

SPECIFICATION RW-2529

Document Number: 108-121035

LFH Cable Markers

HLX Cable Marker

HLX-NEL (Narrow Edge Leading)

SCOPE

This Quality Assurance Specification establishes the quality standard for Low Fire Hazard (LFH) Cable Markers for use in applications where smoke, gases or corrosive by products would constitute a particular hazard to life, or property. These special requirements are detailed in the specific requirements table.

The operating temperature for this product is -40°C to +105°C (-40°F to +221°F).

This system is an automatic method of identifying wire and cable by printing a mark onto a Cable Marker. This system is designed to be applied once cabling has been installed. Each label is bound to the assembly by two Cable ties. Note for a LFH system the Cable ties must also be classed as Low Fire Hazard. Cable Markers have high print quality, mark adherence, and print permanence after printing.

The marker system comprises specific printers and ribbons (refer to Identification Printer Product Ribbon Matrix Document 411-121005). Compliance to this specification can only be guaranteed if TE Connectivity approved printers and ribbons are used.

The HLX Cable Marker description used for testing is HLX125WE2NEL60S, this covers all family derivatives including formats, sizes and colors. This standard applies to the Cable Marker product only and not the system.

Approved Signatories:

This document is electronically reviewed and approved by TE Connectivity.

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1. REVISION HISTORY

Revision Number	Description of change	Date	Incorporated By
1	Initial	September 2006	Alan Kean
2	See PCN	December 2013	Lee Smith
3	See PCN Note RW-2523 HLX made obsolete and incorporated into this document	March 2014	Lee Smith

2. REQUIREMENTS

2.1 Composition, appearance and color

The Cable Marker shall be fabricated from an irradiation cross-linked, UV and thermally stabilised, polyolefin compound. Halogens, Phosphorus, Silicone and Nitrogen shall not be intentionally added to the compound, nor shall these substances be present by more than trace amounts in the finished article.

The finished article shall be homogeneous and essentially free from flaws, defects, pinholes, bubbles, seams, cracks or inclusions.

The markers shall be White or Yellow unless otherwise specified.

2.2 Dimensions, available sizes and formats

Refer to figures 1 and 2

Color codes for ordering description:

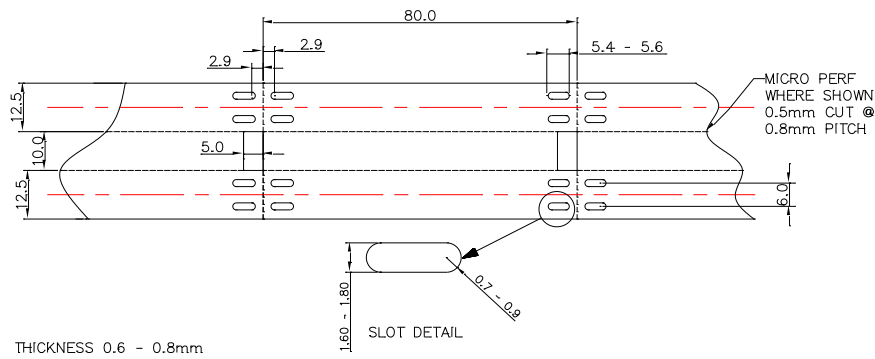
YW: Yellow

WE: White

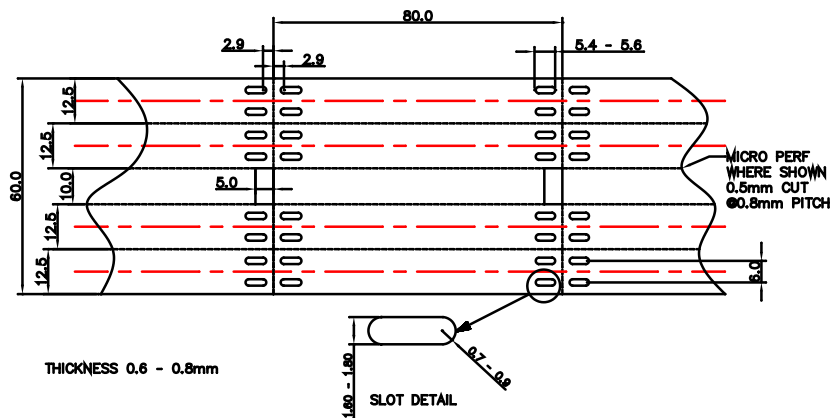
Label markers of non-standard dimensions may be supplied as specified in the contract of order

