

## RW-2519



# SPECIFICATION RW-2519

TE 108-121020

## D-SCE and D-SCE-FLAT HEAT SHRINK MARKER SLEEVES

### SCOPE

This quality assurance specification establishes the quality standard for a heat-shrinkable identification sleeving for use in applications where high performance during exposure to organic fluids, especially oils and diesel fuel is required. These special requirements are detailed in Table 3.

The operating temperature for this product is  $-75^{\circ}\text{C}$  to  $+135^{\circ}\text{C}$ .

This system is an automatic method of identifying items by printing a mark on D-SCE marker sleeves. The mark is permanent upon printing. D-SCE markers are designed to operate in chemically hazardous conditions at elevated temperatures for extended periods of time, where strain relief, electrical insulation and protection from mechanical abuse is required, making them ideal in rail, aerospace and construction industries.

The marker shall be fabricated from cross linked polymer tubing, flattened and then mounted on a carrier as D-SCE or supplied as flattened spooled continuous tube as D-SCE-FLAT. All format sizes (apart from 38.1 size which is 2:1 shrink ratio) are available in 3:1 shrink ratio.

The marker system comprises specific printers and ribbons. Compliance to this specification can only be guaranteed if TE Connectivity approved printers and ribbons are used. This information can be found in TE document 411-121005 'TE Identification Printer Product Ribbon Matrix'.

Unless specified, the tube size for qualification testing is 6.4mm.

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## 1 REVISION HISTORY

Revision Number	Description of change	Date	Incorporated By
1	-	23 July 2004	Alan Kean
2	-	7 Jan 2009	Alan Kean
3	-	16 Nov 2011	Lee Smith
4	Specification rationalisation	June 2013	Ewelina Mojsak
5	Drafting corrections	Nov 2013	Shaun Carolan
6	Ref. PDMLink	July 2016	Lee Smith

## 2 SCOPE

The tests in this specification, as made on D-SCE products, define the nature of a diesel resistant, self-extinguishing, heat shrink marker sleeve for rail, aerospace and construction industries. Test procedures have been selected based on the ability of that test to provide key performance data which can be used by an engineer to provide information which can be used to validate the fit form and function of installed products.

## 3 REQUIREMENTS

### 3.1 Composition, appearance and color

The sleeving shall be fabricated from irradiated, thermally-stabilised polyolefin compound. It shall be homogeneous and essentially free from flaws, defects, pinholes, bubbles, seams, cracks or inclusions. The marker sleeves shall be Yellow unless otherwise specified.

## 4 DIMENSIONS

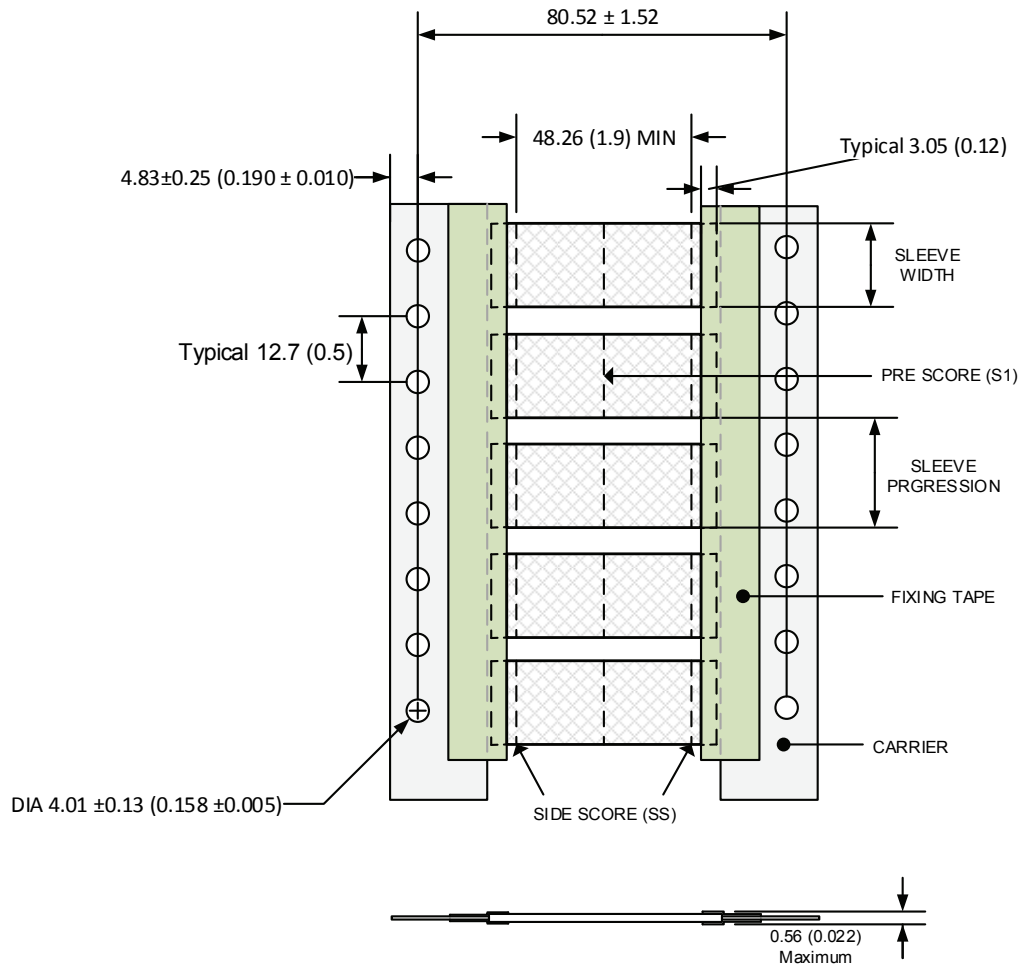
The product shall be supplied in one of the following formats:

