



BSTS/BSTS-FR Tubing Specification

108-120034 (Formerly RW-2017)

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

BSTS/BSTS-FR is a thick wall, general purpose, heat-shrinkable tubing. It is available in both flame-retardant and non-flame-retardant materials. Its thick wall provides excellent insulation and abrasion protection, while it still maintains its excellent electrical properties. It is composed of a rugged polymer that has resistance to moisture, fungus, and weathering.

BSTS/BSTS-FR is approved by the American Bureau of Shipping (ABS) and Lloyd's Register of Shipping.

RoHS compliant.

Continuous operating temperature -55 to 110°C (-67 to 230°F).

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1. SCOPE

This specification covers the requirements for two types of electrical insulating, extruded tubing whose diameter will reduce to a predetermined size upon the application of heat in excess of 120°C (248°F).

1.1. FORM

BSTS-FR: The tubing shall be flame retarded and shall be black, but also available in white or red.

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

2. APPLICABLE DOCUMENTS

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

2.1. AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM)

ASTM D570	Standard Test Method for Water Absorption
ASTM G638	Standard Test Method for Tensile Properties of Plastic
ASTM D792	Standard Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D876	Standard Test Methods for Non-Rigid Vinyl Chloride Polymer Tubing Used for Electrical Insulation
ASTM D882	Standard Test Method for Tensile Properties of Thin Plastic Sheet
ASTM D2671	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>).

2.2. 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>)

2.3. MILITARY DOCUMENTS

MIL-DTL-83133	JP-8 turbine fuel (NATO type F-34)
MIL-PRF-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-STD-104	Limits for Electrical Insulation Color
MIL-PRF-7808	Lubricating Oil
MIL-PRF-23699	Lubricating Oil



(Copies of Military documents are available online at <http://quicksearch.dla.mil>.)

2.4. OTHER DOCUMENTS

BSTS/BSTS-FR SCD
SAE-AMS-1424
SAE-AS23053™

A-A-694

BSTS/BSTS-FR Tubing SCD
De-Icing Fluid
Insulation Tubing, Electrical, Heat Shrinkable, General
Specification
SODIUM CHLORIDE, TECHNICAL - 5% NaCl

3. REQUIREMENTS

3.1. MATERIALS

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

3.2. PROPERTIES

The tubing shall meet the requirements of Table 1.

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. Qualification test samples shall consist of 50 m (150 feet) of tubing.

4.1.2. Acceptance Tests

Full acceptance tests shall be carried out on tubing produced from every new batch of compound, unless otherwise specified and shall consist of the following: Dimensions, Longitudinal Change, Tensile Strength, Ultimate Elongation, Heat Shock, Secant Modulus, Low temperature flexibility, Flammability (BSTS-FR only). Statistical process control data may be used to demonstrate conformance for dimensions. Physical property tests performed at this time qualify subsequent tubing lots produced from the same compound batch. For subsequent tubing lots produced from the same compound batch, Dimensions and longitudinal change shall be measured.



4.2. SAMPLING INSTRUCTIONS

4.2.1. Qualification Test Samples

Qualification test samples shall consist of 150 feet (50 m) of tubing. Qualification of one size from 13 to 17 qualifies all sizes for non-FR version. For FR version, qualification of size 7 and one size from 13 to 17 qualifies all sizes. The color shall be black and clear (BSTS only) unless otherwise specified.

For the following property tests (Applicable for Trutnov): Color stability, Specific gravity, Fungus resistance, and Volume resistivity, size 7 shall qualify all sizes for FR version.

Note: For Ottobrunn, any one size from size 17 to 45 will qualify all sizes for FR and non-FR version.

4.2.2. Acceptance Test Samples

Acceptance test samples shall consist of a sufficient length to perform the tests listed in 4.1.2. selected at random from each 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

Dimensions can be found in BSTS/BSTS-FR SCD or the specific drawing for the numbered size.

Unless otherwise specified the tubing shall be recovered in a forced air circulation oven for 10-min at $150 \pm 2^\circ\text{C}$

4.3.1. Dimensions and Longitudinal Change

The test method shall be as specified in ASTM D2671. 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.

Calculate the longitudinal change as follows:

$$LC = \frac{(L_1 - L_0)}{L_0} \times 100$$

Where: LC = Longitudinal Change [percent]
L₀ = Length Before Conditioning [inches (mm)]
L₁ = Length After Conditioning [inches (mm)]



4.3.2. 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 $23 \pm 2^{\circ}\text{C}$.

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 Quality.

5. PREPARATION FOR DELIVERY

5.1. FORM

5.1.1. The tubing shall be supplied in cut lengths unless otherwise specified.

5.2. PACKAGING

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

5.3. MARKING

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



APPENDIX

**TABLE 1
REQUIREMENTS**

PROPERTY	UNIT	BSTS	BSTS -FR	TEST METHOD
PHYSICAL Dimensions	mm (inch)	In accordance with BSTS-BSTS/FR SCD	In accordance with BSTS-BSTS/FR SCD	Section 4.3.1 ASTM D 2671
Longitudinal Change	percent	+1, - 10	+1, -10	Section 4.3.1 ASTM D 2671
Tensile Strength	MPa (psi)	8.4 (1,200) minimum	8.4 (1,200) minimum	Section 4.3.2 ASTM D 638
Ultimate Elongation	percent	300 minimum	200 minimum	Section 4.3.2 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 AS23053™
Heat Shock 4 hours at 225 ± 3°C		No dripping, flowing or cracking	No dripping, flowing or cracking	SAE AS23053™
Heat Resistance 168 hrs at 175 ± 2°C Followed by tests for: Tensile Strength	MPa (psi)	7.0 (1,000) minimum	7.0 (1,000) minimum	ASTM D 638
Ultimate Elongation	percent	100 minimum	100 minimum	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 AS23053™
Copper Contact Corrosion 16 hours at 120 ± 2°C		No pitting or blackening of copper	No pitting or blackening of copper	SAE AS23053™
Flammability	seconds	N/A	60 maximum	SAE AS23053™ (ASTM D 2671 Procedure C)
Water Absorption 24 hours at 23 ± 2°C	percent	0.5 maximum	0.5 maximum	ASTM D 570

Requirements are continued on next page.



TABLE 2
REQUIREMENTS (continued)

PROPERTY	UNIT	BSTS	BSTS -FR	TEST METHOD
CHEMICAL (continued) Fungus Resistance Followed by tests for: Tensile Strength	MPa (psi)	8.4 (1,200) minimum	8.4 (1,200) minimum	ISO 846 Method B ASTM D 638
Ultimate Elongation	percent	300 minimum	200 minimum	ASTM D 638
Dielectric Strength	kV/mm (V/mil)	7.9 (200) minimum	7.9 (200) minimum	ASTM D 2671
Fluid Resistance 24 hours at 23 ± 2°C JP-8 Fuel (MIL-DTL-83133) Hydraulic Fluid (MIL-PRF-5606) De-icing Fluid (SAE-AMS-1424) Lube Oil (MIL-PRF-7808) Lube Oil (MIL-PRF-23699) 5% NaCl (A-A-694) Followed by tests for: Tensile Strength	MPa (psi)	5.2 (750) minimum	5.2 (750) minimum	SAE AS23053™ ASTM D 638
Ultimate Elongation	percent	100 minimum	100 minimum	ASTM D 638
Dielectric Strength	kV/mm (V/mil)	7.9 (200) minimum	7.9 (200) minimum	ASTM D 2671 *Note 2
<p>*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.</p> <p>*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.</p>				