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Raychem  
Tubing

Specification  
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## **Raychem HRHF, HRNF, and HRSR High Shrink Ratio Heat Shrinkable Tubing**

### **1. SCOPE**

This specification covers the requirements for three types of electrically insulating, extruded tubing whose diameter will reduce to a predetermined size upon the application of heat in excess of 120°C. They are suitable for use with Hot Melt Adhesive /97 or Sealant /226.

#### **1.1 HRSR.**

HRSR tubing is a semi rigid, flame retardant, cross-linked modified polyolefin. The standard color is black and can be supplied with a Sealant or Hot Melt Adhesive.

#### **1.2 HRHF**

HRHF tubing is a highly flexible, flame retardant cross-linked modified polyolefin. The standard color is black (and clear for non-flame retardant material) and can be supplied with a Sealant or Hot Melt Adhesive.

#### **1.3 HRNF**

HRNF tubing is a semi rigid, non-flame retarded, cross-linked modified polyolefin. The standard color is black and can be supplied with a Sealant or Hot Melt Adhesive.

### **2. REQUIREMENTS**

#### **2.1 Composition and Appearance**

The tubing shall be fabricated from thermally stabilized, modified polyolefin and shall be irradiation cross-linked. 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 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, heat shock, low temperature flexibility and flammability. Flammability is not applicable for HRNF and clear tubings.

### **5. SAMPLING INSTRUCTIONS**

#### **5.1 Qualification Test Sample**

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 circulating oven for 10 minutes at  $150 \pm 2^\circ\text{C}$ . All tests shall be performed without the adhesive. Uncoated samples are available upon request.

**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  $500 \pm 10$  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**

|                   |                                                                                                      |
|-------------------|------------------------------------------------------------------------------------------------------|
| A-A-694           | 5% NaCl                                                                                              |
| 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 Method 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 Sheeting                                |
| ASTM D 2671       | Standard Test Methods for Heat-Shrinkable Tubing for Electrical Use                                  |
| ISO 846 Method B  | Plastics – Evaluation of the Action of Microorganisms                                                |
| MIL-H-5606        | Hydraulic Fluid Petroleum Base, Aircraft, Missile and Ordnance                                       |
| MIL-PRF-7808      | Lubricating Oil                                                                                      |
| MIL-A-8243        | De-icing Fluids                                                                                      |
| MIL-L-23699       | Lubricating Oil                                                                                      |
| MIL-DTL-83133     | Turbine Fuel, Aviation, Grade JP-8                                                                   |
| SAE-AMS-DTL-23053 | Insulating Tubing, Electrical, Heat Shrinkable, General Specification                                |

| <b>Table 1</b>                  |                                    |                                       |                                       |
|---------------------------------|------------------------------------|---------------------------------------|---------------------------------------|
| <b><u>Tubing Dimensions</u></b> |                                    |                                       |                                       |
| <b>Part Number</b>              | <b>Internal Diameter, mm</b>       |                                       | <b>Wall Thickness, mm</b>             |
|                                 | <b>(Min.) Expanded as Supplied</b> | <b>(Max.) Recovered After Heating</b> | <b>(Nom.) Recovered After Heating</b> |
| HR**060                         | 15.24 (0.600)                      | 3.81 (0.150)                          | 1.52 ( 0.060)                         |
| HR**125                         | 31.75 (1.250)                      | 6.10 (0.240)                          | 1.52 (0.060)                          |
| HR**175                         | 44.45 (1.750)                      | 8.00 (0.315)                          | 2.41 (0.095)                          |
| HR**200                         | 50.80 (2.000)                      | 9.53 (0.375)                          | 2.67 (0.105)                          |
| HR**250                         | 63.50 (2.500)                      | 12.70 (0.500)                         | 3.05 (0.120)                          |
| HR**300                         | 76.20 (3.000)                      | 19.05 (0.750)                         | 3.05 (0.120)                          |
| HR**400                         | 101.60 (4.000)                     | 22.86 (0.900)                         | 3.56 (0.140)                          |