- D-SCE As shown in figure 1 and to the dimensions of Table 1.
- D-SCE-FLAT Continuous tubing to the dimensions of Table 1.

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5 FIGURE 1: D-SCE SLEEVE FORMAT



Dimensions in mm (inch)



**6 TABLE 2: DIMENSIONS**

D-SCE and D-SCE-FLAT						
Part Description	Minimum Supplied Inside Diameter mm (inches)	Maximum Recovered Inside Diameter mm (inches)	Wall Thickness after Recovery mm (inches)	Minimum Sleeve Width mm	Sleeve Progression <sup>1</sup> mm (inches)	Nominal Weight of single sleeve (~50mm long) grams
D-SCE 2.4	2.4 (0.094)	0.8 (0.03)	0.51 ± 0.08 (0.020 ± 0.003)	4.7 ± 0.4	12.70 ± 0.89 (0.500 ± 0.035)	0.13
D-SCE 3.2	3.2 (0.125)	1.1 (0.04)	0.51 ± 0.08 (0.020 ± 0.003)	6.22 ± 0.4	12.70 ± 0.89 (0.500 ± 0.035)	0.18
D-SCE 4.8	4.8 (0.187)	1.6 (0.06)	0.58 ± 0.08 (0.023 ± 0.003)	8.38 ± 0.4	12.70 ± 0.89 (0.500 ± 0.035)	0.27
D-SCE 6.4	6.4 (0.250)	2.1 (0.08)	0.58 ± 0.08 (0.023 ± 0.003)	11.05 ± 0.4	16.94 ± 0.89 (0.667 ± 0.035)	0.35
D-SCE 9.5	9.5 (0.375)	3.2 (0.13)	0.61 ± 0.08 (0.024 ± 0.003)	15.88 ± 0.4	25.40 ± 1.14 (1.000 ± 0.045)	0.50
D-SCE 12	12.7 (0.500)	4.2 (0.17)	0.61 ± 0.08 (0.024 ± 0.003)	21.08 ± 0.6	29.64 ± 1.14 (1.167 ± 0.045)	0.68
D-SCE 18	19.1 (0.750)	6.4 (0.25)	0.61 ± 0.08 (0.024 ± 0.003)	31.12 ± 0.6	42.34 ± 1.14 (1.667 ± 0.045)	0.90
D-SCE 25	25.4 (1.000)	8.5 (0.33)	0.64 ± 0.08 (0.025 ± 0.003)	41.40 ± 1.0	50.80 ± 1.14 (2.000 ± 0.045)	1.35
D-SCE 38	38.1 (1.500)	19.1 (0.75)	0.64 ± 0.08 (0.025 ± 0.003)	61.34 ± 1.0	71.96 ± 1.14 (2.833 ± 0.045)	2.58

<sup>1</sup> Sleeve progression column is applicable only for ladder format

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### 7. TEST REQUIREMENTS

This specification details the requirements for the D-SCE family of products. Table 3 lists the general requirements and Table 4 lists the specific performance.

### 8. TEST METHODS

#### 8.1. Preparation of Test Specimens

When required by the test procedure, product shall be printed using printers and ribbons specified by TE Connectivity. The full list can be found in TE document 411-121005 'TE Identification Printer Product Ribbon Matrix'.

Print random characters onto the sleeving to within approximately 6mm (1/4 inch) of both ends using font type Arial 10 bold. Markers are to be removed from the carrier (non-continuous products) or cut/perforated and separated using TE approved printer systems (D-SCE-FLAT) before testing. Test in both 'as received' and 'fully recovered' form.

The marking shall be examined for legibility in accordance with TE Document 411-121002 Print Contrast Reference Scale. The initial print contrast must be 8 or above.

As required, sleeves or tubing should be recovered by placing them in a forced air oven for 3 minutes at  $200 \pm 5^{\circ}\text{C}$ . Specimens will be removed from the oven and allow to cool to  $23 \pm 3^{\circ}\text{C}$  for at least 4 hours before continuing. Where required by the test method, testing shall be done on continuous tubing (D-SCE-FLAT). No pre-conditioning period is required prior to testing except where specified.

