



ES-CAP SPECIFICATION

108-120037
Formerly RW-3006

Raychem ES Caps
High Shrink Ratio, Adhesive-Lined,
Semi-rigid Polyolefin Caps

Adhesive-lined, heat-shrinkable ES Caps are specifically designed to provide mechanical and environmental protection of stub splices in electrical harnesses. Clear ES Caps allow see-through inspection; black ES Caps are flame-retardant. The radiation crosslinked polyolefin outer jacket is mechanically tough, providing abrasion protection. The cap's inner layer is a unique hot-melt adhesive, specially formulated to seal to most types of commercial wire insulation and to perform well at an extended temperature range. The thick adhesive forms an effective barrier against fluids and moisture, helping protect the harness from the effects of corrosion and water wicking. UL recognized.
RoHS and REACH compliant.
Continuous operating temperature: -40 to 105°C (-40 to 221°F).

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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. APPLICABLE DOCUMENTS

This specification takes precedence over documents referenced herein. Unless otherwise specified, the latest issue of referenced documents applies. The following documents form a part of this specification to the extent specified herein.

2.1. AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM)

ASTM D 2671 Testing Heat Shrinkable Sleeving.
ASTM D 3032 Method of Testing Hook Up Wire Insulation.
ASTM D471 Test Method for Rubber Properties -- Effects of Liquids

(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. OTHER SPECIFICATIONS

International Organization for Standardization (ISO)

ISO 6722/1 Unscreened Low Tension Cables - General Requirements and Test Methods
ISO 1817 Determination of the Effects of Liquids

(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>)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J1703 Motor Vehicle Brake Fluid

(Copies of SAE publications may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096 or via the SAE website at <https://www.sae.org/standards>).

3. REQUIREMENTS

3.1. COMPOSITION AND APPEARANCE

The pre-formed components shall comprise of two parts:

- a. The jacket shall be fabricated from a thermally stabilized, modified semi rigid polyolefin and shall be cross linked by irradiation.

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- 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.

3.2. MATERIAL CHARACTERISTICS

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

3.3. Dimensions

The dimensions shall be in accordance with ES-CAP drawing ([ES-CAP_BLK+CLR](#))

3.4. Properties

The components 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 sleeving or components 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 components submitted for acceptance under contract and shall consist of:

Dimensions only

4.2. SAMPLING INSTRUCTIONS

4.2.1. Qualification Test Samples

Qualification Test Samples shall consist of components and tubing from which the components are produced.

Qualification of ES-CAP-NO.1-40MM qualifies ES-CAP-NO.0 and ES-CAP-NO.1.

Qualification of ES-CAP-NO.3-50MM qualifies ES-CAP-NO.2 and ES-CAP-NO.3.



4.2.2. 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.

4.3. TEST PROCEDURES

4.3.1. Material Properties

Unless otherwise specified, the tests shall be performed on specimens which have been recovered by conditioning for 3 minutes at $200 \pm 5^{\circ}\text{C}$ ($392 \pm 9^{\circ}\text{F}$) 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.

4.3.2. Dimensions (Caps) and Longitudinal Change (tubing)

Note: Longitudinal change measurement shall be carried out on lengths of tubing. All other dimensions are carried out on the finished caps.

Longitudinal change

Measure three lengths of tubing as supplied, length 150 ± 2.5 mm (6 ± 0.098 in). Condition the specimens for 3 minutes in a $200 \pm 5^{\circ}\text{C}$ ($392 \pm 9^{\circ}\text{F}$) oven, cool to $23 \pm 3^{\circ}\text{C}$ ($70 \pm 5^{\circ}\text{F}$) and then remeasure.

Finished caps

Condition the specimens for 3 minutes in a $200 \pm 5^{\circ}\text{C}$ ($392 \pm 9^{\circ}\text{F}$) 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 the ES-CAP SCD.

4.3.3. Tensile Strength and Ultimate Elongation (tubing only)

Perform the tests in accordance with ASTM D 2671, using 25 mm (1 in) benchmarks, 25 mm (1 in) initial jaw separation and jaw separation, unless using an extensometer, at a speed of 50 ± 5 mm (2 ± 0.2 in) per minute. Calculate the tensile strength based on the wall thickness of the jacket only.

