



**RW-2058 Revision 4**

**Raychem brand ZHTM Sleeving**

**SCOPE**

**This Quality Assurance Specification establishes the quality standard for a flexible, electrically insulating, low hazard, flame retarded sleeving which will recover to a predetermined size on the application of heat in excess of 120°C.**

**Approved Signatories\***

**Tyco Electronics :                      Approved electronically via DMTech**

**\* This document is electronically reviewed and approved - therefore no signatures will appear.**

**1. REVISION HISTORY**

| Revision Number | Change Request            | Date                            | Incorporated By         |
|-----------------|---------------------------|---------------------------------|-------------------------|
| 0               | Formerly RK6155 Revn 4    |                                 |                         |
| 1               | CRF T1020<br>CR-98-DM0144 | 27 August 1997<br>3 August 1998 | C. Woosnam<br>L. Abrams |
| 2               | CR04-DM-0027              | 5 February 2004                 | Linda Abrams            |
| 3               | CR07-DM-069               | 1 May 2007                      | Paul Dixon              |
| 4               | CR10-DM-009               | 3 August 2010                   | Paul Dixon              |

**2. REQUIREMENTS****2.1 Composition, Appearance and Colour**

The sleeving shall be homogeneous and essentially free from pinholes, bubbles, flaws, cracks and inclusions. The standard colour shall be black unless otherwise specified.

**2.2 Dimensions**

| Size  | Inside Diameter as supplied (min)<br>mm | Inside Diameter after recovery (max)<br>mm | Wall Thickness after recovery<br>mm |
|-------|---|--|-------------------------------------|
| 3/1.5 | 3.0                                     | 1.5  | 0.70 ± 0.10                         |
| 5/2.5 | 5.0                                     | 2.5  | 0.75 ± 0.12                         |
| 8/4   | 8.0                                     | 4.0  | 0.80 ± 0.15                         |
| 12/6  | 12.0                                    | 6.0  | 0.90 ± 0.15                         |
| 18/9  | 18.0                                    | 9.0  | 1.00 ± 0.18                         |
| 24/12 | 24.0                                    | 12.0                                       | 1.10 ± 0.20                         |
| 40/20 | 40.0                                    | 20.0                                       | 1.30 ± 0.23                         |
| 50/30 | 50.0                                    | 30.0                                       | 1.50 ± 0.28                         |

Sleeving of special expanded or recovered dimensions may be supplied as specified in the contract or order.

**2.3 Test Requirements**

The test requirements shall be as specified in Table 1.

### 3. TEST METHODS

#### 3.1 Preparation of Test Specimens

Unless otherwise specified, tests shall be carried out on specimens of sleeving recovered by conditioning in a fan assisted air circulating oven at  $150 \pm 5^\circ\text{C}$  for  $6 \pm 1$  minutes and allowed to cool in air to ambient temperature. No pre-conditioning period is required prior to testing. Unless otherwise specified, all tests shall be made under standard ambient conditions according to IEC Publication 60212. In cases of dispute the tests shall be carried out at a temperature of  $23 \pm 2^\circ\text{C}$  and at  $50 \pm 5\%$  relative humidity.

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#### 3.2 Dimensions and Longitudinal Change

The test method shall be as specified in ASTM D2671. The length and inside diameter of three 150mm long specimens of expanded sleeving shall be measured. The specimens shall be recovered in a fan assisted air circulating oven 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 thickness shall be determined.

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#### 3.3 Tensile Strength and Ultimate Elongation

The test method shall be as specified in ISO 37. For sleeving of recovered bore 6mm and greater as specified, five Type 2 dumb-bell specimens shall be tested. For sleeving of recovered bore smaller than 6mm as specified, five tubular specimens 125mm long shall be tested. Initial jaw separation shall be 50 mm and rate of jaw separation shall be  $100 \pm 10$ mm per minute. The test shall be carried out at a temperature of  $23 \pm 2^\circ\text{C}$ .

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#### 3.4 Secant Modulus at 2% Strain

The test method shall be as specified in Method A of ASTM D882. For sleeving of recovered bore greater than 6mm, five strip specimens 150mm long shall be tested. For sleeving of recovered bore less than or equal to 6mm five tubular specimens 150mm long shall be tested. Initial jaw separation shall be 100mm and rate of jaw separation  $10 \pm 1$ mm per minute. The test shall be carried out at a temperature of  $23 \pm 2^\circ\text{C}$ .

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#### 3.5 Specific Gravity

The test method shall be as specified in Method A of ISO 1183.

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#### 3.6 Heat Shock

The test method shall be as specified in ASTM D2671. The specimens shall be conditioned in a fan assisted air circulating oven as specified in Table 1.

**TEST METHODS (Cont'd)****3.7 Heat Ageing**

The test method shall be as specified in ISO 188.