Unless otherwise specified, all tests shall be made at a temperature of  $23 \pm 2^{\circ}\text{C}$ .

#### 8.2. Workmanship

Visually examine three samples for workmanship using normal vision and without magnification. Check for flaws, defects, pinholes, bubbles, seams, cracks or inclusions. The visual examination should be made with the specimen placed inside a laboratory light box with D65 illumination.

Measure the colour of as received sleeves before any printing using a spectrophotometer. Measure and record values for  $L^*a^*b^*$  using the 3mm aperture and D65 illuminance. Colour results are recorded for information only.

#### 8.3. Print Performance

##### 8.3.1. Mark Adherence

Three as supplied and three fully recovered sleeves shall be prepared as detailed in Clause 8.1 and tested in accordance with TE 109-121012. Samples shall be tested using a Crockmeter fitted with an eraser and 1kg load using the number of rubs specified in the requirement table.

After the Mark Adherence test, the marking shall be examined for legibility using normal reading vision. Print contrast shall be evaluated in accordance with TE 411-121002.

##### 8.3.2. Solvent Resistance

Nine as supplied and nine fully recovered sleeves shall be prepared as detailed in Clause 8.1 and tested in accordance with TE 109-121014.

The marking shall be examined for legibility using normal reading vision. Print contrast shall be evaluated in accordance with TE 411-121002



### 8.3.3. Fluid Resistance, Mark Permanence

The test method shall be as specified in TE 109-121012. Prepare three as received and three fully recovered markers as detailed in Clause 8.1. Markers shall be completely immersed in each of the fluids for the times and at the temperatures specified in the requirements table. The volume of the fluid shall not be less than 20 times that of the specimen. After immersion, the markers are lightly blotted with tissue paper to remove excess surface fluid and air dried at  $23 \pm 2^{\circ}\text{C}$  for  $45 \pm 15\text{min}$ . Samples are tested with a Crockmeter fitted with 'Super Twill' cloth and a 1kg load.

Additional testing in IPA is required using three as received and three fully recovered markers as detailed in Clause 8.1. Load the Super Twill' cloth with IPA and test for mark permanence as detailed in TE 108-121-012.

After the print permanence test, marking shall be examined for legibility using normal reading vision. Print contrast shall be evaluated in accordance with TE 411-121002.

## 8.4. Physical Testing

### 8.4.1. Dimensions and Longitudinal Change

The test method shall be as specified in TE 109-121003.

Three 50mm long marker sleeves shall be tested for inside diameter, and a further three 150mm long sleeves taken from a continuous reel shall be tested for Longitudinal Change. For Longitudinal Change, two gauge marks shall be positioned 100mm apart on each sleeve. The markers shall be recovered in a fan assisted air-circulating oven using the details given in 8.1 and the distance between gauge lengths and inside diameter of each shall be measured, after cooling to room temperature. The longitudinal change shall be expressed as a percentage of the original gauge length. The minimum and maximum recovered wall thickness shall be determined.

### 8.4.2. Tensile Strength and Ultimate Elongation

The test method shall be as specified in TE 109-121002. Test five recovered tubular specimens 125mm long. An initial jaw separation of 50mm with a gauge length of 20mm and rate of jaw separation of  $100 \pm 5\text{mm per minute}$  shall be used.

### 8.4.3. Specific Gravity

Samples of un-printed product shall be tested to the procedure as specified in TE 109-121015. Three specimens of fully recovered tubing 25mm long should be tested. Test specimens should be prepared to prevent trapping of air.

### 8.4.4. Split Testing

The test method shall be as specified in TE 109-121031. Ten perforated or scored marker sleeves should be tested. Samples should be recovered, onto an ambient temperature mandrel for five minutes in the fan assisted oven at  $200^{\circ}\text{C}$ . Samples should be examined for splitting after cooling to  $23^{\circ}\text{C}$  as specified in section 8.1.

### 8.4.5. 2% Secant Modulus

The test method shall be as specified in TE 109-121004. Five specimens 180mm long of expanded tubing should be tested.

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### 8.5. Thermal Testing

#### 8.5.1. Heat Shock

The test method shall be as specified in TE 109-121007. Six sleeves shall be prepared as detailed in section 8.1. Specimens shall be conditioned for 4 hours at  $175\pm 2^{\circ}\text{C}$  ( $347\pm 7^{\circ}\text{F}$ ) in an air circulating oven. Remove the markers and leave to cool to room temperature for a minimum of 2 hours at  $23\pm 2^{\circ}\text{C}$  ( $73 \pm 7^{\circ}\text{F}$ ).

After conditioning three samples shall be tested for Mark Adherence in accordance with section 8.3.1.

The marking shall be examined for legibility using normal reading vision. Print contrast shall be evaluated in accordance with TE 411-121002.

