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Raychem

Specification	**RT-375**
This Issue:	Issue 7
Date:	4 February 2004
Replaces:	Issue 6

THERMOFIT® RT-375 TUBING
Fluoropolymer, Semi-Flexible, Clear, Flame Resistant, Heat-Shrinkable

1. SCOPE

This specification covers the requirements for one type of flexible, flame resistant, electrical insulating, extruded tubing whose diameter will reduce to a predetermined size upon the application of heat in excess of 150°C *(302°F)*. The tubing shall be flame resistant and 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

O-S-1926	Sodium Chloride, Technical

Military

MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-T-83133	Turbine Fuel, Aviation, Grade JP-8
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-A-8243	Anti-icing and Deicing - Defrosting Fluid
MIL-L-23699	Lubricating Oil, Aircraft Turbine Engines, Synthetic Base

2.2 OTHER PUBLICATIONS

American Society for Testing and Materials (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 or via the ASTM website at http://www.astm.org).

International Organization for Standardization (ISO)

ISO 846 Plastics – Evaluation of the action of Microorganisms

(Copies of ISO publications may be obtained from the International Organization for Standardization, 1, rue de Varembé, CH-1211 Geneva 20, Switzerland or via the ISO website at http://www.iso.ch/iso/en/ISOOnline.frontpage)

SAE International

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

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 1/4
3/8 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 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 ± 5°C *(392 ± 9°F)* oven. 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 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 Low Temperature Flexibility

For tubing of expanded diameter less than 1/4 inch *(6 mm)*, cut three tubular specimens, 12 inches *(300 mm)* long, from the expanded tubing. For tubing of expanded diameter 1/4 inch *(6 mm)* or greater, cut three strip specimens, 1/4 inch *(6 mm)* wide and 12 inches *(300 mm)* long, from the expanded tubing. Recover the specimens in accordance with Section 4.3 and condition with appropriate mandrels for 4 hours at -55 ± 2°C *(-67 ± 4°F)*. The mandrel diameter shall be 10 times the specimen thickness, ± 10 percent. For tubular specimens, the specimen thickness shall be equivalent to the outside diameter. While at the specified temperature, and without removing the specimens from the cold chamber, wrap the specimens 360° around the mandrel in approximately 2 seconds. Disregard any side cracking, caused by flattening of the specimens on the mandrel.

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*
1-1/2	1.500	*38.10*	.750	*19.05*	.017	*0.43*	.023	*0.58*	.020	*0.51*
2	2.000	*50.80*	1.000	*25.40*	.017	*0.43*	.023	*0.58*	.020	*0.51*

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 2 inclusive	7/16 ± 0.004	11.1 ± 0.10

TABLE 3
Requirements

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
PHYSICAL			
Dimensions	Inches *(mm)*	In accordance with Table 1	ASTM D 2671
Longitudinal Change	Percent	+0, -10	Note 1
Tensile Strength	psi *(MPa)*	3500 *(24.1)* minimum	ASTM D 2671
Ultimate Elongation	Percent	300 minimum	Note 2
Concentricity (Expanded)			ASTM D 2671
Sizes 3/64 through 1	Percent	70 minimum	
Sizes 1-1/2 and 2	Percent	60 minimum	
Secant Modulus (Expanded)	psi *(MPa)*	2.5×10^4 *(172)* minimum	ASTM D 2671
Specific Gravity	---	1.90 maximum	ASTM D 2671
Low Temperature Flexibility 4 hours at -55 ± 2°C *(-67 ± 4°F)*	---	No cracking	Section 4.3.1
Heat Shock 4 hours at 250 ± 3°C *(482 ± 5°F)*	---	No dripping, flowing or cracking	Table 2 ASTM D 2671
Heat Resistance 336 hours at 225 ± 3°C *(437 ± 5°F)* Followed by test for:			ASTM D 2671
Ultimate Elongation	Percent	100 minimum	
Clarity Stability 24 hours at 200 ± 3°C *(392 ± 5°F)*	---	Marking legible through tubing wall	AMS-DTL-23053
ELECTRICAL			
Dielectric Strength	Volts/mil *(volts/mm)*	400 *(15,760)* minimum	ASTM D 2671 Note 3
Volume Resistivity	ohm-cm	10^{11} minimum	ASTM D 2671
CHEMICAL			
Copper Mirror Corrosion 16 hours at 160 ± 2°C *(320 ± 4°F)*	---	Noncorrosive	ASTM D 2671 Procedure A
Copper Contact Corrosion 16 hours at 160 ± 2°C *(320 ± 4°F)*	---	No pitting or blackening of copper	ASTM D 2671 Procedure B
Flammability	---	Self-extinguishing within 1 minute, 25% maximum flag burn	ASTM D 2671 Procedure C
Fungus Resistance			ISO 846 Method B
Followed by tests for:			
Tensile Strength	psi *(Mpa)*	3500 minimum *(24.1)*	Note 2
Ultimate Elongation	percent	300 minimum	ASTM D 2671
Dielectric Strength	Volts per mil *(volts per mm)*	400 minimum *(15,760)*	ASTM D 2671
Water Absorption 24 hours at 23 ± 3°C *(73 ± 5°F)*	Percent	0.5 maximum	ASTM D 2671

TABLE 3
Requirements (continued)

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
Fluid Resistance 24 hours at 50 ± 3°C *(122 ± 5°F)* in: JP-8 Fuel (MIL-T-83133) Hydraulic Fluid (MIL-H-5606) Lubricating Oil, (MIL-L-23699) Lubricating Oil, (MIL-L-7808) 5% NaCl, O-S-1926 De-icing Fluid (MIL-A-8243) Water Followed by tests for:	---	---	ASTM D 2671 Note 4
Tensile Strength	psi *(MPa)*	2000 *(13.8)* minimum	
Ultimate Elongation	Percent	250	
Dielectric Strength	Volts/mil *(volts/mm)*	400 *(15,760)* minimum	

NOTE 1: Condition the specimens for 3 minutes at 200 ± 3°C *(392 ± 5°F)* and cool to room temperature before final measurements.

NOTE 2: Use 1-inch *(25.4-mm)* bench marks, 1-inch *(25.4-mm)* initial jaw separation, and 2 ± .2-inch *(50 ± 5-mm)* jaw separation speed.

NOTE 3: Recover the specimens on the metal mandrels for 10 minutes, minimum, at 175 ± 2°C *(347 ± 4°F)* or until the tubing is completely shrunk on the mandrels.

NOTE 4: To measure the dielectric strength, immerse the recovered specimens in the fluids prior to inserting the mandrels into the wiped and dried specimens.

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