

**ES-CAP**  
**SEALING CAPS**

**1. SCOPE**

This specification establishes the quality standard of pre-formed sleeving components whose dimensions will reduce to a pre-determined size upon the application of heat in excess of 135°C to provide mechanical and environmental protection on a range of stub splices.

**2. REQUIREMENTS**

**2.1 Composition and Appearance**

The pre-formed components shall comprise of two parts:

- a. The jacket shall be fabricated from a thermally stabilised, modified semi rigid polyolefin and shall be cross linked by irradiation.
- b. The liner shall be a thermoplastic adhesive sealant which melts and flows at the shrink temperature of the jacket.

The components shall be essentially free from flaws, defects, pinholes, bubbles, seams, cracks and inclusions.

**2.2 Material Characteristics**

The components can be supplied with Black or Clear jacket material. The adhesive liner shall be Amber.

**2.3 Dimensions**

The dimensions shall be in accordance with Table 1.

**2.4 Properties**

The components shall meet the requirements of Table 2.

### **3. QUALITY ASSURANCE PROVISIONS**

#### **3.1 Classification of Tests**

##### **3.1.1 Qualification Tests**

Qualification tests are those performed on sleeving or components submitted for qualification as a satisfactory product and shall consist of all tests listed in this specification.

##### **3.1.2 Acceptance Tests**

Acceptance tests are those performed on components submitted for acceptance under contract and shall consist of:

Dimensions only

### **4. SAMPLING INSTRUCTIONS**

#### **4.1 Qualification Test Samples**

Qualification Test Samples shall consist of components and tubing from which the components are produced. Qualification of size; -1 1/2 or No.3 shall qualify the product range.

#### **4.2 Acceptance Test Samples**

Acceptance test samples shall consist of 5 components selected at random from each batch. A batch shall consist of components of the same size from the same production run and offered for inspection at the same time.

### **5. TEST PROCEDURES**

#### **5.1 Material Properties**

Unless otherwise specified, the tests shall be performed on specimens which have been recovered by conditioning for 3 minutes at  $200 \pm 5^{\circ}\text{C}$  ( $400 \pm 9^{\circ}\text{F}$ ) in an air circulating oven.

Condition the test specimens (and measurement gauges when applicable) for 3 hours at  $23 \pm 3^{\circ}\text{C}$  ( $70 \pm 5^{\circ}\text{F}$ ) and  $50 \pm 5\%$  relative humidity prior to all testing.

Use mechanical convection type ovens in which air passes the specimens at a velocity of 30 to 60 m (100 to 200 ft) per minute.

##### **Dimensions and Longitudinal Change**

**5.2** Measure three components as supplied, for length  $\pm 1$  mm ( $\pm 0.040$  in) and inside diameter in accordance with ASTM D 2671. Condition the specimens for 3 minutes in a  $200 \pm 5^{\circ}\text{C}$  ( $400 \pm 9^{\circ}\text{F}$ ) oven, cool to  $23 \pm 3^{\circ}\text{C}$  ( $70 \pm 5^{\circ}\text{F}$ ) and then remeasure. Prior to and after conditioning, the dimensions of the components shall be in accordance with Table 1.

**5.3 Tensile Strength and Ultimate Elongation(tubing only)**

Perform the tests in accordance with ASTM D 2671, using 25 mm (1 in) bench marks, 25 mm (1 in) initial jaw separation and jaw separation speed of  $50 \pm 5$  mm ( $2 \pm 0.2$  in) per minute. Calculate the tensile strength based on the wall thickness of the jacket only.

**5.4 Dynamic Cut-Through (tubing only)**

Perform the test in accordance with ASTM D 3032. Recover the specimens on a 4.7 mm (0.185 in) diameter steel rod and cool to room temperature. Use the optional cutting edge with a flat configuration of 0.127 mm (0.005 in).

**5.5 Flammability (tubing only)**

Applicable to Black tubing only.

The test shall be carried out essentially in accordance with ASTM D2671 procedure B. Solid Copper mandrels shall be used and the average time to extinguish of 5 specimens shall be expressed as the result.

**5.6 Stub Splice Performance Properties****5.6.1. Splice Construction**

Construct a wire stub splice having  $3 \times 2.5$  mm<sup>2</sup> (# 14 AWG) thin wall insulated wires using conventional assembly techniques and wires approximately 300 mm (12 in) long.