The three remaining samples shall be tested for resistance to bending. Mandrel diameter for D-SCE-6.4 size tubing is 9.5mm.

#### 8.5.2. Heat Ageing

The test method shall be as specified in TE 109-121008. Six sleeves shall be prepared as detailed in section 8.1. Specimens shall be conditioned for 168 hours at  $150 \pm 2^{\circ}\text{C}$  ( $302 \pm 7^{\circ}\text{F}$ ) in an air circulating oven. Markers shall be removed and allowed to cool to room temperature for a minimum of 4 hours at  $23 \pm 2^{\circ}\text{C}$  ( $73 \pm 7^{\circ}\text{F}$ ).

After conditioning three samples shall be tested for Mark Adherence, in accordance with section 8.3.1.

The marking shall be examined for legibility using normal reading vision. Print contrast shall be evaluated in accordance with TE 411-121002. The remaining three samples shall be tested for resistance to bending. Mandrel diameter for D-SCE 6.4 size tubing is 9.5mm.

Additionally five recovered tubular specimens 125mm long should be prepared and conditioned as specified in section 5.2.1. Samples shall be tested for Tensile Strength and Ultimate Elongation, using the test method specified in TE 109-121002

#### 8.5.3. Thermal Cycling

The test method shall be as specified in TE 109-121046. Six as received samples should be prepared for testing as detailed in section 8.1. Specimens shall be conditioned for 4 cycles of 1 hour at  $-75\pm 2^{\circ}\text{C}$  and then 1 hour at  $135^{\circ}\text{C}\pm 2^{\circ}\text{C}$  in an air circulating oven. After each heating and cooling period samples shall be allowed to store at  $23\pm 2^{\circ}\text{C}$  for 16 hours. After cycling remove the markers and leave to cool to room temperature for a minimum of 2 hours at  $23\pm 2^{\circ}\text{C}$

Three samples shall be tested for Mark Adherence in accordance with TE 108-121012. The marking shall be examined for legibility using normal reading vision. Print contrast shall be evaluated in accordance with TE 411-121002.

The three remaining samples shall be tested for resistance to bending. Mandrel diameter for D-SCE 6.4 size tubing is 9.5mm.





#### 8.5.4. Low Temperature Flexibility

The test method shall be as specified in TE 109-121006. Six as received and six fully recovered sleeves shall be prepared as detailed in section 8.1. Specimens shall be conditioned for 4 hours at  $-75\pm 2^{\circ}\text{C}$  in a cold chamber. After conditioning, and whilst still at  $-75^{\circ}\text{C}$ , half of the samples shall be immediately tested for resistance to bending. Mandrel diameter for D-SCE 6.4 size tubing is 9.5mm.

Three of each of the remaining markers shall be removed from the cold chamber and allowed to return to room temperature for a minimum of 2 hours at  $23\pm 2^{\circ}\text{C}$ . Samples shall be tested for Mark Adherence in accordance with section 8.3.1. The marking shall be examined for legibility using normal reading vision. Print contrast shall be evaluated in accordance with TE 411-121002.

#### 8.6. Environmental Testing

##### 8.6.1. Copper Mirror Corrosion

The test method shall be as specified in TE 109-121009. Three glass test tubes should be used. Prepare one control tube with copper mirror only, and two tubes with mirrors and printed product. Prepare samples out of recovered specimens, using at least  $150\text{mm}^2$  surface area of product in each tube. Use a printed sample 10mm long. After the test, mirrors should be assessed for corrosion.

##### 8.6.2. Water Absorption

The test method shall be as specified in TE 109-121016. Three 25mm long helical samples should be cut from recovered printed tubing specimens. Samples should be weighed after drying in the oven and after immersion in water. The mean average of three samples should be stated.

##### 8.6.3. UV Resistance

The test shall be carried out using a UV-O-meter chamber in accordance with ASTM G154. Test for 1000 hours at  $1.35\text{ W/m}^2/\text{nm}$  irradiance.

Prepare three recovered and three as supplied for print adherence testing with an additional three recovered and three as supplied installed on wire for bend tests.

Condition two sets of markers prepared as specified in section 8.1 to the following regimes:

- i) UVA type fluorescent bulbs, consisting of a repeating cycle of 8 hours exposure at  $60^{\circ}\text{C}$  ( $140^{\circ}\text{F}$ ) followed by 4 hours of condensation at  $50^{\circ}\text{C}$ .
- ii) UVB type fluorescent bulbs, consisting of a repeating cycle of 8 hours exposure at  $60^{\circ}\text{C}$  ( $140^{\circ}\text{F}$ ) followed by 4 hours of condensation at  $50^{\circ}\text{C}$ .

After conditioning test half of the sleeves for flexibility using a  $90^{\circ}$  mandrel bend test. Mandrel diameter for D-SCE 6.4 size tubing is 9.5mm. Samples shall be visually examined for cracking or splitting.

