

SPECIFICATION RW-2519

Document Number: 108-121020

D-SCE and D-SCE-FLAT range

Heat Shrink Sleeving

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°C to + 135°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 (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 tube size for qualification testing is 6.4mm as supplied internal diameter.

Approved Signatories:

This document is electronically reviewed and approved by TE Connectivity.

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

2. REQUIREMENTS

2.1 Composition, appearance and colour

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 markers shall be Yellow unless otherwise specified.

2.2 Dimensions

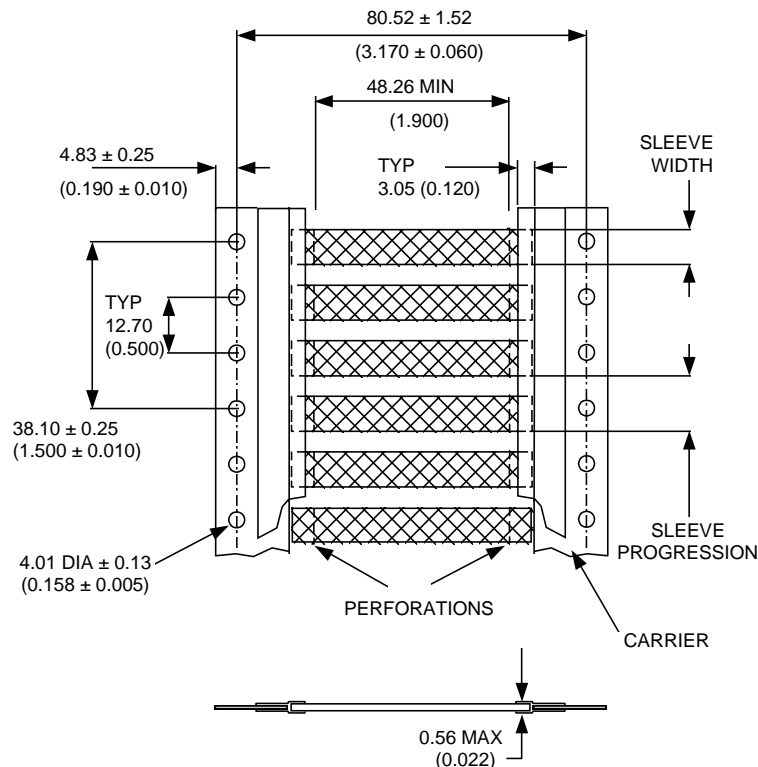
The product shall be supplied in one of the following formats:

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.

Figure 1. D-SCE format

Note: Dimensions in mm (inch)



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TABLE 1: Product 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* 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

* Sleeve Progression column is applicable only for ladder format.

2.3 Tests Requirements

This specification details the requirements for the D-SCE family of products. Table 2 lists the general requirements and Table 3 lists the specific performance.

3. TEST METHODS

3.1 Preparation of Test Specimens

Finished markers for testing shall be printed with TE approved printers and ribbons and printed with

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Arial size 10 pt font, (the initial print contrast must be C8 or above – reference Doc. No: 411-121002). 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. Unless otherwise specified, tests shall be carried out on markers, recovered by conditioning in a fan assisted air circulating oven for 5 ± 1 minute at $200 \pm 5^\circ\text{C}$ and allowed to cool in air to ambient temperature for at least four hours. All print permanence tests shall be carried out on both expanded and recovered markers. 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 under standard ambient conditions; this shall be a temperature of $23 \pm 2^\circ\text{C}$.

3.2 Physical Testing

3.2.1 Dimensions and Longitudinal Change

The test method shall be as specified in IEWI-003.

The length and inside diameter of three marker sleeves shall be measured. Mark two gauge marks 100mm apart. The markers shall be recovered in a fan assisted air-circulating oven 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.

3.2.2 Tensile Strength and Ultimate Elongation - Specific to D-SCE range

The test method shall be as specified in IEWI-002. 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 ± 10 mm per minute shall be used.

3.2.3 Specific Gravity

The test method shall be as specified in IEWI-015. Three specimens of fully recovered tubing 25mm long should be tested. Helical test specimens should be prepared to prevent trapping of air.

3.2.4 Split Testing

The test method shall be as specified in IEWI-031. Ten perforated or scored marker sleeves should be tested. Samples should be recovered, onto an ambient temperature mandrel for twenty minutes in a fan assisted oven at 200°C . Samples should be examined for splitting after they have been cooled down to room temperature.

3.2.5 2% Secant Modulus – Specific to D-SCE range

The test method shall be as specified in IEWI-004. Five specimens 180mm long of expanded tubing should be tested.