Install component size -11/2 or No.3 onto the wire assembly using an air circulating oven at  $150 \pm 3^\circ\text{C}$  ( $300 \pm 5^\circ\text{F}$ ) for 3 minutes. Allow to cool to room temperature.

**5.7 Environmental Seal Tests**

The cap and 50 mm (2 in) of wire shall be immersed in salt solution (5% by weight) at  $23 \pm 3^\circ\text{C}$  ( $70 \pm 5^\circ\text{F}$ ) for  $24 \pm 2$  hours. The ends of the specimens shall be a minimum of 50 mm (2 in) above the surface of the water line. After environmental exposure (Sections 5.8 through 5.12) the immersion period shall be 4 hours.

Either the Current Leakage Test or the Insulation Resistance Test may be used to confirm the environmental seal of the assemblies.

**5.7.1 Current Leakage Test**

After this conditioning period the current between each specimen and the water bath shall be measured by means of a suitable meter. The reading shall be taken 30 seconds after application of 50 Vdc.

**5.7.2 Insulation Resistance Test**

After this conditioning period the insulation resistance between each specimen and the water bath shall be measured by means of a suitable meter. The reading shall be taken 30 seconds after application of 100 Vdc.

**5.8 Flex Test**

Three wire stub splices shall be flexed at room temperature through 180° for five cycles under a 3 kg (6.6 pound) load at a rate of 10-14 cycles per minute.

Each splice shall be centrally mounted on a face plate such that the weighted wire shall hang vertically about the rotational axis. (See Figure 1 for typical set up) .

After flexing all specimens shall be tested for environmental seal per section 5.7.

**5.9 Thermal Shock**

Suspend vertically 3 specimens in a circulating air oven for 30 minutes.

For XLPE Wires the temperature shall be  $125 \pm 3^{\circ}\text{C}$  ( $257 \pm 5^{\circ}\text{F}$ ).

Note:

Fabric tape rated at an operating temperature of 125°C or higher is advised to secure the cap to the wire bundle for temperature exposures above 105°C. For PVC Wires the temperature shall be  $105 \pm 3^{\circ}\text{C}$  ( $221 \pm 5^{\circ}\text{F}$ ). Remove the specimens from the oven and within 2 minutes immerse the cap and 50 mm (2 in) of wire in a 5% saline solution at  $5 \pm 5^{\circ}\text{C}$  ( $9 \pm 9^{\circ}\text{F}$ ). A minimum of 50 mm (2 in) of wire shall remain above the water surface. Remove them from the bath in 30 minutes. This shall be one cycle. Test the samples for 5 cycles and check for environmental seal in accordance with section 5.7.

**5.10 Cold Impact**

The test apparatus and method shall be based on ISO 6722/1. Three wire stub specimens shall be conditioned together with the test apparatus in a suitable cold chamber for a minimum of 4 hours at  $-40 \pm 2^{\circ}\text{C}$  ( $-40 \pm 3^{\circ}\text{F}$ ). The apparatus shall be pre-conditioned for a minimum of 4 hours prior to commencement of testing.

Each specimen shall be subjected to a single drop of a 200 g (0.44 pound) weight from a height of 100 mm (3.94 inches) while remaining in the cold chamber ensuring the weight centrally impacts the splice area.

After the test the specimens shall be removed from the cold chamber, allowed to stabilise to room temperature and examined visually for signs of cracking of the outer jacket. Each specimen shall then be tested for environmental seal per section 5.7.

**5.11 Heat Ageing**

Suspend the specimens vertically (sealed joint lower most) for 168 hours in a circulating air oven.

XLPE wire Heat Age at  $125 \pm 3^{\circ}\text{C}$  ( $257 \pm 5^{\circ}\text{F}$ )

PVC wire Heat Age at  $105 \pm 3^{\circ}\text{C}$  ( $221 \pm 5^{\circ}\text{F}$ )

Note:

Fabric tape rated at an operating temperature of 125°C or higher is advised to secure the cap to the wire bundle for temperature exposures above 105°C.

Remove the specimens from the oven and allow to cool to room temperature. Check the environmental seal in accordance with section 5.7.