FIGURE 1: HLX-NEL DETAIL

Two Across – HLX125**2NEL60S



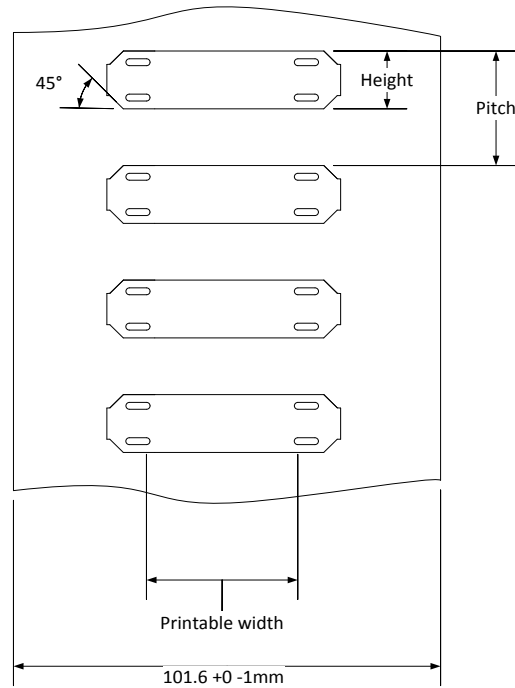
Four Across – HLX125**4NEL60S



Note: Dimensions in mm.

Ordering Description	Marker Dimensions (Width x Height)		Printable Area (Width x Height)		Number of Markers Across Width
	mm	Inches	mm	Inches	
HLX125<color>2NEL60S	80 x 12.5	3.15 x 0.49	60 x 10.5	2.36 x 0.40	2
HLX125<color>4NEL60S	80 x 12.5	3.15 x 0.49	60 x 10.5	2.36 x 0.40	4

FIGURE 2: HLX DETAIL



Product Code	Number of markers per page	Pitch		Number of slots	Marker length		Printable width		Marker height	
		mm	Inches		mm	Inches	mm	Inches	mm	Inches
HLX104**TS025	20	12.7	0.5	4	45	1.77	25	0.98	10.4	0.41
HLX104**TS033	20	12.7	0.5	4	53	2.09	33	1.30	10.4	0.41
HLX104**TS038	20	12.7	0.5	4	58	2.28	38	1.50	10.4	0.41
HLX104**TS050	20	12.7	0.5	4	70	2.76	50	1.97	10.4	0.41
HLX104**TS070	20	12.7	0.5	4	90	3.54	70	2.76	10.4	0.41
HLX150**TS025	10	25.4	1.0	4	45	1.77	25	0.98	15.0	0.59
HLX150**TS033	10	25.4	1.0	4	53	2.09	33	1.30	15.0	0.59
HLX150**TS038	10	25.4	1.0	4	58	2.28	38	1.50	15.0	0.59
HLX150**TS050	10	25.4	1.0	4	70	2.76	50	1.97	15.0	0.59
HLX150**TS070	10	25.4	1.0	4	90	3.54	70	2.76	15.0	0.59
HLX203**TS025	10	25.4	1.0	4	45	1.77	25	0.98	20.3	0.80
HLX203**TS033	10	25.4	1.0	4	53	2.09	33	1.30	20.3	0.80
HLX203**TS038	10	25.4	1.0	4	58	2.28	38	1.50	20.3	0.80
HLX203**TS050	10	25.4	1.0	4	70	2.76	50	1.97	20.3	0.80
HLX203**TS070	10	25.4	1.0	4	90	3.54	70	2.76	20.3	0.80
HLX253**TS025	5	50.8	2.0	4	45	1.77	25	0.98	25.3	1.00
HLX253**TS033	5	50.8	2.0	4	53	2.09	33	1.30	25.3	1.00
HLX253**TS038	5	50.8	2.0	4	58	2.28	38	1.50	25.3	1.00
HLX253**TS050	5	50.8	2.0	4	70	2.76	50	1.97	25.3	1.00
HLX253**TS070	5	50.8	2.0	4	90	3.54	70	2.76	25.3	1.00

2.3 Test Requirements

This specification details the requirements for HLX family of products. The performance requirements are listed in the general and specific requirements tables.