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3.3 Thermal Testing

3.3.1 Heat Ageing- Specific to D-SCE range

The test method shall be as specified in IEWI-008. Six samples should be prepared and conditioned as specified in Table 2. Three markers prepared as detailed in Clause 3.1 shall be assessed for print legibility after mark adherence test and three markers recovered onto wire to be used for mandrel bend test. Mandrel diameter for D-SCE 6.4 size tubing is 9.5mm. Refer to IEWI-008 if 6.4 size product is not available. Also five recovered tubular specimens 125mm long should be prepared and conditioned before Tensile Strength and Ultimate Elongation test. The test method shall be as specified in IEWI-002

3.3.2 Heat Shock

The test method shall be as specified in IEWI-007. Six samples should be prepared and conditioned as specified in Table 2. Three markers prepared as detailed in Clause 3.1 shall be assessed for print legibility after mark adherence test and three markers recovered onto wire to be used for mandrel bend test. Mandrel diameter for D-SCE 6.4 size tubing is 9.5mm. Refer to IEWI-007 if 6.4 size product is not available.

3.3.3 Thermal Cycling

The test method shall be as specified in IEWI-046. Six of each recovered and expanded samples should be prepared for testing. Samples should be prepared and conditioned as specified in Table 2. Three markers prepared as detailed in Clause 3.1 shall be assessed for print legibility after mark adherence test and three samples installed onto wire to be used for mandrel bend test. Mandrel diameter for D-SCE 6.4 size tubing is 9.5mm. Refer to IEWI-046 if 6.4 size product is not available.

3.3.4 Low Temperature Flexibility- Specific to D-SCE range

The test method shall be as specified in IEWI-006. Six of each recovered and expanded samples should be prepared for testing. Samples should be prepared and conditioned as specified in Table 2. Three of each markers prepared as detailed in Clause 3.1 shall be assessed for print legibility after mark adherence test and three of each samples installed onto wire to be used for mandrel bend test. Mandrel diameter for D-SCE 6.4 size tubing is 9.5mm. Refer to IEWI-006 if 6.4 size product is not available.

3.4 Electrical Testing

3.4.1 Dielectric strength

The test method shall be as specified in IEWI-005. Five printed 150mm long specimens to be recovered on mandrels (tight fit) 24 hours before testing. A 25mm wide aluminum 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.

3.4.2 Volume Resistivity

The test method shall be as specified in IEWI-017. Three 200-250mm 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.

3.5 Chemical Testing

3.5.1 Copper Mirror Corrosion

The test method shall be as specified in IEWI-009. Three glass test tubes should be set up. One control sample with copper mirror only and two tubes with mirrors and printed product samples together. Make samples out of recovered specimens of 150mm² surface areas each. Use a printed sample 10 mm long. After the test, mirrors should be assessed for corrosion. Refer to IEWI-009 if 6.4 size product is not available.

3.5.2 Water Absorption

The test method shall be as specified in IEWI-016. Three 25mm long helical samples should be made from recovered printed tubing specimens. Samples should be weighed after conditioning both in the oven and in the water and the results should be calculated. The average of three samples should be used for the results. Refer to IEWI-016 if 6.4 size product is not available.

3.6 Environmental Testing

3.6.1 UV Exposure

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. Condition two sets of markers prepared as specified in section 3.1 to the following regimes. A set consists of three recovered and three as supplied for print adherence testing with three recovered and three as supplied installed on wire for bend tests:

- 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 IEWI-012 test method and flexibility using a 90°

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mandrel bend test. Mandrel diameter for D-SCE 6.4 size tubing is 9.5mm.

3.7 Flammability Testing

3.7.1 Flammability ASTM D2671 Procedure B

Five printed samples shall be prepared and tested in accordance with IEWI-053. 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 70° angle. The flame should be applied five times for 15s on and 15s off. For results record the duration of the burning and percentage of the burnt area.

3.7.2 Limited Oxygen Index - LOI EN 45545-2 , BS6853 (BS EN ISO 4589-2)

The test method shall be as specified in IEWI-054. Tests shall be carried out on 3mm plaques of the material from which the sleeving is fabricated. The plaque will 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 and 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.

3.7.3 Surface Flame ASTM E162

This test is performed in accordance with ASTM E162, reference IEWI-052 document for test house details. Supply continuous printed tubing taken from 19.0 mm size for testing.

3.7.4 Smoke ASTM E662

This test is performed in accordance with ASTM E662, reference IEWI-052 document for test house details. Supply continuous printed tubing taken from 19.0 mm size for testing performed under flaming exposure and non-flaming condition.

3.7.5 Heat release ASTM E1354

This test is performed in accordance with ASTM E1354, reference IEWI-052 document for test house details. Supply continuous printed tubing taken from 19.0 mm size for testing. Test in accordance with 'EN45545', using 50kW/m² flame.