**5.12 Fluid Immersion**

**5.12.1** Immerse 3 specimens of each wire type for 1 hour at  $100 \pm 3^{\circ}\text{C}$  ( $212 \pm 5^{\circ}\text{F}$ ) in each of the following fluids

IRM 903 Oil.  
Automatic Transmission Fluid (Dextron II)  
Engine Coolant (50/50 by volume)

**5.12.2** Immerse 3 specimens of each wire type for 24 hours at  $23 \pm 3^{\circ}\text{C}$  ( $70 \pm 5^{\circ}\text{F}$ ) in each of the following fluids:

Diesel Fuel (ISO 1817 liquid F)  
Windshield Washer Fluid  
ASTM Fuel C (XLPE wire only)

**5.12.3** Immerse 3 specimens of each wire type for 10 seconds in each of the following fluids at intervals of 30 minutes for 16 hours at  $23 \pm 3^{\circ}\text{C}$  ( $70 \pm 5^{\circ}\text{F}$ ) to simulate a splash environment:

GUNK \* Engine Cleaner  
Brake Fluid (SAE J1703)

Allow the specimens to drain between immersions.

\* Trademark of the Radiator Speciality Company, Charlotte, NC

**5.12.4** Lightly wipe all specimens to remove surplus fluid and visually inspect all specimens for splice insulation integrity. Within one hour check the environmental seal in accordance with section 5.7.

**5.13 REJECTION AND RETEST**

Failure of any sample of sleeving or components to conform to any of the requirements of this specification shall be cause for rejection of the batch represented. Sleeving which has been rejected may be replaced or reworked to correct the defect and then resubmitted for acceptance. Before resubmitting, full particulars concerning previous rejection and action taken to correct the defects shall be furnished to the inspector.

**6. PREPARATION FOR DELIVERY****6.1 FORM**

The components shall be supplied in quantities in accordance with the customer or Raychem MOQ

**6.2 PACKAGING**

Packaging shall be in accordance with good commercial practice.

**6.3 MARKING**

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

**7. RELATED DOCUMENTS**

|             |   |
|-------------|---|
| ASTM D 2671 | Testing Heat Shrinkable Sleeving.                                     |
| ASTM D 3032 | Method of Testing Hook Up Wire Insulation.                            |
| ISO 6722/1  | Unscreened Low Tension Cables - General Requirements and Test Methods |
| ISO 1817    | Determination of the Effects of Liquids                               |
| SAE J1703   | Motor Vehicle Brake Fluid   |
| ASTM D471   | Test Method for Rubber Properties -- Effects of Liquids               |