4.3.4. Dynamic Cut-Through (tubing only)

Perform the test in accordance with ASTM D 3032. Recover the specimens on a 1.6mm diameter steel rod (0.063 in), for NO.1; and 4.7mm (0.185 in) diameter steel rod for NO.3, and cool to room temperature. Use the optional cutting edge with a flat configuration of 0.127 mm (0.005 in).



4.3.5. Flammability (tubing only, jacket and adhesive)

Applicable to Black tubing only, Clear tubing is not flame retarded.
Recover five 500mm (20 inch) lengths of tubing over steel mandrels with a diameter 75 ± 5 percent of the specified minimum expanded (as supplied) inside diameter of the tubing.

Using a Bunsen burner with a 100mm (4 inch) tube, adjust the burner to achieve a flame with an inner blue cone of approximately 50mm (2 inches).

Suspend each specimen in a draft free environment in the configuration shown in Figure 1. The time of exposure of the test flame to each specimen is one 30 second application.

Record the time for each specimen to self-extinguish after removal of the flame. The result is the average burning time for all five specimens.

4.3.6. Stub Splice Performance Properties

4.3.6.1. Splice Construction

ES-CAP-NO.1

Construct a wire stub splice having $2 \times 1.0 \text{ mm}^2$ (# 17 AWG) thin wall insulated wires using conventional assembly techniques and wires approximately 300 mm (12 in) long. ES-CAP-NO.1 will be 40mm in length

ES-CAP-NO.3

Construct a wire stub splice having $3 \times 2.5 \text{ mm}^2$ (# 14 AWG) thin wall insulated wires using conventional assembly techniques and wires approximately 300 mm (12 in) long. ES-CAP-NO.3 will be 50mm in length

Install component sizes onto the wire assembly using equipment with controllable parameters. For example, the equipment listed in Clause 4.3.6.2. Product Application Equipment. The installation window and set temperature shall be identified in accordance with the Product Installation Procedure for ES Caps (114-120003). After installation allow the samples to cool to room temperature before any testing is performed.

4.3.6.2. Product Application Equipment

- TE RBK-ILS Processor
- Belt heater
- Air circulating oven



4.3.7. 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 ± 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 4.3.8. through 4.3.12.) 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.

4.3.7.1. 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.

4.3.7.2. 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.

4.3.8. Flex Test

Three wire stub splices shall be flexed at room temperature through 180° for five cycles under a 1.5 kg (3.3 pound) load for NO.1 and a 3 kg (6.6 pound) load for NO.3 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 2 for typical set up) .

After flexing all specimens shall be tested for environmental seal per section 4.3.7.

4.3.9. 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 $5 \pm 5^{\circ}\text{C}$ ($41 \pm 9^{\circ}\text{F}$). 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 4.3.7.



4.3.10. 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 4.3.7.

4.3.11. Heat Aging

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 4.3.7.

4.3.12. Fluid Immersion

4.3.12.1. 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 (Dexron® II)
Engine Coolant (50/50 by volume)

4.3.12.2. 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 D471 Fuel C (XLPE wire only)

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4.3.12.3. 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.

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4.3.12.3.1. 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 4.3.7.

4.4. 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.

5. PREPARATION FOR DELIVERY

5.1. FORM

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

5.2. PACKAGING

Packaging shall be in accordance with good commercial practice.

