAL			
Dimensions	Inches (<i>mm</i>)	In accordance with Table 1	ASTM D2671
Longitudinal Change	Percent	+0, -10	Note 1
Tensile Strength	psi (<i>MPa</i>)	1500 (<i>10.3</i>) minimum	Section 4.3.1
Ultimate Elongation	Percent	250 minimum	ASTM D2671
Concentricity (Expanded)	Percent	70 minimum	ASTM D2671
Secant Modulus (Expanded)	psi (<i>MPa</i>)	2.5×10^4 (<i>172</i>) maximum	ASTM D2671
Specific Gravity	---	2.0 maximum	ASTM D2671
Low Temperature Flexibility 4 hours at $-70 \pm 2^\circ\text{C}$ ($-94 \pm 4^\circ\text{F}$)	---	No cracking	AMS-DTL-23053, Paragraph 4.6.7.1
Heat Shock 4 hours at $300 \pm 3^\circ\text{C}$ ($482 \pm 5^\circ\text{F}$)	---	No dripping, flowing or cracking	Table 2 ASTM D2671
Heat Resistance 168 hours at $250 \pm 3^\circ\text{C}$ ($437 \pm 5^\circ\text{F}$) Followed by tests for: Tensile Strength Ultimate Elongation	Psi Percent	1200 minimum 200 minimum	Section 4.3.1 ASTM D2671
Vacuum Outgassing TML (Total Mass Loss) VCM (Volatile Condensable Material)	Percent Percent	1.0 Maximum 0.1 Maximum	NASA SP-R-0022A
Clarity Stability 24 hours at $200 \pm 3^\circ\text{C}$ ($392 \pm 5^\circ\text{F}$)	---	Marking legible through tubing wall (Clear only)	AMS-DTL-23053
ELECTRICAL			
Dielectric Strength	Volts/mil (<i>volts/mm</i>)	500 (<i>19,700</i>) minimum	ASTM D2671 Note 2
Volume Resistivity	ohm-cm	10^{13} minimum	ASTM D2671
CHEMICAL			
Copper Mirror Corrosion 16 hours at $175 \pm 2^\circ\text{C}$ ($347 \pm 4^\circ\text{F}$)	---	Non-corrosive	ASTM D2671 Procedure A
Flammability	---	Self-extinguishing within 15 seconds, 25% maximum flag burn	ASTM D2671 Procedure C
Fungus Resistance		Rating of 0	ASTM G21
Water Absorption 24 hours at $23 \pm 3^\circ\text{C}$ ($73 \pm 5^\circ\text{F}$)	Percent	0.1 maximum	ASTM D 2671

TABLE 3
Requirements (continued)

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
Fluid Resistance 24 hours at $24 \pm 3^{\circ}\text{C}$ ($75 \pm 5^{\circ}\text{F}$) in: JP-8 Fuel (MIL-DTL-83133) Hydraulic Fluid (MIL-PRF-5606) Lubricating Oil, (MIL-PRF-23699) Lubricating Oil, (MIL-PRF-7808) Skydrol 500 5% NaCl, A-A-694 De-icing Fluid (AMS 1424) Water Followed by tests for:	---	---	ASTM D 2671
Tensile Strength	psi (<i>MPa</i>)	1200 (8.3) minimum	
Ultimate Elongation	Percent	250	

NOTE 1: Condition the specimens for 3 minutes at $200 \pm 3^{\circ}\text{C}$ ($392 \pm 5^{\circ}\text{F}$) and cool to room temperature before final measurements.

NOTE 2: Recover the specimens on the metal mandrels for 10 minutes, minimum, at $175 \pm 2^{\circ}\text{C}$ ($347 \pm 4^{\circ}\text{F}$) or until the tubing is completely shrunk on the mandrels.