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

**TABLE 1**

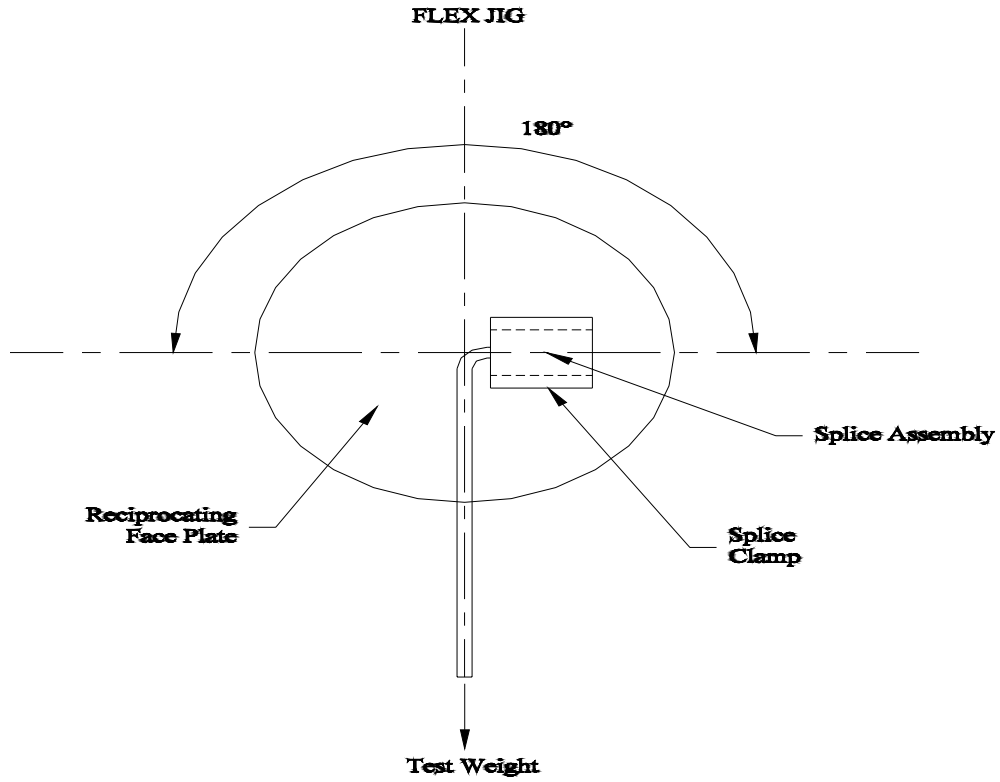
**COMPONENT DIMENSIONS**

| As Supplied   |                                    |       |                     |              | As Recovered                         |       |                                 |       |                              |       |
|---------------|------------------------------------|-------|---------------------|--------------|--------------------------------------|-------|---------------------------------|-------|------------------------------|-------|
| Part Number   | Minimum Expanded ID including Core |       | Standard cut Length |              | Maximum recovered ID) including Core |       | Minimum Recovered Adhesive Wall |       | Minimum Recovered Total Wall |       |
|               | (mm)                               | (in)  | ±3.81 (mm)          | ±0.150 (in)  | (mm)                                 | (in)  | (mm)                            | (in)  | (mm)                         | (in)  |
| ES-Cap -No. 1 | 5.70                               | 0.225 | 30<br>35            | 1.18<br>1.38 | 1.27                                 | 0.050 | 0.56                            | 0.022 | 1.20                         | 0.047 |
| ES-Cap -No. 2 | 7.40                               | 0.293 | 30<br>35            | 1.18<br>1.38 | 1.65                                 | 0.065 | 0.76                            | 0.030 | 1.52                         | 0.060 |
| ES-Cap -No. 3 | 10.85                              | 0.427 | 40<br>50            | 1.57<br>1.97 | 2.41                                 | 0.095 | 1.02                            | 0.040 | 1.91                         | 0.075 |

**TABLE 2  
REQUIREMENTS**

| PROPERTY                                 | UNIT        | REQUIREMENT                                       | TEST METHOD                |
|--|-------------|---|----------------------------|
| <b>Material Properties</b><br>Dimensions | mm (in)     | In accordance with Table 1                        | ASTM D 2671                |
| Tensile Strength                         | MPa (psi)   | 10.3 minimum (1500)                               | ASTM D 2671                |
| Ultimate Elongation                      | percent     | 250 minimum                                       | Section 5.3                |
| Heat Shock<br>+ 4 Hours at 225°C         | --          | No dripping, flowing or cracking of outer jacket. | ASTM D 2671                |
| Dynamic Cut Through                      | kg (pounds) | 13.6 minimum (30)                                 | ASTM D 3032<br>Section 5.4 |
| Flammability                             | seconds     | Self-extinguishing within 60 seconds              | Section 5.5                |
| <b>Splice Performance Properties</b>     | --          |   | Section 5.7                |
| Current Leakage Test                     | microamps   | 0.25 max.   |                            |
| Insulation Resistance Test               | ohms        | 10 <sup>8</sup> min                               |                            |
| Room Temperature Flex Test               | --          | --  | Section 5.8                |
| Current Leakage Test                     | microamps   | 0.25 max.   | Section 5.7                |
| Insulation Resistance Test               | ohms        | 10 <sup>8</sup> min                               |                            |
| Thermal Shock                            | --          | --  | Section 5.9                |
| Current Leakage Test                     | microamps   | 0.25 max.   | Section 5.7                |
| Insulation Resistance Test               | ohms        | 10 <sup>8</sup> min                               |                            |
| Cold Impact                              | --          | No cracking of outer jacket                       | Section 5.10               |
| Current Leakage Test                     | microamps   | 0.25 max.   | Section 5.7                |
| Insulation Resistance Test               | ohms        | 10 <sup>8</sup> min                               |                            |
| Heat Ageing                              | --          | --  | Section 5.11               |
| Current Leakage Test                     | microamps   | 0.25 max.   | Section 5.7                |
| Insulation Resistance Test               | ohms        | 10 <sup>8</sup> min                               |                            |
| Fluid Immersion                          | --          | --  | Section 5.12               |
| Current Leakage Test                     | microamps   | 0.25 max.   | Section 5.7                |
| Insulation Resistance Test               | ohms        | 10 <sup>8</sup> min                               |                            |

FIGURE 1



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