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Raychem Tubing	Specification	**RW-2016**
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Raychem XFFR Zero Halogen Heat Shrinkable Tubing

1. SCOPE

This specification covers the requirements for one type of low fire hazard, electrically insulating, extruded tubing whose diameter will reduce to a predetermined size upon the application of heat in excess of 120°C. It is suitable for use with Hot Melt Adhesive Tape S1030 or Flame-Retardant Mastic Tape S1305.

2. REQUIREMENTS

2.1 **Composition and Appearance**

The tubing shall be fabricated from thermally stabilized, flame-retardant modified polyolefin and shall be irradiation crosslinked. It shall be homogeneous and essentially free from flaws, defects, pinholes, bubbles, seams, cracks and inclusions. It shall contain essentially no halogens.

2.2 **Color**

The tubing color shall be black.

3. PROPERTIES

The tubing shall meet the requirements of Tables 1 and 2.

4. QUALITY ASSURANCE PROVISIONS

4.1 **Classification of Tests**

4.1.1 **Qualification Tests**

Qualification tests are those performed on the tubing submitted for qualification as a satisfactory product and shall consist of all the tests listed in this specification.

4.1 .2 **Production Routine Tests**

Production routine tests shall be carried out on every batch, unless otherwise specified and shall consist of the following: dimensions, longitudinal change, tensile strength, ultimate elongation, low temperature flexibility and flammability.

5. SAMPLING INSTRUCTIONS

5.1 **Qualification Test Samples**

Qualification test samples shall consist of 45 m (150 feet) of tubing. Qualification of size 15 or 20 qualifies all sizes. The color shall be black.

5.2 **Production Routine Test Samples**

Production routine test samples shall consist of a sufficient length to perform all the tests in 4.1.2 selected at random from each batch. A batch shall consist of all tubing of the same size, from the same production run and offered for inspection at the same time. Physical property tests performed at this time qualify subsequent tubing lots produced from the same compound batch.

6. TEST PROCEDURES

Unless otherwise specified the tubing shall be recovered in a forced air circulating oven for 10 minutes at 150 ± 2°C.

6.1 **Dimensions and Longitudinal Change**

The test method shall be as specified in ASTM D 2671.

The length and inside diameter of three 250 mm (10 inch) long specimens of expanded tubing shall be measured**.** The specimens shall be recovered and the length and inside diameter of each shall be measured. The longitudinal change shall be expressed as a percentage of the original length. The minimum and maximum recovered wall thicknesses shall be determined**.**

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6.2 **Tensile Strength and Ultimate Elongation**
The test method shall be as specified in ASTM D 638.
For tubing of recovered inside diameter greater than 6.0 mm (0.236 inch), five Type IV dumbbell specimens shall be tested. For tubing of recovered inside diameter less than or equal to 6.0 mm (0.236 inch), five tubular specimens 150 mm (6 inches) long shall be tested. Rate of jaw separation shall be 500 ± 10 mm (20 ± 0.5 inches) per minute. The test shall be carried out at a temperature of 23 ± 2°C.

6.3 **Halogen Content**
Determine the halogen content (fluorine, chlorine and bromine) of tubing by any suitable elemental analysis technique capable of measuring each halogen to ± 50 ppm or all three halogens together to ± 100 ppm.

7. PREPARATION FOR DELIVERY

7.1 **Form**
The tubing shall be supplied in cut lengths unless otherwise specified.

7.2 Packaging
Packaging shall be in accordance with good commercial practice.

7.3 Marking
Each container of tubing shall be permanently and legibly marked with the size, quantity, manufacturer's identification and batch number**.**

8. 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.

8.1 GOVERNMENT FURNISHED DOCUMENTS

Military

MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-DTL-83133	Turbine Fuel, Aviation, Grade JP-8
MIL-C-24643	Cable and Cords Electrical Low Smoke for Shipboard Use, General Specification
NES 711	Determination of the Smoke Index of the Products of Combustion from Small Specimens of Material
NES 713	Determination of the Toxicity Index of the Products of Combustion from Small Specimens of Material

8.2 OTHER PUBLICATIONS

American Society for Testing and Materials (ASTM)

ASTM D 570	Standard Test Method for Water Absorption
ASTM D 638	Standard Test Methods for Tensile Properties of Plastics
ASTM D 792	Standard Test Methods for Specific Gravity (Relative Density) and Density of Plastic by Displacement
ASTM D 876	Standard Test Methods for Non Rigid Vinyl Chloride Polymer Tubing Used for Electrical Insulation
ASTM D 2671	Standard Methods of Testing Heat-Shrinkable Tubing for Electrical Use

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ASTM D 2863 Test Method for Measuring Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)

(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 Method B 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

SAE-AMS-DTL-23053 Insulating Tubing, Electrical, Heat Shrinkable, General Specification

(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.)