3.7.6 Toxicity BSS 7239

This test is performed in accordance with BSS 7239, reference IEWI-052 document for test house details. Supply continuous printed tubing taken from 19.0 mm size for testing.

3.8 Print Performance

3.8.1 Mark Adherence

Six markers shall be prepared as detailed in Clause 3.1 and tested in accordance with SAE AS 5942. Samples shall be tested using a Crockmeter with a 1kg load using the number of rubs specified in table 2. Three as supplied and three fully recovered markers shall be tested.

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3.8.2 Fluid Resistance- Specific to D-SCE range

For Print Permanence, six markers shall be prepared as detailed in Clause 3.1. A set of three recovered and three unrecovered samples shall be conditioned as specified in tables 2 and 3. After conditioning samples will be tested in accordance with SAE AS 5942. Samples are tested with a Crockmeter fitted with a cloth and 1kg load using the number of wipes specified in tables 2 and 3. For Tensile Strength and Ultimate Elongation, five recovered tubular specimens 125mm long shall be prepared as detailed in Clause 3.1 and to be conditioned as specified in tables 2 and 3. After conditioning samples will be tested in accordance with ASTM D2671 reference IEWI-002.

4. RELATED DOCUMENTS

4.1 Technical Engineering Work Instructions IEWI

TE reference		Complies with
IEWI-002	Tensile Strength and Ultimate Elongation at 23°C	ASTM D2671
IEWI-003	Dimensions	ASTM D2671
IEWI-005	Dielectric strength	ASTM D2671 (ASTM D149)
IEWI-006	Low temperature flexibility	SAE-AS-23053 and IEC 60684-2
IEWI-007	Heat Shock	SAE-AS-23053 ASTM D2671
IEWI-008	Heat Ageing	SAE-AS-23053 ASTM D2671
IEWI-009	Copper mirror corrosion	ASTM D2671

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IEWI-012	Print permanence testing using the mechanical Crockmeter	SAE AS5942
IEWI-015	Specific Gravity	ASTM D792
IEWI-016	Water absorption	ASTM D570
IEWI-017	Volume Resistivity	ASTM D2671 ASTM D257
IEWI- 031	Split Testing	
IEWI-046	Thermal Cycling	
IEWI-052	External test house matrix	
IEWI-053	Flammability testing	ASTM D2671 procedure B
IEWI-054	Limited Oxygen Index	LOI EN 45545-2 , BS6853

4.2. Standards and Issue

ASTM D2671: 1999	Standard Test Methods for Heat-Shrinkable Tubing for Electrical Use
ASTM G-154	Standard plastics for operating light and water exposure apparatus (fluorescent UV condensation type) for exposure of non metallic materials.
AMS-DTL-23053	Insulating Sleeving, Electrical, Heat Shrinkable, General Specification for Marking of Electrical Insulation Materials.
BS 4G-198-3: 1999	Sleeves and molded 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 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
NF F 16-101	Railway Rolling stock fire behavior choice of materials Rolling Stock Classification A1
1-085 A3	London Underground Engineering Standard 1-085 A3 Fire safety performance of materials
DIN 5510-2	Preventive fire protection in railway vehicles-Part 2 Fire behavior and fire side effects of materials and parts; classification, requirements and test methods. Dripping Classification ST2
EN 45545-2	Railway applications- Fire protection on railway vehicles
SAE AS5942	Marking Of Electrical Insulating Materials
Doc. No: 411-121002	TE Connectivity Print contrast reference scale

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Doc. No: 411-
121005

TE Identification Printer Product Ribbon Matrix

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

5. SAMPLING

Tests shall be carried out on samples taken at random from each batch of marker sleeves.

A batch of markers is defined as that quantity of tubing 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.

6. 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.

TABLE 2 General Requirements for Identification Products

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2519 CLAUSE
PHYSICAL				
Visual examination				2.1
Dimensions	IEWI-003 ASTM D2671	mm	In accordance with Table 1	3.2.1
Longitudinal Change	IEWI-003 ASTM D2671	%	0 to -10	3.2.1
Tensile strength	IEWI-002 ASTM D2671	MPa	15 minimum	3.2.2
Ultimate elongation	IEWI-002 ASTM D2671	%	300 minimum	3.2.3
Specific Gravity	IEWI-015 ASTM D792	g/cm ³	1.30 +/- 0.05	3.2.4
Split testing	IEWI-031	%	100 pass	3.2.5