Five tensile test specimens prepared as in Clause 3.3 shall be conditioned in a fan assisted air circulating oven as specified in Table 1. After conditioning the specimens shall be removed from the oven, allowed to cool naturally to room temperature and tested for Tensile Strength and Ultimate Elongation according to clause 3.3.

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**3.8 Low Temperature Flexibility**

The test method shall be as specified in Procedure C of ASTM D2671.

For sleeving of recovered bore less than 6 mm as specified, apply the test to whole sections of recovered sleeving. For sleeving of recovered bore 6mm and greater as specified, apply the test to strips 6mm wide, cut from the recovered sleeving, with their lengths parallel to the extruded axis.

Mandrel diameter shall be 10 x specimen thickness  $\pm$  10%. For tubular specimens the thickness is the outside diameter.

The specimens and mandrel shall be conditioned as specified in Table 1.

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**3.9 Flammability**

The test method shall be as specified in ASTM D876 for sizes 18/9 and above and ASTM D2671 Procedure B for sizes 12/6 and below.

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**3.10 Electric Strength**

The test method shall be as specified in IEC 60243 (Short time test).

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**3.11 Volume Resistivity**

The test method shall be as specified in IEC 60093.

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**3.12 Water Absorption**

The test method shall be as specified in Method 1 of ISO 62.

For sleeving of recovered bore greater than 8mm, three disc specimens of diameter  $25 \pm 1$  mm shall be cut from the sleeving. For sleeving of recovered bore less than or equal to 8mm, three tubular specimens 50mm long shall be cut from the sleeving.

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**3.13 Fluid Resistance**

The test method shall be as specified in ISO 1817.

Five tensile test specimens prepared as in Clause 3.3. shall be completely immersed in each of the fluids for the times and temperatures specified in Table 1. The volume of the fluid shall not be less than 20 times that of the specimen. After immersion, lightly wipe the specimens and allow to air dry at  $23 \pm 2^\circ\text{C}$  for  $1\text{h} \pm 15\text{m}$ . The Tensile Strength and Ultimate Elongation of each specimen shall be tested according to Clause 3.3. The test shall be repeated on the remaining specified fluids.

**TEST METHODS (Cont'd)****3.14 Oxygen Index at Ambient Temperature**

The test method shall be as specified in ISO 4589-2.

Type IV test specimens shall be prepared using a 3mm thick sheet moulded from the material from which the sleeving is fabricated. The sheet shall be crosslinked to the same degree as the sleeving.

**3.15 Oxygen Index at Elevated Temperature**

The test method shall be as specified in ISO 4589-3

Type IV test specimens shall be prepared using a 3mm thick sheet moulded from the material from which the sleeving is fabricated. The sheet shall be crosslinked to the same degree as the sleeving.

**3.16 Acid Gas Generation**

The test method shall be as specified in IEC 60754-2.

**3.17 Smoke Index**

The test method shall be as specified in IEC 60684-2 Clause 43.

**3.18 Toxicity Index**

The test method shall be as specified in IEC 60684-2 Clause 44.

**4. RELATED STANDARDS & ISSUE**

|                   |   |
|-------------------|---|
| ASTM D876-09      | Standard Test Methods for Nonrigid Vinyl Chloride Polymer Tubing Used for Electrical Insulation         |
| ASTM D882-10      | Standard Test Methods for Tensile Properties of Thin Plastic Sheet                                      |
| ASTM D2671-09     | Standard Test Methods for Heat-Shrinkable Tubing for Electrical Use                                     |
| IEC 60093: 1980   | Method of Test for Volume Resistivity and Surface Resistivity of Solid Electrical Insulating Materials. |
| IEC 60212: 1971   | Standard Conditions for Use Prior to and During Testing of Solid Electrical Insulating Materials        |
| IEC 60243-1: 1998 | Electrical Strength Of Insulating Materials - Test Methods - Tests At Power Frequencies                 |
| IEC 60684-2: 2005 | Flexible Insulating Sleeving- Part 2: Methods of test   |

**4. RELATED STANDARDS & issue (Cont'd)**

|                   |   |
|-------------------|---|
| IEC 60754-2: 1997 | Test on Gases Evolved During Combustion of Electric Cables - Part 2: Determination of Degree of Acidity of Gases Evolved During the Combustion of Materials Taken From Electric Cables by Measuring pH and Conductivity |
| ISO 37: 2005      | Rubber, Vulcanized or Thermoplastic - Determination of Tensile Stress-Strain Properties   |
| ISO 62: 2008      | Determination of Water Absorption   |
| ISO 188: 2007     | Rubber, Vulcanized - Accelerated Ageing or Heat Resistance Tests.   |
| ISO 1183-1: 2004  | Plastics - Methods for Determining the Density of Non-Cellular Plastics - Part 1: Immersion Method, Liquid Pycnometer Method and Titration Method   |
| ISO 1817: 2005    | Rubber, Vulcanized - Determination of the Effect of Liquids   |
| ISO 4589-2: 2005  | Plastics - Determination of Burning Behaviour by Oxygen Index - Part 2: Ambient-Temperature Test  |
| ISO 4589-3: 1996  | Plastics - Determination of Burning Behaviour by Oxygen Index - Part 3: Elevated-Temperature Test   |