TABLE 1
TUBING DIMENSIONS

	Internal Diameter, mm (inch)		Wall Thickness, mm (inch)
Size	**(Min.) Expanded as Supplied**	**(Max.) Recovered After Heating**	**(Nom.) Recovered After Heating**
-03	7.62 (0.300)	2.54 (0.100)	2.03 (0.080)
-04	10.16 (0.400)	3.81 (0.150)	2.03 (0.080)
-07	19.05 (0.750)	5.59 (0.220)	2.03 (0.080)
-11	27.94 (1.100)	9.53 (0.375)	2.79 (0.110)
-15	38.10 (1.500)	12.70 (0.500)	3.05 (0.120)
-20	50.80 (2.000)	19.05 (0.750)	3.05 (0.120)
-30	76.20 (3.000)	31.75 (1.250)	4.06 (0.160)
-40	101.60 (4.000)	44.45 (1.750)	4.06 (0.160)

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TABLE 2
REQUIREMENTS

PROPERTY	UNIT	XFFR	TEST METHOD
PHYSICAL			
Dimensions	mm (inch)	In accordance with Table 1	Section 6.1 ASTM D 2671
Longitudinal Change	percent	+1, -10	Section 6.1 ASTM D 2671
Tensile Strength	MPa (psi)	9.0 (1,300) minimum	Section 6.2 ASTM D 638
Ultimate Elongation	percent	150 minimum	Section 6.2 ASTM D 638
Specific Gravity		1.5 maximum	ASTM D 792
Low Temperature Flexibility 4 hrs at -55 ± 2°C		No cracking	SAE-AMS-DTL-23053
Heat Resistance 168 hrs at 175 ± 2°C Followed by tests for: Tensile Strength Ultimate Elongation	 MPa (psi) percent	 8.4 (1,200) minimum 100 minimum	 ASTM D 638 ASTM D 638
ELECTRICAL Dielectric Strength	 kV/mm (V/mil)	 10 (250) minimum	 ASTM D 2671 ***Note 1**
Volume Resistivity	ohm-cm	10^{12} minimum	ASTM D 876
CHEMICAL Copper Mirror Corrosion 16 hours at 120 ± 2°C		No removal of copper	SAE-AMS-DTL-23053
Copper Contact Corrosion 16 hrs at 120 ± 2°C		No pitting or blackening of copper	SAE-AMS-DTL-23053
Halogen Content	percent (ppm)	0.1 (1,000) maximum	Section 6.3
Flammability	seconds	15 maximum	ASTM D 2671 Procedure A
Water Absorption 24 hrs at 23 ± 2°C	percent	0.2 maximum	ASTM D 570
Fungus Resistance Followed by tests for: Tensile Strength Ultimate Elongation Dielectric Strength	 MPa (psi) percent kV/mm (V/mil)	 9.0 (1,300) minimum 150 minimum 7.9 (200) minimum	ISO 846 Method B ASTM D 638 ASTM D 638 ASTM D 2671
Fluid Resistance 24 hours at 23 ± 2°C JP-8 Fuel (MIL-DTL-83133) Hydraulic Fluid (MIL-H-5606) Followed by tests for: Tensile Strength Ultimate Elongation	 MPa (psi) percent	 5.0 (720) minimum 100 minimum	SAE-AMS-DTL-23053 ASTM D 638 ASTM D 638
Acid Gas Generation	percent	2 maximum	MIL-C-24643
Smoke Index		25 maximum	NES 711 with Wire Support Screen
Toxicity Index		5 maximum	NES 713
Oxygen Index		30 minimum	ASTM D 2863

***Note 1:** Recover specimens on the metal mandrels for 10 minutes minimum at 200 ± 3°C or until the tubing is completely recovered on the mandrels.

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