The remainder of the samples shall be measured for colour change using a spectrophotometer. Measure an area of the sleeve which has not been printed.

Test Mark Adherence in accordance with section 8.3.1. The marking shall be examined for legibility using normal reading vision. Print contrast shall be evaluated in accordance with TE 411-121002.

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### 8.6.4. Fluid Resistance at Ambient Temperature, Physical Properties

The test method shall be as specified in TE 109-121012. Tests shall be made on five x 125mm long fully recovered tubes taken from a continuous reel. Prepare as detailed in clause 8.1.

Tubes shall be completely immersed in each of the fluids for the times and at the temperatures specified in the requirements table. The volume of the fluid shall not be less than 20 times that of the specimen. After immersion, the markers are lightly blotted with tissue paper to remove excess surface fluid and air dried at  $23 \pm 2^{\circ}\text{C}$  for  $45 \pm 15\text{min}$ .

After conditioning samples will be tested for Tensile Strength and Ultimate Elongation in accordance with TE 109-121012.

### 8.6.5. Fluid Resistance at Elevated Temperature, Physical Properties

The test method shall be as specified in TE 109-121012 with the following additions.

For each fluid, tensile tests shall be made on five x 125mm long fully recovered tubes taken from a continuous reel. Prepare as detailed in clause 8.1.

For Diesel testing, an additional set of five samples is required for volume change. Each sample should have a total volume which exceeds  $3\text{cm}^3$ . For volume change, measure sleeve length and wall thickness of each sample before and after immersion.

Samples immersed in Diesel shall be removed from fluid, drained and blotted to remove excess diesel, and then stored at  $20 \pm 5^{\circ}\text{C}$  for a duration of between 3 hours 50 and 4 hours before testing. Where applicable, measure tube dimensions and report volume change, and test for tensile strength and ultimate elongation.

The remaining samples shall be lightly drained and blotted dry with tissue paper, air dried at  $23 \pm 2^{\circ}\text{C}$  for  $45 \pm 15\text{min}$  and then tested tensile strength and ultimate elongation.

## 8.7. Electrical Testing

### 8.7.1. Dielectric strength

The test method shall be as specified in TE 109-121005. Five printed 150mm long specimens to be recovered onto clean steel mandrels (ensuring a tight fit) 24 hours before testing. A 25mm wide aluminium self-adhesive foil electrode to be installed in the centre of each of the recovered and cooled down samples. Average dielectric strength of five samples to be recorded as the result.

### 8.7.2. Volume Resistivity

The test method shall be as specified in TE 109-121017. Three 200-250mm long printed specimens are to be recovered onto clean 300mm long, steel mandrels (no larger in diameter than 15% of the fully recovered diameter of the tested tubing). Each sample should have a 150mm long silver paint electrode painted a minimum 4 hours before testing. Average volume resistivity value should be recorded as the result.



## 8.8. Fire Safety

### 8.8.1. Fire Propagation, ASTM D2671 Procedure B

Five printed samples shall be prepared and tested in accordance with TE method 109-121053. 460mm long samples should be installed onto 530mm long mandrels. Each sample should have a paper flag indicator 250mm above the flame impingement point. The flame should be applied to the sample at a 70° angle. The flame should be applied five times, each application is 15s on and 15s off.

The duration of burning and percentage of the burnt area shall be recorded.

### 8.8.2. EN45545-2 Flammability Hazard Level, Oxygen Index, BS EN ISO 4589-2

The test method shall be as specified in TE 109-121054. Tests shall be carried out on 3mm thick plaques of the material from which the sleeving is fabricated. The plaque should be irradiation cross-linked to the same degree as the sleeving. Test piece dimensions shall be  $6.5 \pm 0.5\text{mm} \times 80 \pm 1\text{mm} \times 3 \pm 0.5\text{mm}$  cut from the plaques. Samples shall be conditioned for at least 24hrs at  $23 \pm 2^\circ\text{C}$  prior to testing. A new test piece shall be used for each determination.

### 8.8.3. Surface Flammability, Flame Spread Index, Is, ASTM E162

This test is performed in accordance with ASTM E162, with the following modification: Instead of testing a moulded plaque, 25.4mm continuous tubing printed with two lines of text is used.

To arrange the samples to form the specified exposed area, 13mm wide cement board fingers are cut from a single board. Six 75mm lengths are cut from the tube, which is then recovered over the cut cement board fingers. The cement board fingers are butted together to form a single sheet. Five single sheets are placed side by side vertically for each test in order to create the required test specimens. Samples are allowed to condition for at least 24 hours at  $23^\circ\text{C}$  before fire testing.

### 8.8.4. Smoke Optical Density, Ds, ASTM E662

This test is performed in accordance with ASTM E662, with the following modification: Instead of testing a moulded plaque, 25.4mm continuous tubing printed with two lines of text is used.