5.3. MARKING

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



APPENDIX

**TABLE 1
REQUIREMENTS**

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
Material Properties			
Dimensions	mm <i>(in)</i>	In accordance with ES-CAP SCD	ASTM D 2671
Longitudinal change	%	0, to -10	
Tensile Strength	MPa <i>(psi)</i>	10.3 minimum <i>(1500)</i>	ASTM D 2671 Section 4.3.3.
Ultimate Elongation	%	250 minimum	
Heat Shock 4 Hours at 225°C	--	No dripping, flowing or cracking of outer jacket.	ASTM D 2671
Dynamic Cut Through	kg <i>(pounds)</i>	13.6 minimum <i>(30)</i>	ASTM D 3032 Section 4.3.4.
Flammability Black ES-Caps	seconds	Self-extinguishing within 30 seconds	Section 4.3.5.
Splice Performance Properties	--		Section 4.3.7.
Current Leakage Test Insulation Resistance Test	microamps ohms	0.25 max. 1 x 10 ⁸ min	
Room Temperature Flex Test	--	--	Section 4.3.8. Section 4.3.7.
Current Leakage Test Insulation Resistance Test	microamps ohms	0.25 max. 1 x 10 ⁸ min	
Thermal Shock Current Leakage Test Insulation Resistance Test	-- microamps ohms	-- 0.25 max. 1 x 10 ⁸ min	Section 4.3.9. Section 4.3.7.
Cold Impact Current Leakage Test Insulation Resistance Test	-- microamps ohms	No cracking of outer jacket 0.25 max. 1 x 10 ⁸ min	
Heat Ageing Current Leakage Test Insulation Resistance Test	-- microamps ohms	-- 0.25 max. 1 x 10 ⁸ min	Section 4.3.11. Section 4.3.7.
Fluid Immersion Current Leakage Test Insulation Resistance Test	-- microamps ohms	-- 0.25 max. 1 x 10 ⁸ min	



FIGURE 1

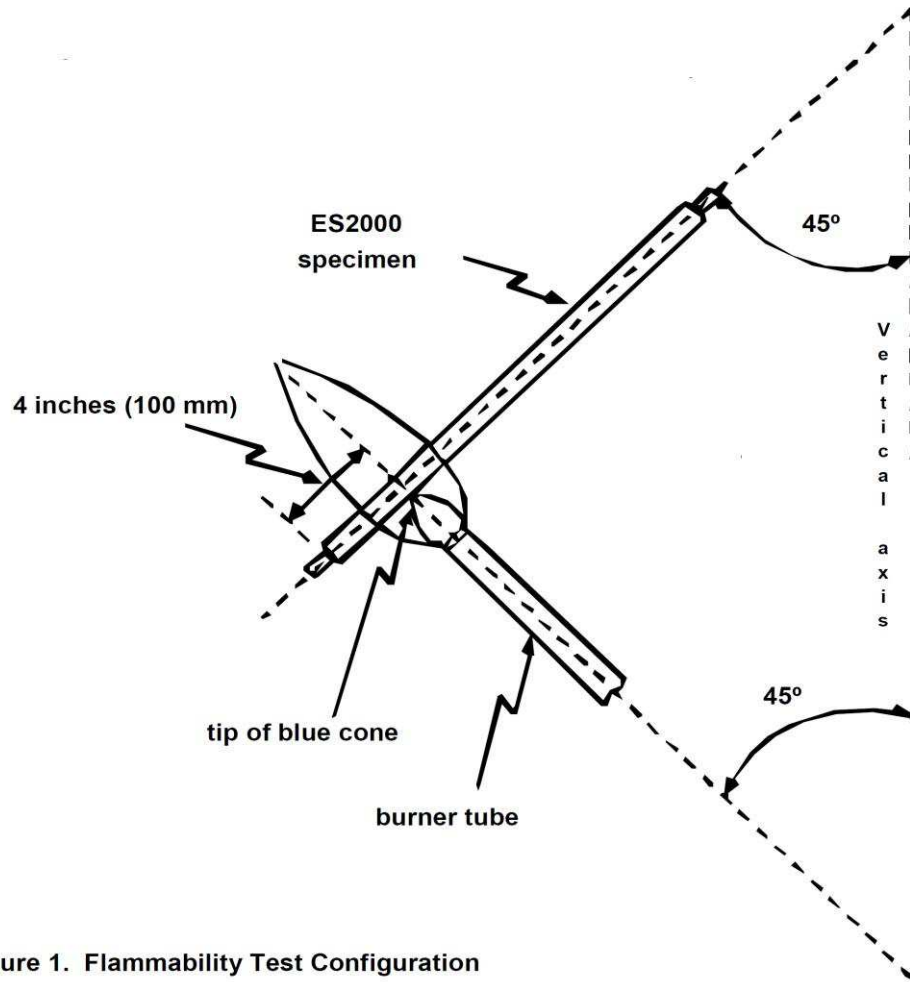


Figure 1. Flammability Test Configuration



FIGURE 2