3. QUALITY ASSURANCE PROVISIONS

3.1. Qualification Tests

Qualification tests are those performed on finished Cable Marker, continuous sheet or material pellets submitted for qualification as a satisfactory product and shall consist of all tests listed in this specification.

Some tests require un-perforated lengths which are not supported by the finished Cable marker format therefore continuous sheet shall be tested. For this document, 'Cable Marker' shall be defined as specimen that represents the finished article; this is the material taken from the end of the production line. 'Continuous strip' is specimen taken from work in progress and is removed from the production line prior to finishing. Other than the format, both of these specimens are identical.

3.2. Qualification Test Samples

Qualification test samples shall consist of 75m (250 feet) of HLX125WE4NEL60S (White). Of this; 60m (200 feet) shall be submitted for fire testing and 15m (50 feet) for all remaining tests.

Cable Marker, Continuous Strip and Material pellets shall be taken from the same compound batch.

4. TEST METHODS

4.1 Preparation of Test Specimens

Finished Cable Markers for testing shall be printed with TE approved printers and ribbons (TE document 411-121005) and printed with Arial size 10 pt font. The initial print contrast must be C8 or above, reference TE Document 411-121002.

Unless otherwise specified, tests shall be carried out on Cable Markers that have had no pre-conditioning. When required by the test method, testing shall be made with continuous strip. 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.

4.2 Print Performance

4.2.1 Mark Adherence

Three Cable Markers shall be prepared as detailed in Clause 4.1 and tested in accordance with TE test reference 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, marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

4.2.2 Solvent Resistance

Nine Cable Markers shall be prepared as detailed in Clause 4.1 and tested in accordance with TE test reference 109-121014.

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

4.2.3 Fluid Resistance

Three Cable Markers as prepared as in Clause 4.1 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 $45 \pm 15\text{min}$. The print shall be tested in accordance with TE test reference 109-121012. Samples are tested with a Crockmeter fitted with 'Super Twill' cloth and a 1kg load.

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

4.3 Physical Testing

4.3.1 Dimensions

Dimensions shall be measured using a calibrated micrometer. A minimum of three markers shall be measured to confirm dimensions.

4.3.2 Tensile Strength and Ultimate Elongation

The test method shall be as specified in TE Document 109-121002. Five 150mm long specimens 6.4mm wide shall be cut from a pre-punched continuous strip. Samples shall be taken from the longitudinal direction. A gauge length of 25mm with a 50mm initial jaw separation and a strain rate of $500 \pm 5\text{mm/m}$ shall be used.

Note: test specimens should not be annealed before testing.

4.3.3 Specific Gravity

Samples of un-printed product shall be tested to the procedure as specified in TE Document 109-121015.

4.4 Thermal Testing

4.4.1 Heat Ageing

The test method shall be as specified in TE document 109-121008. Six Cable Markers shall be prepared as detailed in section 4.1. Specimens shall be conditioned for 168 hours at $135\pm 2^{\circ}\text{C}$ in an air circulating oven. Markers shall be removed and allowed to cool to room temperature for a minimum of 4 hours at $23\pm 2^{\circ}\text{C}$.

After conditioning three samples shall be tested for Mark Adherence, in accordance with section 4.2.1. The marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

The remaining three samples shall be tested for resistance to bending. Specimens shall be bent around a mandrel with a diameter 10 x specimen thickness ($\pm 10\%$).

4.4.2 Heat Shock

The test method shall be as specified in TE Document 109-121007. Six Cable Markers shall be prepared as detailed in section 4.1. Specimens shall be conditioned for 4 hours at $175\pm 2^{\circ}\text{C}$ in an air circulating oven. Remove the markers and leave to cool to room temperature for a minimum of 2 hours at $23\pm 2^{\circ}\text{C}$.

