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**Raychem
Tubing**

Specification: **RW-2017**
This Issue: Issue 8
Date: November 18, 2014
Replaces: Issue 7

**Raychem BSTS/BSTS-FR Tubing
General Purpose Polyolefin Heat-Shrinkable**

1. SCOPE

This specification covers requirements for two types of electrically insulating, extruded tubing whose diameter will reduce to a predetermined size upon the application of heat in excess of 120°C.

BSTS

BSTS is not flame-retardant. The standard color shall be black, but also available in white, red or clear.

BSTS-FR

BSTS-FR is flame-retardant. The standard color shall be black, but also available in white or red.

2. REQUIREMENTS

2.1 Composition and Appearance

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

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 tubing submitted for qualification as a satisfactory product and shall consist of all tests listed in this specification.

4.1.2 Production Routine

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, heat shock, low temperature flexibility and flammability. Flammability is not applicable to BSTS.

5. SAMPLING INSTRUCTIONS

5.1 Qualification Test Samples

Qualification test samples shall consist of 45 m (150 feet) of tubing. Qualification of one size from 13 to 17 qualifies all sizes. The color shall be black or clear (BSTS only) unless otherwise specified.

5.2 Production Routine Test Samples

Production routine test samples shall consist of a sufficient length to perform the tests listed 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 circulation 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.

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 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 $23 \pm 2^\circ\text{C}$.

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 legibly marked with the size, quantity, manufacturer's identification and batch number.

8. RELATED DOCUMENTS

SAE-AMS-1424	De-icing Fluid
SAE-AMS-DTL-23053	Insulation Tubing, Electrical, Heat Shrinkable, General Specification
MIL-STD-104	Limits for Electrical Insulating Color
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordinance
MIL-PRF-7808	Lubricating Oil
MIL-L-23699	Lubricating Oil
MIL-DTL-83133	Turbine Fuel, Aviation, Grade JP-8
A-A-694	5% NaCl
ASTM D 570	Standard Test Method for Water Absorption
ASTM D 638	Standard Test Methods for Tensile Properties of Plastic
ASTM D 792	Standard Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D 876	Standard Test Methods for Non Rigid Vinyl Chloride Polymer Tubing Used for Electrical Insulation
ASTM D 882	Standard Test Methods for Tensile Properties of Thin Plastic Sheet
ASTM D 2671	Standard Methods of Testing Heat-Shrinkable Tubing for Electrical Use
ISO 846 Method B	Plastics – Evaluation of the Action of Microorganisms

TABLE 1 TUBING DIMENSIONS for BSTS and BSTS-FR			
Size	Internal Diameter, mm (inch)		Wall Thickness Nom., mm (inch)
	Minimum Expanded D	Maximum Recovered D	Recovered W
-03	7.62 (0.300)	2.54 (0.100)	1.78 (0.070)
-04	10.16 (0.400)	3.81 (0.150)	1.78 (0.070)
-07	19.05 (0.750)	5.59 (0.220)	2.54 (0.100)
-11	27.94 (1.100)	9.53 (0.375)	3.05 (0.120)
-13	33.02 (1.300)	9.65 (0.380)	3.05 (0.120)
-15	38.10 (1.500)	12.70 (0.500)	3.56 (0.140)
-17	43.18 (1.700)	12.70 (0.500)	3.56 (0.140)
-20	50.80 (2.000)	19.05 (0.750)	4.06 (0.160)
-27	68.58 (2.700)	22.86 (0.900)	4.06 (0.160)
-30	76.20 (3.000)	31.75 (1.250)	4.06 (0.160)
-35	88.90 (3.500)	31.75 (1.250)	4.06 (0.160)
-40	101.60 (4.000)	44.45 (1.750)	4.06 (0.160)
-45	114.30 (4.500)	44.45 (1.750)	4.06 (0.160)

TABLE 2
REQUIREMENTS

PROPERTY	UNIT	BSTS	BSTS -FR	TEST METHOD
PHYSICAL				
Dimensions	mm (inch)	In accordance with Table 1	In accordance with Table 1	Section 6.1 ASTM D 2671
Longitudinal Change	percent	+1, - 10	+1, -10	Section 6.1 ASTM D 2671
Tensile Strength	MPa (psi)	8.4 (1,200) minimum	8.4 (1,200) minimum	Section 6.2 ASTM D 638
Ultimate Elongation	percent	300 minimum	200 minimum	Section 6.2 ASTM D 638
2% Secant Modulus (Expanded)	MPa (psi)	N/A	172.4 (25,000) maximum	ASTM D 882
Specific Gravity		1.1 maximum	1.5 maximum	ASTM D 792
Low Temperature Flexibility 4 hours at -55 ± 2°C		No cracking	No cracking	SAE-AMS-DTL-23053
Heat Shock 4 hours at 225 ± 3°C		No dripping, flowing or cracking	No dripping, flowing or cracking	SAE-AMS-DTL-23053
Heat Resistance 168 hrs at 175 ± 2°C Followed by tests for: Tensile Strength Ultimate Elongation	MPa (psi) percent	7.0 (1,000) minimum 100 minimum	7.0 (1,000) minimum 100 minimum	ASTM D 638 ASTM D 638
ELECTRICAL				
Dielectric Strength	kV/mm (V/mil)	7.9 (200) minimum	7.9 (200) minimum	ASTM D 2671 *Note 1
Volume Resistivity	ohm-cm	10 ¹³ minimum	10 ¹³ minimum	ASTM D 876
CHEMICAL				
Copper Mirror Corrosion 16 hours at 120 ± 2°C		No removal of copper	No removal of copper	SAE-AMS-DTL-23053
Copper Contact Corrosion 16 hours at 120 ± 2°C		No pitting or blackening of copper	No pitting or blackening of copper	SAE-AMS-DTL-23053
Flammability	seconds	N/A	60 maximum	SAE-AMS-DTL-23053 (ASTM D 2671 Procedure C)
Water Absorption 24 hours at 23 ± 2°C	percent	0.5 maximum	0.5 maximum	ASTM D 570
Fungus Resistance Followed by tests for: Tensile Strength Ultimate Elongation Dielectric Strength	MPa (psi) percent kV/mm (V/mil)	8.4 (1,200) minimum 300 minimum 7.9 (200) minimum	8.4 (1,200) minimum 200 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) De-icing Fluid (SAE-AMS- 1424) Lube Oil (MIL-PRF-7808) Lube Oil (MIL-L-23699) 5% NaCl (A-A-694) Followed by tests for: Tensile Strength Ultimate Elongation Dielectric Strength	MPa (psi) percent kV/mm (V/mil)	5.2 (750) minimum 100 minimum 7.9 (200) minimum	5.2 (750) minimum 100 minimum 7.9 (200) minimum	SAE-AMS-DTL-23053 ASTM D 638 ASTM D 638 ASTM D 2671 *Note 2
*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.				
*Note 2: For dielectric strength, immerse the recovered specimens in the fluids for 24 hours at 50 ± 2°C. After drying, place the specimens over closest fitting metal mandrels.				