**\*\*NF, HF or SR ( ) Inches**

**TABLE 2**  
**REQUIREMENTS**

| PROPERTY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | UNIT                    | HRNF                               | HRHF                                     | HRSR                               | TEST METHOD                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|------------------------------------|------------------------------------------|------------------------------------|--------------------------------------------------------------------------------------------------------|
| <b>PHYSICAL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                         |                                    |                                          |                                    |                                                                                                        |
| Dimensions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | mm (in.)                | In accordance with Table 1         | In accordance with Table 1               | In accordance with Table 1         | Section 6.1<br>ASTM D 2671                                                                             |
| Longitudinal Change                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Percent                 | +1, -10                            | +1, -10                                  | +1, -10                            | Section 6.1<br>ASTM D 2671                                                                             |
| Tensile Strength                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | MPa                     | 8.4 Min.                           | 8.4 Min.                                 | 8.4 Min.                           | Section 6.2<br>ASTM D 638                                                                              |
| Ultimate Elongation                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Percent                 | 200 Min.                           | 200 Min.                                 | 200 Min.                           | Section 6.2<br>ASTM D 638                                                                              |
| Secant Modulus (Expanded)                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | MPa                     | 150 Max.                           | 120 Max.                                 | 220 Max.                           | ASTM D 882                                                                                             |
| Specific Gravity                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                         | 1.5 Max.                           | 1.4 Max.                                 | 1.5 Max.                           | ASTM D 792                                                                                             |
| Low Temperature Flexibility<br>4 hours at $-55 \pm 2^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                         |                         | No cracking                        | No cracking                              | No cracking                        | SAE-AMS-DTL-23053                                                                                      |
| Heat Shock<br>4 hours at $225 \pm 3^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                          |                         | No dripping, flowing or cracking   | No dripping, flowing or cracking         | No dripping, flowing or cracking   | SAE-AMS-DTL-23053                                                                                      |
| Heat Resistance<br>168 hrs at $175 \pm 2^{\circ}\text{C}$ for HRHF-BK/HRSR<br>168 hrs at $150 \pm 2^{\circ}\text{C}$ for HRNF/HRHF-CL<br>Followed by tests for Tensile Strength<br>Ultimate Elongation                                                                                                                                                                                                                                                                                        | MPa<br>Percent          | 7.0 Min.<br>300 Min.               | 7.0 Min.<br>100 Min.                     | 7.0 Min.<br>100 Min.               | ASTM D 638<br>ASTM D 638                                                                               |
| <b>ELECTRICAL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                         |                                    |                                          |                                    |                                                                                                        |
| Dielectric Strength                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | KV/mm                   | 7.9 Min.                           | 7.9 Min.                                 | 7.9 Min.                           | ASTM D 2671<br><b>*Note 1</b>                                                                          |
| Volume Resistivity                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Ohm-cm                  | $10^{13}$ Min.                     | $10^{13}$ Min.                           | $10^{13}$ Min.                     | ASTM D 876                                                                                             |
| <b>CHEMICAL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                         |                                    |                                          |                                    |                                                                                                        |
| Copper Mirror Corrosion<br>16 hours at $120 \pm 2^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                            |                         | No removal of copper               | No removal of copper                     | No removal of copper               | SAE-AMS-DTL-23053                                                                                      |
| Copper Contact Corrosion<br>16 hours at $120 \pm 2^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                           |                         | No pitting or blackening of copper | No pitting or blackening of copper       | No pitting or blackening of copper | SAE-AMS-DTL-23053                                                                                      |
| Flammability                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Seconds                 | N/A                                | Procedure B<br>15 Max.<br><b>*Note 3</b> | Procedure C<br>60 Max.             | SAE-AMS-DTL-23053 ASTM D2671                                                                           |
| Fungus Resistance<br>Followed by tests for Tensile Strength<br>Ultimate Elongation<br>Dielectric Strength                                                                                                                                                                                                                                                                                                                                                                                     | MPa<br>Percent<br>KV/mm | 8.4 Min.<br>200 Min.<br>7.9 Min.   | 8.4 Min.<br>200 Min.<br>7.9 Min.         | 8.4 Min.<br>200 Min.<br>7.9 Min.   | ISO 846 Method B<br>ASTM D 638<br>ASTM D 638<br>ASTM D 2671                                            |
| Water Absorption<br>24 hours at $23 \pm 2^{\circ}\text{C}$                                                                                                                                                                                                                                                                                                                                                                                                                                    | Percent                 | 0.5 Max.                           | 0.5 Max.                                 | 0.5 Max.                           | ASTM D 570                                                                                             |
| Fluid Resistance 24 hours at $23 \pm 2^{\circ}\text{C}$<br>JP-8 Fuel (MIL-DTL-83133)<br>Hydraulic Fluid (MIL-H-5606)<br>De-icing Fluid (MIL-A-8243)<br>Lube Oil (MIL-PRF-7808)<br>Lube Oil (MIL-L-23699)<br>5% NaCl (A-A-694)<br>Followed by tests for Tensile Strength<br>Ultimate Elongation<br>Dielectric Strength                                                                                                                                                                         | MPa<br>Percent<br>KV/mm | 5.2 Min.<br>100 Min.<br>7.9 Min.   | 5.2 Min.<br>100 Min.<br>7.9 Min.         | 5.2 Min.<br>100 Min.<br>7.9 Min.   | SAE-AMS-DTL-23053<br><br><br><br><br><br><br>ASTM D 638<br>ASTM D 638<br>ASTM D 2671<br><b>*Note 2</b> |
| <p><b>*Note 1</b> Recover specimens on the metal mandrels for 10 minutes, minimum, at <math>200 \pm 3^{\circ}\text{C}</math> or until the tubing is completely recovered on the mandrels.</p> <p><b>*Note 2</b> For dielectric strength, immerse the recovered specimens in the fluids for 24 hours at <math>50 \pm 2^{\circ}\text{C}</math>. After drying, place the specimens over closest fitting metal mandrels.</p> <p><b>*Note 3</b> N/A for HRHF-CL, which is non-flame retardant.</p> |                         |                                    |                                          |                                    |                                                                                                        |