After conditioning three samples shall be tested for Mark Adherence in accordance with section 4.2.1. The marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

The three remaining samples shall be tested for resistance to bending. Specimens shall be bent around a mandrel with a diameter 10 x specimen thickness ($\pm 10\%$).

4.4.3 Low Temperature Flexibility

The test method shall be as specified in TE Document 109-121006. Six Cable Markers shall be prepared as detailed in section 4.1. Specimens shall be conditioned for 4 hours at $-40\pm 2^{\circ}\text{C}$ in a cold chamber. The markers are removed and allowed to cool to room temperature for a minimum of 2 hours at $23\pm 2^{\circ}\text{C}$.

After conditioning three samples shall be tested for Mark Adherence in accordance with section 4.2.1. The marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

The three remaining samples shall be tested for resistance to bending. Specimens shall be bent around a mandrel with a diameter 10 x specimen thickness ($\pm 10\%$).

4.5 Environmental Testing

4.5.1. Fungus Resistance

Three Cable Marker specimens shall be printed and prepared as specified in section 4.1.

Care should be taken during handling, printing, and with any packaging used. Product contamination may lead to erroneous results.

The test method shall be as specified in BS EN 60068-2-10:2005. Samples shall be conditioned for 28 days after which Fungus growth is visually assessed in accordance with BS EN 60068-2-10:2005.

After conditioning three samples shall be tested for Mark Adherence in accordance with section 4.2.1. The marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

4.5.2. UV Exposure

Tests shall be carried out on product prepared for Mark Adherence, Tensile Strength and Ultimate Elongation as detailed above.

The test shall be carried out using a UV-O-meter chamber in accordance with ASTM G154. Test for 1000 hours at 1.35 W/m²/nm irradiance:

- i) UVA type fluorescent bulbs, consisting of a repeating cycle of 8 hours exposure at 60°C and followed by 4 hours of condensation at 50°C.
- ii) UVB type fluorescent bulbs, consisting of a repeating cycle of 8 hours exposure at 60°C and followed by 4 hours of condensation at 50°C.

After conditioning test for Mark Adherence using TE test method 109-121012 and Tensile Strength and Ultimate Elongation using TE test method 109-121002.

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

4.5.3. Colorfastness to light (Color and mark fading)

Three Cable Markers shall be submitted for testing. Specimen shall be printed and prepared as specified in section 4.1.

Samples shall be tested in accordance with BS 2782: Part 5: Method 540B using a Xenon arc discharge lamp. Blue Wool reference standards conforming to BS 1006: B01 shall be similarly exposed. The test should be terminated when the Blue wool scale standard 5 has faded to 4 on the geometric grey scale. The specimen temperature shall not exceed 40°C; no control over humidity shall be exercised.

The specimen shall be observed in standard illuminant D65 using normal vision for color change against the reference wool standards.

Guide to light fastness rating:

Rating 8	Excellent light fastness
Rating 7	Excellent light fastness
Rating 6	Very good light fastness
Rating 5	Fair light fastness (Impermanent)
Rating 4	Fair light fastness (Impermanent)
Rating 3	Poor light fastness (Fugitive)
Rating 2	Poor light fastness (Fugitive)
Rating 1	Very poor light fastness (Fugitive)

Samples are tested for Mark Adherence, in accordance with section 4.2.1. The marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

4.6 Flammability Testing

4.6.1. Fire Propagation

Continuous Cable Marker strip taken from manufacturing prior to punching is printed as stated in section 4.1 'Preparation of test samples', and then tested in accordance with Airbus directive ABD0031, 15 second horizontal test. The conditions used are stated in specification AITM 2.0003.

4.6.2. Flame Spread Index, ASTM E162

The test is performed in accordance with ASTM E162 on continuous Cable Marker strip taken from manufacturing prior to punching. All samples tested are printed using the standard TE Identification printing system as stated in section 4.1. 'Preparation of test samples'. Samples are tested in both flaming and non-flaming modes. Measurements are taken at 1.5 and 4 minutes.

4.6.3. Specific Optical Density, ASTM E 662

The test is performed in accordance with ASTM E662 on continuous Cable Marker strip taken from manufacturing prior to punching. All samples tested are printed using the standard TE Identification printing system as stated in section 4.1. 'Preparation of test samples'.