**Subsequent amendments to, or revisions of, any of the above publications apply to this standard only when incorporated in it by updating or revision.**

**5. SAMPLING**

Tests shall be carried out on a sample taken at random from each batch of finished sleeving. A batch of sleeving is defined as that quantity of sleeving extruded at any one time. Testing frequency shall be Production Routine or Qualification. Production Routine tests consisting of Visual Examination, Dimensions, Longitudinal Change, Tensile Strength, Ultimate Elongation and Secant Modulus at 2% Strain shall be carried out on every batch of sleeving. Qualification tests shall be carried out to the requirements of the Design Authority.

**6. PACKAGING**

Packaging shall be in accordance with good commercial practice. Each package shall bear an identification label showing material quantity, description, size, colour, batch number and maximum storage temperature of 40°C. Additional information shall be supplied as specified in the contract or order.

TABLE 1 Test Requirements

| Test   | Test Method | Test Requirements                |
|--|-------------|----------------------------------|
| Visual Examination                                     | -           | As per Clause 2.1                |
| Dimensions   | ASTM D2671  | As per Clause 2.2                |
| Longitudinal Change                                    | ASTM D2671  | 0 to - 10%                       |
| Tensile Strength                                       | ISO 37      | 8 MPa minimum                    |
| Ultimate Elongation                                    | ISO 37      | 200 % minimum                    |
| Secant Modulus at 2% Strain                            | ASTM D882   | 130 MPa maximum                  |
| Specific Gravity                                       | ISO 1183    | 1.5 maximum                      |
| Heat Shock<br>(4h ± 15m at 225 ± 5°C)                  | ASTM D2671  | No dripping, cracking or flowing |
| Heat Ageing<br>(168h ± 2h at 150 ± 3°C)                | ISO 188     |                                  |
| - Tensile Strength                                     | ISO 37      | 8 MPa minimum                    |
| - Ultimate Elongation                                  |             | 100% minimum                     |
| Low Temperature Flexibility<br>(4h ± 15m at -40 ± 2°C) | ASTM D2671  | No cracking                      |
| Flammability   |             |                                  |
| Sizes 18/9 and above                                   | ASTM D876   | Duration of burning 30 s maximum |
| Sizes 12/6 and below                                   | ASTM D2671  | Duration of burning 60 s maximum |
| Electric Strength                                      | IEC 60243-1 | 15 MV/m minimum                  |
| Volume Resistivity                                     | IEC 60093   | 10 <sup>12</sup> ohm.cm minimum  |
| Water Absorption<br>(24 ± 2h immersion at 23 ± 2°C)    | ISO 62      | 0.75 % maximum                   |
| (24 ± 2h immersion at 70 ± 2°C)                        |             | 3.5 % maximum                    |

TABLE 1 Test Requirements (Cont'd)

| Test   | Test Method  | Test Requirements   |
|--|--|---|
| Fluid Resistance<br>(24 ± 2h immersion at 23 ± 2°C) <ul style="list-style-type: none"> <li>• Hydraulic Fluid to H-515 (Mil-H-5606)</li> <li>• Gasoline Fuel to ISO 1817 Test Liquid B</li> <li>• Diesel Fuel to BS 2869 Class A1</li> <li>• Hydraulic Fluid DTD900/4881</li> <li>• Water</li> <li>• Lubricating Oil to O-149</li> <li>• Insulating Oil, Electrical S-756 to BS 148</li> <li>• IRM 902 Standard Oil               <ul style="list-style-type: none"> <li>- Tensile Strength</li> <li>- Ultimate Elongation</li> </ul> </li> </ul> | ISO 1817<br><br><br><br><br><br><br><br><br><br><br>ISO 37 | <br><br><br><br><br><br><br><br><br><br><br>4 MPa minimum<br>100% minimum |
| Oxygen Index at Ambient Temperature  | ISO 4589-2   | 29 minimum  |
| Oxygen Index at Elevated Temperature   | ISO 4589-3   | 250°C minimum   |
| Acid Gas Generation <ul style="list-style-type: none"> <li>-pH Index</li> <li>-Electrolytic Conductivity</li> </ul>  | IEC 60754-2  | 4.3 - 10.5<br>10 µS/mm maximum  |
| Smoke Index  | IEC 60684-2  | 20 maximum  |
| Toxicity Index   | IEC 60684-2  | 3 maximum per 100 grams   |

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