To arrange the samples to form the specified exposed area, 13mm wide cement board fingers are cut from a single board. Six 75mm lengths are cut from the tube, which is then recovered over the cut cement board fingers. The cement board fingers are butted together to form a single sheet. Samples are allowed to condition for at least 24 hours at  $23^\circ\text{C}$  before fire testing. Testing is carried out using an NBS smoke chamber with a  $25\text{kW/m}^2$  radiant heat. Tests are carried out with and without a pilot flame.

### 8.8.5. Heat Release, ASTM E1354

This test is performed in accordance with ASTM E1354, with the following modification: Instead of testing moulded plaques, 25.4mm continuous tubing which has been printed with two lines of text is used.

To arrange the samples to form the specified exposed area, 13mm wide cement board fingers are cut from a single board. Six 75mm lengths are cut from the tube, which is then recovered over the fingers. The cement board fingers are butted together to form a single sheet. Samples are allowed to condition for at least 24 hours at  $23^\circ\text{C}$  ( $73 \pm 7^\circ\text{F}$ ) before fire testing.

Samples are tested using a  $50\text{kW/m}^2$  heat flux. Average Heat Release Rate, Maximum (peak) heat release rate and Average Specific Extinction Area at 3 minutes is measured.

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### 8.8.6. Toxic Gas Generation, Bombardier SMP 800-C

This test is performed in accordance with Bombardier SMP 800-C, with the following modification: Instead of testing a moulded plaque, 25.4mm continuous tubing printed with two lines of text is used to represent end use condition.

To arrange the samples to form the specified exposed area, 13mm wide cement board fingers are cut from a single board. Six 75mm lengths are cut from the tube, which is then recovered over the cut cement board fingers. The cement board fingers are butted together to form a single sheet. Samples are allowed to condition for at least 24 hours at 23°C before fire testing

SMP 800-C is carried out during the ASTM E662 test. Gases are extracted and analysed using the techniques described in SMP 800-C

## 9. RELATED DOCUMENTS

### 9.1. Related Standards and Issue

ASTM D2671: 1999	Standard Test Methods for Heat-Shrinkable Tubing for Electrical Use
ASTM G-154-12a	Standard plastics for operating light and water exposure apparatus (fluorescent UV condensation type) for exposure of non-metallic materials.
AMS-DTL-23053E	Insulating Sleeving, Electrical, Heat Shrinkable, General Specification for Marking of Electrical Insulation Materials.
BS 4G 198-3: 1999	Sleeves and moulded components for aircraft electric cables and equipment wires. Specification for heat shrinkable sleeving for binding, insulation and identification
BS 6853:1999	Code Of Practice for Fire Precautions In The Design and Construction of Passenger Carrying Trains
IEC 60684-2: 1997	Flexible insulating sleeving - Part 2: Methods of test
BS EN ISO 4589-2: 1996	Plastics – Determination of burning behaviour by oxygen index - Part 2: Ambient temperature test
NF X 70 – 100: 1986	Fire Tests Analysis of Pyrolysis and Combustion Gases Tube Furnace Method
NF F 16-101: 1988	Railway Rolling stock fire behaviour choice of materials Rolling Stock Classification A1
DIN 5510-2: 2009-05	Preventive fire protection in railway vehicles-Part 2 Fire behaviour and fire side effects of materials and parts; classification, requirements and test methods. Dripping Classification ST2
BS EN 45545-2: 2013+A1:2015	Railway applications- Fire protection on railway vehicles
SAE AS5942: 2014	Marking Of Electrical Insulating Materials



**9.2. TE Connectivity Documents**

TE Reference	Title	Complies with
411-121002	TE Connectivity Print contrast reference scale	---
411-121005	TE Identification Printer Product Ribbon Matrix	---
109-121002	Tensile Strength and Ultimate Elongation at 23°C	ASTM D2671
109-121003	Dimensions	---
109-121005	Dielectric strength	ASTM D2671 (ASTM D149)
109-121006	Low Temperature Flexibility	IEC 60684-2
109-121007	Heat Shock	SAE-AS-23053 ASTM D2671
109-121008	Heat Ageing	SAE-AS-23053 ASTM D2671
109-121009	Copper Mirror Corrosion	AMS DTL 23053
109-121012	Print Permanence testing using the Mechanical Crockmeter	SAE AS5942
109-121014	Resistance to Solvents	MIL 202 Method 215
109-121015	Specific Gravity	ASTM D792
109-121016	Water Absorption	ASTM D570
109-121017	Volume Resistivity	ASTM D2671 ASTM D257
109-121031	Split Testing	---
109-121046	Thermal Cycling	---
109-121053	Flammability testing	ASTM D2671, procedure B
109-121054	Limited Oxygen Index	BS EN ISO 4589-2:1999

**The current document issue should be used and reference made in the qualification report**

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### 10. SAMPLING

Tests shall be carried out on a sample taken at random from a batch. A batch is defined as that quantity of product extruded at any one time.

Testing frequency shall be Production Routine or Qualification.