4.6.4. Toxic gas generation from material combustion, BSS 7239

The test is performed in accordance with BSS 7239 on continuous Cable Marker strip taken from manufacturing prior to punching. All samples tested are printed using the standard TE Identification printing system as stated in section 4.1. 'Preparation of test samples'.

4.6.5. Effective Heat of Combustion, ASTM E1354

The test is performed in accordance with ASTM E1354 on continuous Cable Marker strip taken from manufacturing prior to punching. All samples tested are printed using the standard TE Identification printing system as stated in section 4.1. 'Preparation of test samples'. Testing is carried out by oxygen consumption calorimeter using a heat flux of 50 kW/m². Average heat release rate after 3 minutes and Average Extinction area after 3 minutes was measured.

4.6.6. Limited Oxygen Index

The test method shall be as specified in BS EN ISO 4589-2. Tests shall be carried out on 3mm thick plaques of the material from which the Cable Marker is fabricated. The plaque will be irradiation cross-linked to the same degree as the Cable Marker. Test piece dimensions shall be 6.5 ± 0.5mm x 80 ± 1mm x 3 ± 0.5mm cut from the plaques and shall be conditioned for at least 24hrs at 23 ± 2°C prior to testing. A new test piece shall be used for each determination.

4.6.7. Glow Wire Test

The test is performed in accordance with BS EN 60695-2-10: 2001 using a glow wire at 850°C. Testing shall be carried out on printed product. A length of 250mm in 4-wide continuous product shall be supplied for testing. Product shall be printed as defined in section 3.1 'Preparation of samples'.

4.6.8. Smoke Density (3m³)

The test method shall be as specified in BS 6853:1999 Annex D.8.3. Tests shall be carried out on 3mm thick plaques of the material from which the sleeving is fabricated. The plaques will be irradiation cross-linked to the same degree as the sleeving.

4.6.9 Smoke Density NF X 10-702

The test is performed in accordance with NF X 10-702 on continuous Cable Marker strip taken from manufacturing prior to punching. All samples tested are printed using the standard TE Identification printing system as stated in section 4.1. 'Preparation of test samples'. One sample is tested using a 25kW/m² radiant heat with and with a pilot flame. Two further samples are tested in the mode which ever gives the worst overall results. Values of maximum specific density of smoke (Dm) and rate of smoke production during the first four minutes (VOS₄) are measured.

4.6.10. Toxic Fume, Elemental Analysis

This test is performed in accordance with London Underground Standard 1-085 A3 Fire safety performance of materials. Tests are to be carried out on printed product. A 250mm length of 4-wide continuous product shall be printed as defined in clause 3.1 'Preparation of samples'.

Testing shall be carried out using qualitative analysis using x-ray fluorescence spectroscopy.

4.6.11. Toxic Gas Emission

The test shall be carried out as specified in NF X 70-100. The mass based method is used. Testing is carried out on continuous cable marker strip taken from manufacturing prior to punching. All samples tested are printed using the standard TE Identification printing system as stated in section 4.1. 'Preparation of test samples'. 50g of material is submitted for testing. The test is conducted at 600°C. Values of CIT and R are determined.