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THERMAL				
Heat ageing 168hrs 150°C Mandrel Bend Mark Adherence	IEWI-008 ASTM D2671		No damage to the marker and print	3.3.1
	IEWI-012		legible after 20 rubs	
Heat shock 4hrs at 250°C Mandrel Bend Mark Adherence	IEWI-007 ASTM D2671		No damage to the marker and print	3.3.2
	IEWI-012		legible after 20 rubs	
Thermal cycling 4 cycles of 1hr at -75°C and 1hr 135°C Mandrel Bend Mark Adherence	IEWI-046		No damage to the marker and print	3.3.3
	IEWI-012		legible after 20 rubs	
Low temp. flex 4hrs at -75°C Mandrel Bend Mark Adherence	IEWI-006 IEC60684-2		No damage to the marker and print	3.3.4
	IEWI-012		legible after 20 rubs	

ELECTRICAL				
Dielectric strength	IEWI-005 ASTM D2671	MV/m	20 minimum	3.4.1
Volume resistivity	IEWI-017 ASTM D2671	Ohm cm	10 ¹⁴	3.4.2
CHEMICAL				
Copper Mirror Corrosion 16hrs at 150°C	IEWI-009 ASTM D2671	%	8 maximum	3.5.1
Water Absorption	IEWI-016 ASTM D570	%	2 maximum	3.5.2
ENVIRONMENTAL				
UV 1000 hr exposure Mandrel Bend Mark Adherence	ASTM G154 IEWI-012		No damage to the marker and print legible after 20 rubs	3.6.1
FLAMMABILITY				

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Flammability	ASTM D2671 pr.B		Duration of burning 30 seconds maximum	3.7.1
LOI	EN 45545-2 (EN ISO 4589-2)	%	30 minimum (Hazard level 1)	3.7.2
Surface flame	ASTM E162		Maximum 35	3.7.3
Smoke	ASTM E662		Ds 1.5 minutes 100 max Ds 4 minutes 200 max.	3.7.4
Heat release	ASTM E1354		Measure and record	3.7.5
Toxicity	BSS 7239	ppm, max	Carbon monoxide 3500 Nitrogen oxides 100 Sulphur dioxide 100 Hydrogen chloride 500 Hydrogen fluoride 200 Hydrogen bromide 100 Hydrogen cyanide 150	3.7.6

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2072 CLAUSE
PRINT PERFORMANCE				
Print Quality			Initial contrast score C8 minimum	3.1
Mark adherence	SAE-AS5942 IEWI-012		Print legible after 50 rubs	3.8.1
Fluid resistance 24hrs fluid immersion at 24° ± 3°C Print Permanence	IEWI-012		Print legible after 20 wipes	3.8.2
IRM902				
MIL-PRF-23699				
Skydrol LD-4				
MIL-H-83282				
JP-8				

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Diesel Fuel				
Propylene Glycol de-icing fluid 50/50				
Tap Water				
5% Sodium chloride solution				
1% Teepol				
Isopropyl alcohol	IEWI-012 Soaked "Super Twill" cloth		Print legible after 20 wipes	

TABLE 3 Specific Test Requirements for D-SCE range Heat Shrink Sleeving

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2519 CLAUSE
PHYSICAL				
2% Secant Modulus	IEWI-004	MPa	172.4 minimum	3.2.5
THERMAL				
Heat ageing 168hrs 150°C TS UE	IEWI-002	MPa % %	15 minimum 300 minimum	3.3.1
FLUID RESISTANCE				
24hrs fluid immersion at 24° ± 3°C TS and UE	IEWI-002	MPa %	10 minimum 300 minimum	3.8.2
IRM902				
MIL-PRF-23699				
Skydrol LD-4				

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MIL-H-83282				
JP-8				
Diesel Fuel				
Propylene Glycol de-icing fluid 50/50				
Tap Water				
5% Sodium chloride solution				
1% Teepol				
Diesel 168 hrs at 70°C Print Permanence TS UE Volume change	IEWI-012 (Crockmeter with 1kg load, "Super Twill" cloth) IEWI-002	MPa % Percent % cm ³ %	Print legible after 20 wipes ± 20% of original ± 20% of original ± 10% of original	3.8.2
IRM 902 72 hrs at 50°C Print Permanence TS UE	IEWI-002	MPa % %	10 minimum 300 minimum	

TABLE 7 Test fluids description

Fluid	Description
IRM902	Reference Oil
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 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 automotive fuel
Propylene Glycol de-icing fluid (SAE-AMS-1424)	50 / 50 % mixture with water

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Tap Water	Universal solvent
5% Sodium chloride solution	Sodium chloride is a universal component of many chemicals and deicing fluids
Detergent (1% Teepol)	Commonly used detergent
IPA - Isopropyl alcohol	Widely used as a solvent and cleaner

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Наши контакты:

Телефон: +7 812 627 14 35

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Адрес: 198099, Санкт-Петербург,
Промышленная ул, дом № 19, литера Н,
помещение 100-Н Офис 331