



Tyco Electronics Corporation
305 Constitution Drive
Menlo Park, CA 94025 USA

Raychem

Specification
This Issue:
Date:
Replaces:

RW-2023
Issue 6
December 22, 2006
Issue 5

**Raychem HF Tubing
Highly Flexible Heat Shrinkable**

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 or adhesive lined) or Flame Retardant Mastic Tape S1305.

2. REQUIREMENTS

2.1 Composition and Appearance

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

2.2 Color

The tubing shall be black unless otherwise specified.

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.

4.2 Production Routine Tests

Production Routine Tests shall be performed 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.

5. SAMPLING INSTRUCTIONS

5.1 Qualification Test Samples

Qualification test samples shall consist of 50 feet (15m) of tubing. Qualification of any size 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 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 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 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 $23 \pm 2^\circ\text{C}$.

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. **RELATED DOCUMENTS**

MIL-A-8243	De-icing Fluid
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-DTL-83133	Turbine Fuel, Aviation, Grade JP-8
MIL-PRF-7808	Lubricating Oil
MIL-L-23699	Lubricating Oil
A-A-694	5% NaCl
SAE-AMS-DTL-23053	Insulation Tubing, Electrical, Heat Shrinkable, General Specification
ASTM D 2671	Standard Methods of Testing Heat Shrinkable Tubing for Electrical Use
ASTM D 882	Standard Test Methods for Tensile Properties of Thin Plastic Sheeting
ASTM D 876	Standard Test Methods for Non Rigid Vinyl Chloride Polymer Tubing Used for Electrical Insulation
ASTM D 638	Standard Test Methods for Tensile Properties of Plastic
ASTM D 570	Standard Test Method for Water Absorption
ASTM D 792	Standard Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement
ISO 846 Method B	Plastics – Evaluation of the Action of Microorganisms

**TABLE 1
TUBING DIMENSIONS**

Part Number	Internal Diameter, mm		Wall Thickness (Nom.), mm
	(Min.) Expanded as Supplied	(Max.) Recovered After Heating	Recovered
HF-04	10.1 (0.400)	3.8 (0.150)	1.8 (0.070)
HF-07	19.0 (0.750)	5.6 (0.220)	1.8 (0.070)
HF-11	27.9 (1.100)	9.5 (0.375)	2.7 (0.105)
HF-13	33.0 (1.300)	9.5 (0.375)	2.7 (0.105)
HF-15	38.1 (1.500)	12.7 (0.500)	3.0 (0.120)
HF-17	43.1 (1.700)	12.7 (0.500)	3.0 (0.120)
HF-20	50.8 (2.000)	19.1 (0.750)	3.6 (0.140)
HF-27	68.5 (2.700)	22.9 (0.900)	3.9 (0.155)

() Inches

TABLE 2
REQUIREMENTS

PROPERTY	UNIT	HF	TEST METHOD
PHYSICAL			
Dimensions	mm (in.)	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	8.4 Min.	Section 6.2 ASTM D 638
Ultimate Elongation	Percent	200 Min.	Section 6.2 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 ± 2°C		No Cracking	SAE-AMS-DTL-23053
Heat Shock 4 hours at 225 ± 3°C		No dripping, flowing or cracking	SAE-AMS-DTL-23053
Heat Resistance 168 hrs at 175 ± 2°C			
Tensile Strength	MPa	7 Min.	ASTM D 638
Ultimate Elongation	Percent	100 Min.	ASTM D 638
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	SAE-AMS-DTL-23053
Copper Contact Corrosion 16 hours at 121 ± 2°C		No pitting or blackening of copper	SAE-AMS-DTL-23053
Flammability	Seconds	15 Max.	SAE-AMS-DTL-23053 Procedure B ASTM D 2671
Fungus Resistance Followed by tests for			ISO 846 Method B
Tensile Strength	MPa	8.4 Min.	ASTM D 638
Ultimate Elongation	Percent	200 Min.	ASTM D 638
Dielectric Strength	KV/mm	7.9 Min.	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			SAE-AMS-DTL-23053
Tensile Strength	MPa	5 Min.	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>			