5. RELATED DOCUMENTS

5.1. Related Standards and Issue

Document, Revision	Description
ABD0031 ISSUE F	FIREWORTHINESS REQUIREMENTS PRESSURIZED SECTION OF FUSELAGE
AFNOR NF FR 16-101: 1988	ROLLING STOCK. FIRE BEHAVIOUR. CHOICE OF MATERIALS
AITM-0003 ISSUE 2	RESISTANCE OF MATERIALS WHEN TESTED ACCORDING TO THE 15S HORIZONTAL BUNSEN BURNER TEST
ASTM E 162-13	STANDARD TEST METHOD FOR SURFACE FLAMMABILITY OF MATERIALS USING A RADIANT HEAT ENERGY SOURCE
ASTM E 662-13D	STANDARD TEST METHOD FOR SPECIFIC OPTICAL DENSITY OF SMOKE GENERATED BY SOLID MATERIALS
ASTM D882 METHOD A	STANDARD TEST METHOD FOR TENSILE PROPERTIES OF THIN PLASTIC SHEETING
ASTM D792 METHOD A	STANDARD TEST METHODS FOR SPECIFIC GRAVITY (RELATIVE DENSITY) AND DENSITY OF PLASTICS BY DISPLACEMENT
ASTM E 1354-13	STANDARD TEST METHOD FOR HEAT AND VISIBLE SMOKE RELEASE RATES FOR MATERIALS AND PRODUCTS USING AN OXYGEN CONSUMPTION CALORIMETER
ASTM G154-06	STANDARD PRACTICE FOR OPERATING FLUORESCENT LIGHT APPARATUS FOR UV EXPOSURE OF NONMETALLIC MATERIALS
EN 45545-2: MARCH 2013	RAILWAY APPLICATIONS - FIRE PROTECTION ON RAILWAY VEHICLES - PART 2: REQUIREMENTS FOR FIRE BEHAVIOUR OF MATERIALS AND COMPONENTS
BS EN 60068-2-10:2005	ENVIRONMENTAL TESTING, TESTS. TEST J AND GUIDANCE: MOULD GROWTH
BS 6853:1999	CODE OF PRACTICE FOR FIRE PRECAUTIONS IN THE DESIGN AND CONSTRUCTION OF PASSENGER CARRYING TRAINS
BS 2782 PART 5 METHOD 540B	METHOD OF EXPOSURE TO LABORATORY LIGHT SOURCES (XENON ARC LAMP, ENCLOSED CARBON ARC LAMP, OPEN FLAME CARBON ARC AND FLUORESCENT TUBE LAMPS)
BS EN 60695-2-10: 2013	FIRE HAZARD TESTING GLOWING/HOT-WIRE BASED TEST METHODS. GLOW-WIRE APPARATUS AND COMMON TEST PROCEDURE
BS EN ISO 4589-2	PLASTICS - DETERMINATION OF BURNING BEHAVIOR BY OXYGEN INDEX - PART 2: AMBIENT TEMPERATURE TEST
NF X 70 – 100:1986	FIRE TESTS ANALYSIS OF PYROLYSIS AND COMBUSTION GASES, TUBE FURNACE METHOD
MIL STD 202 METHOD 215	TEST METHODS FOR ELECTRONIC AND ELECTRICAL COMPONENT PARTS. RESISTANCE OF SOLVENTS.
SAE AS5942	MARKING OF ELECTRICAL INSULATING MATERIALS
LONDON UNDERGROUND STANDARD 1-085	REVISION A3, FIRE SAFETY PERFORMANCE OF MATERIALS.
IEC 60212 ED3.0	STANDARD CONDITIONS FOR USE PRIOR TO AND DURING THE TESTING OF SOLID ELECTRICAL INSULATING MATERIALS

5.2. TE Connectivity Documents

TE Reference	Issue	Title	Complies with
109-121002	4	Tensile Strength and Ultimate Elongation at 23°C	ASTM D882 Method A
109-121003	3	Dimensions	---
109-121006	4	Low Temperature Flexibility	IEC 60684-2
109-121007	4	Heat Shock	---
109-121008	3	Heat Ageing	---
109-121012	5	Print Permanence testing using the Mechanical Crockmeter	SAE AS5942
109-121014	4	Resistance to Solvents	MIL 202 Method 215
109-121015	3	Specific Gravity	ASTM D792 Method A

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

6. Sampling

Tests shall be carried out on a sample taken at random from a batch of Cable Marker. A batch of Cable Marker 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 and Dimensions shall be carried out on every batch of product.

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

7. Storage Conditions

Cable Markers should be stored in a clean dry location. Maximum storage temperature is 40°C (104 °F).

8. Packing

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.