Production routine tests consisting of visual examination, dimensions and longitudinal change, print quality and adherence of marking shall be carried out on every batch of sleeving.

Qualification tests shall be carried out to the requirements of the Design Authority.

### 11. STORAGE CONDITIONS

D-SCE should be stored in its original packaging, with any plastic covers which were included during shipping. Store out of direct sunlight in a clean, dry, dust free, environment. Product should not be stored outside of the designed storage temperature, which is  $-10^{\circ}\text{C}$  ( $14^{\circ}\text{F}$ ) to  $40^{\circ}\text{C}$  ( $104^{\circ}\text{F}$ ), and  $50\pm 30\%$  RH.

### 12. PACKAGING

Packaging shall be in accordance with good commercial practice. Each package shall bear an identification label showing material quantity, description, size, color and batch number. Additional information shall be supplied as specified in the contract or order

### 13. STORAGE LIFE<sup>2</sup>

When stored as prescribed above, the shelf life of D-SCE is 144 months from date of manufacture.

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<sup>2</sup> Storage life is a guideline based on 30 years of experience. TE Connectivity cannot provide any test data to validate this statement.





PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2519 SECTION
<b>PHYSICAL TESTING</b>				
<b>Workmanship</b>	Laboratory light box with D65 lighting, using normal or corrected vision at a distance of 14 inches.	---	In accordance with section 8.2	8.2.
<b>Dimensions</b>	TE 109-121003	mm	Table 1	8.4.1.
<b>Longitudinal Change</b>	TE 109-121003	%	0 to -10	8.4.1.
<b>Tensile Strength</b>	TE 109-121002	MPa	15 Minimum	8.4.2.
<b>Ultimate Elongation</b>	TE 109-121002	%	300 Minimum	8.4.2.
<b>Specific Gravity</b>	TE 109-121015	---	1.30 +/- 0.05	8.4.3.
<b>Split testing</b>	TE 109-121031	%	100 pass	8.4.4.
<b>THERMAL TESTING</b>				
<b>Heat Shock</b> 4 hours at 250°C Mandrel Bend Mark Adherence	TE 109-121007	---	No damage to the marker and print	8.5.1.
	TE 109-121012		Legible, minimum print contrast C3	
<b>Heat Ageing</b> 168hrs at 150°C Mandrel Bend Mark Adherence	TE 109-121008	---	No damage to the marker and print	8.5.2.
	TE 109-121012		Legible, minimum print contrast C3	
<b>Thermal cycling</b> 4 cycles of: 1 hour at -75°C then 1 hour at 135°C and 16 hours 23°C, followed by:  Mandrel Bend  Mark Adherence	TE 109-121046			8.5.3.
	90° bend around a 9.5mm mandrel	---	No damage to the marker and print	
	TE 109-121012 20 rubs, 1kg load, eraser	---	Legible, minimum print contrast C3	
<b>Low Temperature flexibility</b> 4 hours at -75°C, followed by:  Mandrel Bend  Mark Adherence	TE 109-121006			8.5.4.
	90° bend around a 9.5mm mandrel	---	No damage to the marker and print	
	TE 109-121012 20 rubs, 1kg load, eraser	---	Legible, minimum print contrast C3	



# RW-2519



PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2519 SECTION
<b>ENVIRONMENTAL TESTING</b>				
<b>Copper Mirror Corrosion</b> 16 Hours at 150°C	TE 109-121009	%	Damaged area of copper mirror, 8 maximum	8.6.1.
<b>Water Absorption</b>	TE 109-121012	%	2 Maximum	8.6.2.
<b>UV Resistance</b> followed by,  Mandrel Bend  Mark Adherence	ASTM G154 UVA and UVB (8 hours dry/4 hours wet cycle)  360° bend around a mandrel (10 x thickness)  TE 109-121012 20 rubs, 1kg load, eraser		1000 hours at each irradiance  No damage to the marker and print  Legible, minimum print contrast 3	8.6.3.
<b>ELECTRICAL</b>				
<b>Dielectric Strength</b>	TE 109-121005	MV/m	20 Minimum	8.7.1.
<b>Volume Resistivity</b>	TE 109-121017	Ohm cm	1 x 10 <sup>14</sup>	8.7.2.
<b>FIRE SAFETY</b>				
<b>Fire Propagation,</b> ASTM D2671 Procedure B	TE 109-121053 ASTM D2671 procedure B	---	Burn time shall not exceed 30 seconds, and not more than 25% of indicator flag shall be burned or charred. No dripping or flowing. No burning of cotton.	8.8.1.
<b>EN45545-2 Flammability Hazard rating:</b>  BS EN ISO 4589-2 Oxygen Index (OI),	BS EN ISO 4589-2 TE 109-121054	%	Requirement set R24 Hazard Level Classification 3 <sup>3</sup>  32% Minimum	8.8.2.
<b>Surface Flammability,</b>  Flame Spread Index (Is)	ASTM E 162	---	35 Maximum	8.8.3.

