



Raychem HF Tubing Specification

Formerly RW-2023

108-120060

Raychem HF Tubing Highly Flexible Heat Shrinkable

HF is a high flex, heavy wall, heat-shrinkable tubing. HF is an excellent insulator, and provides abrasion protection. Its flexibility makes it well suited for cable jacketing applications where sharp bends or turns are required.

HF can be used in situations where the cable is subject to motion. Such situations include applications in transportation equipment, robotics, and industrial machinery. In addition, HF is flame retardant, and can be used with sealant or adhesive for protection against water and corrosion.

It is approved by the American Bureau of Shipping (ABS) and Lloyd's Register of Shipping.

RoHS compliant.

Continuous operating temperature -55 to 90°C (-67 to 194°F).

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1. SCOPE

This specification covers the requirements for one type of highly flexible, flame retardant, 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 /97 (Tape S1297) or Flame Retardant Mastic Tape S1305.

1.1. FORM

The tubing shall be flame retarded and shall be black.

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 D2671	Standard Methods of Testing Heat-Shrinkable Tubing for Electrical Use
ASTM D882	Standard Test Methods of Tensile Properties of Thin Plastic Sheeting
ASTM D876	Standard Test Methods for Non-Rigid Vinyl Chloride Polymer Tubing Used for Electrical Insulation
ASTM D638	Standard Test Methods for Tensile Properties of Plastic
ASTM D570	Standard Test Method for Water Absorption
ASTM D792	Standard Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement

(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-A-8243	De-icing Fluid
MIL-T-83133	JP-8 turbine fuel (NATO type F-34)
MIL-PRF-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-PRF-7808	Lubricating Oil
MIL-PRF-23699	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base

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



2.4. OTHER DOCUMENTS

HF SCD	HF Tubing SCD
A-A-694	5% NaCl
AS23053™	SAE - Insulation Sleeving, Electrical, Heat Shrinkable, General Specification

3. REQUIREMENTS

3.1. MATERIALS

The tubing shall be fabricated from thermally stabilized, modified flexible 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.

4.1.2. Acceptance Tests

Acceptance tests are those performed on tubing submitted for acceptance under contract. Acceptance tests shall be:

Dimensions
Longitudinal Change
Tensile Strength
Ultimate Elongation
Low Temperature Flexibility
Flammability
Heat Shock

Statistical process control data may be used to demonstrate conformance for dimensions. Acceptance tests shall consist of:

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 shall qualify all sizes. The color shall be black.



4.2.2. Acceptance Test Samples

Acceptance test samples shall consist of a sufficient length to perform all the tests in 4.4.1. 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

Dimensions can be found in HF 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 minutes at $150 \pm 2^\circ\text{C}$.

4.3.1. Dimensions and Longitudinal Change

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

The length and inside diameter of three 250 mm 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:

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

Where: LC = Longitudinal Change [percent]

L_0 = Length Before Conditioning [inches (mm)]

L_1 = 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 mm, five Type IV dumbbell specimens shall be tested. For tubing of recovered inside diameter less than or equal to 6 mm, five tubular specimens 150 mm long shall be tested. Rate of jaw separation shall be 500 ± 10 mm 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	HF	TEST METHOD
PHYSICAL Dimensions	mm (in.)	In accordance with HF SCD	Section 4.3.1 ASTM D 2671
Longitudinal Change	Percent	+1, - 10	Section 4.3.1 ASTM D 2671
Tensile Strength	MPa	8.4 Min.	Section 4.3.2 ASTM D 638
Ultimate Elongation	Percent	200 Min.	Section 4.3.2 ASTM D 638
Secant Modulus (Expanded)	MPa	105 Max.	ASTM D 882
Specific Gravity		1.4 Max.	ASTM D 792
Low Temperature Flexibility 4 hours at $-55 \pm 2^{\circ}\text{C}$		No Cracking	AS23053™
Heat Shock 4 hours at $225 \pm 3^{\circ}\text{C}$		No dripping, flowing or cracking	AS23053™
Heat Resistance 168 hrs at $175 \pm 2^{\circ}\text{C}$ Tensile Strength Ultimate Elongation	MPa Percent	7 Min. 100 Min.	ASTM D 638 ASTM D 638

Requirements are continued on next page.

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TABLE 2
REQUIREMENTS (continued)

PROPERTY	UNIT	HF	TEST METHOD
ELECTRICAL			
Dielectric Strength	KV/mm	7.9 Min.	ASTM D 2671 *Note 1
Volume Resistivity	Ohm-cm	10 ¹³ Min.	ASTM D 876
CHEMICAL			
Copper Mirror Corrosion 16 hours at 121 ± 2°C		No removal of copper	AS23053™
Copper Contact Corrosion 16 hours at 121 ± 2° C		No pitting or blackening of copper	AS23053™
Flammability	Seconds	15 Max.	AS23053™ Procedure B ASTM D 2671
Fungus Resistance Followed by tests for Tensile Strength Ultimate Elongation Dielectric Strength	MPa Percent KV/mm	8.4 Min. 200 Min. 7.9 Min.	ISO 846 Method B ASTM D 638 ASTM D 638 ASTM D 2671
Water Absorption 24 hours at 23 ± 2°C	Percent	0.5 Max	ASTM D 570
Fluid Resistance 24 hours at 23 ± 2°C JP-8 Fuel (MIL-DTL-83133) Hydraulic Fluid (MIL-H-5606) De-icing Fluid (MIL-A-8243) Lube Oil (MIL-PRF-7808) Lube Oil (MIL-L-23699) 5% NaCl (A-A-694) Followed by tests for Tensile Strength	MPa	5 Min.	AS23053™ ASTM D 638
Ultimate Elongation	Percent	100 Min.	ASTM D 638
Dielectric Strength	KV/mm	7.9 Min.	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>			