GENERAL REQUIREMENTS

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2529 SECTION
PRINT PERFORMANCE				
Mark Adherence	TE Document 109-121012 20 rubs, 1kg load, eraser	---	Legible, minimum print contrast 3	4.2.1.
Solvent Resistance	TE Document 109-121014 30 strokes, tooth brush	---	Legible, minimum print contrast 3	4.2.2.
Fluid Resistance	<ul style="list-style-type: none"> • Aircraft Fuel ISO 1817 Liquid B • Phosphate Ester Based, ISO 1817 Liquid 103 • Silicone Based S1714 • Propan-2-ol • De-icing Fluid, 50% ethylene glycol in water 	<ul style="list-style-type: none"> 24 ± 2hours immersion, 40 ± 2°C 24 ± 2hours immersion, 70 ± 2°C 24 ± 2hours immersion, 50 ± 2°C 24 ± 2hours immersion, 23 ± 2°C 24 ± 2hours immersion, 23 ± 2°C 	<ul style="list-style-type: none"> --- --- --- --- --- 	<ul style="list-style-type: none"> 4.2.3.
Followed by Mark Adherence	TE test method 109-121012 20 rubs, 1kg load, Cloth.		20 rubs, legible Minimum Print Contrast 3	
PHYSICAL				
Visual Inspection	In good lighting, using normal or corrected vision at a distance of 14 inches.	---	In accordance with section 2.1.	2.1.
Dimensions	TE test method 101-121003	---	Figures 1 and 2	4.3.1.

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2529 SECTION
Tensile Strength	TE test method 101-121002	MPa	7 Minimum	4.3.2.
Ultimate Elongation	TE test method 101-121002	%	80 Minimum	4.3.2.
Specific Gravity	TE test method 101-121015	---	1.57 ± 0.03	4.3.3.
THERMAL				
Heat Ageing 168 hours at 135°C, followed by:	TE test method 101-121008			
	<ul style="list-style-type: none"> Mandrel Bend Mark Adherence 	360° bend around a mandrel (10 x thickness) TE Document 109-121012 20 rubs, 1kg load, eraser	--- ---	No damage to the marker and print Legible, minimum print contrast 3
Heat Shock 4 hours at 175°C, followed by:	TE test method 101-121007			
	<ul style="list-style-type: none"> Mandrel Bend Mark Adherence 	360° bend around a mandrel (10 x thickness) TE Document 109-121012 20 rubs, 1kg load, eraser	--- ---	No damage to the marker and print Legible, minimum print contrast 3
Low Temperature flexibility 4 hours at -40°C, followed by:	TE test method 101-121006			
	<ul style="list-style-type: none"> Mandrel Bend Mark Adherence 	360° bend around a mandrel (10 x thickness) TE Document 109-121012 20 rubs, 1kg load, eraser	--- ---	No damage to the marker and print Legible, minimum print contrast 3

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2529 SECTION
ENVIRONMENTAL				
Fungus Resistance Followed by <ul style="list-style-type: none"> Fungus Growth Rating Mark Adherence 	BS EN 60068-2-10:2005 Visual Inspection TE Document 109-121012 20 rubs, 1Kg load	--- ---	Maximum Rating 0 Legible, minimum print contrast 3	4.5.1.
UV Resistance Followed by <ul style="list-style-type: none"> Tensile Strength Ultimate Elongation Mark Adherence 	ASTM G154 UVA (100% dry cycle) UVB (8 hours dry/4 hours wet cycle) TE test method 101-121002 TE test method 101-121002 TE Document 109-121012 20 rubs, 1Kg load	MPa % ---	>90% original value >40% original value Legible, minimum print contrast 3	4.5.2.
Colorfastness to Light (Color and mark fading) followed by <ul style="list-style-type: none"> Visual Inspection Mark Adherence 	BS 2782 Part 5 Method 540B Using normal or corrected vision at a distance of 14 inches TE Document 109-121012 20 rubs, 1Kg load	--- ---	Slight increase in brightness is acceptable; the hue of the tested marker shall clearly match that of the original. Legible, minimum print contrast 3	4.5.3.