<sup>3</sup> R22 / HL3 supports unlimited internal use, in any operating category and rail car design.



PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2519 SECTION
<b>Specific Optical Smoke Density, D<sub>s</sub></b>  Flaming Mode 1.5 minutes 4 minutes  Flaming Mode 1.5 minutes 4 minutes	ASTM E 662 25kW/m <sup>2</sup> radiant heat source.  Flaming mode and non-flaming mode.		100 Maximum 200 Maximum  100 Maximum 200 Maximum	8.8.4.
<b>Heat Release<sup>4</sup></b>  Average Heat Release Rate (180 s)  Maximum (Peak) Heat Release Rate  Average specific extinction area (180 s)	ASTM E1354  50kWm <sup>2</sup> applied heat flux with retainer frame	kW/m <sup>2</sup>  kW/m <sup>2</sup>  m <sup>2</sup> /kg	≤ 120  Over course of test ≤ 140  ≤ 500	8.8.5.
<b>Toxic Gas Generation</b> Bombardier BMS 800-C  Carbon Monoxide (CO) Carbon Dioxide (CO <sub>2</sub> ) Nitrogen Oxides (NO <sub>2</sub> ) Sulphur Dioxide (SO <sub>2</sub> ) Hydrogen Chloride (HCl) Hydrogen Fluoride (HF) Hydrogen Bromide (HBr) Hydrogen Cyanide (HCN)	Gas extracted during ASTM E662 test. 25kW/m <sup>2</sup> radiant heat source.  Flaming mode and non-flaming mode assessed, worst case reported.	ppm	Maxima:  3500 90000 100 100 500 100 100 100	8.8.6.

<sup>4</sup> There is currently no requirement for Heat Release testing. TE have incorporated proposed changes to existing FRA 49 CFR Ch. II, Part 238, App. B as recommended by the National Association of State Fire Marshals



**8 TABLE 4: SPECIFIC REQUIREMENTS FOR D-SCE HEAT SHRINK SLEEVING**

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2519 SECTION
<b>ENVIRONMENTAL TESTING</b>				
2% Secant Modulus	TE 109-121004	MPa	172.4 Minimum	8.4.5.
<b>THERMAL TESTING</b>				
Heat Ageing, Mechanical Properties 168 hours at 150°C	TE 109-121002	MPa %	15 Minimum 300 Minimum	8.5.2.
Tensile Strength Ultimate Elongation				
<b>ENVIRONMENTAL PROPERTIES</b>				
<b>Fluid Resistance at Ambient Temperature, Physical Properties</b>	TE 109-121012	MPa %	15 Minimum 300 Minimum	8.6.4.
Tensile Strength Ultimate Elongation  Reference test oil IRM 902 MIL-PRF-23699 lubricating oil Skydrol LD-4 phosphate ester hydraulic fluid MIL-H-83282 Hydraulic Fluid JP8 Jet Fuel Diesel Fuel Propylene Glycol de-icing fluid 50/50 Tap Water 5% Sodium Chloride Solution 1% Teepol detergent				
<b>Fluid Resistance at Elevated Temperature, Physical Properties</b>	TE 108-121012 TE 108-121002	MPa % Percent % cm <sup>3</sup> %	Print legible after 20 wipes ± 20% of original ± 20% of original ± 10% of original	8.6.5.
Diesel Fuel, 168 hours at 70°C  Print Permanence Tensile Strength Ultimate Elongation Volume change IRM 902, 72 hours at 50°C  Print Permanence Tensile Strength Ultimate Elongation				
	TE 108-121012 TE 108-121002	--- MPa % %	Print legible after 20 wipes ± 20% of original ± 20% of original	

## RW-2519



### 9 TEST FLUIDS DESCRIPTION

Fluid	Description
IRM902	Reference Oil (ASTM oil NO. 2 replacement)
MIL-PRF-23699	Synthetic lubricating oil STD class (NATO Code 0-156). Has replaced MIL-L-7808 oil at temperatures above 25°C.
Skydrol LD-4	Widely used aviation phosphate ester based hydraulic fluid.
MIL-H-83282	The principal hydraulic fluid used in military aircraft. It replaces MIL-H-5606.
JP-8	Kerosene based jet fuel, replacement for JP-4. NATO code is F-34. It's specified by MIL-DTL-83133 and British Defence Standard 91-87.
Diesel Fuel (BS EN 590:2009+A1)	General fuel used in transportation
Propylene Glycol de-icing fluid (SAE-AMS-1424)	Aerospace De-icing fluid, 50/50 % mixture with water
Tap Water	Universal solvent
5% Sodium chloride solution	Sodium chloride is a universal compound used in many chemicals and de-icing fluids
Detergent (1% Teepol)	Commonly used industrial detergent
IPA - Isopropyl alcohol	Widely used as a solvent and cleaner

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