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2529 SECTION
FIRE SAFETY				
Fire Propagation	Airbus Directive ABD0031 Issue F, Fire worthiness requirements pressured section of fuselage (15 s horizontal test – AITM 2.0003)	mm/s (mm/inch)	Burn rate must not exceed 102mm/min (4 inches/min)	4.6.1.
Surface Flammability, Flame Spread Index, Is	ASTM E162	---	35 Maximum	4.6.2.
Specific Optical Smoke Density, Ds Flaming Mode Specific Optical Density 1.5 minutes 4 minutes Non Flaming Mode 1.5 minutes 4 minutes	ASTM E 662	--- --- --- ---	100 Maximum 200 Maximum 100 Maximum 200 Maximum	4.6.3.
Toxic Gas Generation from Material Combustion Carbon Monoxide (CO) Carbon Dioxide (CO ₂) Nitrogen Oxides (NO ₂) Sulphur Dioxide (SO ₂) Hydrogen Chloride (HCl) Hydrogen Fluoride (HF) Hydrogen Bromide (HBr) Hydrogen Cyanide (HCN)	BSS 7239 Measured at maximum smoke density. Flaming mode and non-flaming mode assessed, worst case reported.	ppm	Maxima: 3500 90000 100 100 500 100 100 100	4.6.4.
Effective Heat of Combustion¹ Average Heat Release Rate, 3 minutes Average Extinction area, 3 minutes	ASTM E1354 50kWm ² applied heat flux with retainer frame	kW/m ² m ² /kg	≤ 100 Maximum 500	4.6.5.

¹ NFPA 130 does not specify a requirement for small electrical components, the figures stated are based on current best practices for US federal rail administration and national fire protection association.

SPECIAL REQUIREMENTS FOR LFH CABLE MARKER

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2529 SECTION
EN45545-2 Flammability Hazard Rating for interior mass 500g (following grouping rules) <i>Based on the following criteria:</i>			Requirement Set R24, Hazard Rating 3	
Oxygen Index (OI)	BS EN ISO 4589-2:1999	%	32 Minimum	4.6.6.
London Underground Standard 1-085: A3 Non-listed items <i>Based on the following criteria:</i>				
Oxygen Index (OI)	BS EN ISO 4589-2:1999	%	30 Minimum	4.6.6.
Smoke Density, Annex D.8.3., 'A0'	BS6853: 1999, Annex D.8.3	M ² /g	0.02 Maximum	4.6.8.
Toxicity, Annex B (using BS6853 cat 1a requirements), 'R'	BS 6853: 1999, Annex B NF X 70-100	---	1.0 Maximum	4.6.11.
Toxic Fume, Elemental Analysis	Use printed product, London Underground Standard 1-085 A3 Fire safety performance of materials.	---	Halogen, Phosphorus, Silicone or Nitrogen shall not be intentionally added or be present at greater than trace amounts (300ppm maximum)	4.6.10.
BS6853 Interior minor use of materials of mass 100-500g <i>Based on the following criteria:</i>			Vehicle Category 1a	
Oxygen Index (OI)	BS EN ISO 4589-2:1999	%	34 Minimum	4.6.6.
Smoke Density, Annex D.8.3, A0	BS6853: 1999, Annex D.8.3.)	M ² /g	0.017 Maximum	4.6.8.
Toxicity, Annex B, R	BS 6853: 1999, Annex B NF X 70-100	---	1.0 Maximum	4.6.11.

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2529 SECTION
AFNOR NF F 16-101 Category A1 Rolling Stock, 'Small dimension parts' ² <i>Based on the following criteria:</i>	Use the methods below for flammability, smoke and toxicity, determine 'I' and 'F'	---	Category A1 NF F 16-101 Grid 10	
Flammability, I Rating (ignitability) Oxygen Index (OI)	Determine I rating using the following tests - BS EN ISO 4589-2:1999	%	I3 28 Minimum	4.6.6.
Glow Wire test	BS EN 60695-2-11: 2001	---	Ignition does not persist at 850°C afterglow wire is withdrawn	4.6.7.
F Rating (Smoke and toxic gas) Measure and record for calculation of F rating: CIT Maximum specific optical density of smoke, Dm Rate of smoke production during first 4 minutes of test, VOS ₄ Smoke Index, SI	Determine F rating using the following tests - NF X 70-100, Toxic gas emission, mass based method. NFX 10-702, Determination of the opacity of smoke in a non-renewed atmosphere.	--- --- --- ---	F1 ≤ 20	

² Situated inside vehicles, individual parts do not exceed 100g, aggregate mass less than 200g/m. Requirements taken from grid 10 of NF 16-101