



SPECIFICATION RW-2514

TE 108-121017

NBC-SCE NBC MARKER SYSTEM

NBC-SCE Markers are designed for use where extreme resistance to cleaning solvents is required. The markers are suitable for use in wire harness systems requiring high fluid resistance and resistance to the effects of nuclear, biological, and chemical agent exposure and decontamination.

In use, the markers should be covered with an appropriate transparent over-sleeve (TMS-CCUV) whose ends are sealed with an appropriate epoxy adhesive.

This system is an automatic method of identifying items by printing a mark on NBC-SCE marker sleeves. The mark is permanent upon printing.

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'.

The test methods and requirements specified within this specification are for Marker sleeves prior to over-sleeving and end sealing.

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 | Replaces RT-1809 issue 2 | July 2004 | |
| 2 | Format update | February 2014 | M. Priddle |
| 3 | Methods, dimension & format updates | August 2017 (released 2024) | M. Priddle |

2 SCOPE

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. Test described in this specification are undertaken on NBC-SCE sleeves. In service the NBC-SCE sleeves are used with the appropriate TMS-CCUV over-sleeve.

3 REQUIREMENTS

3.1 Test requirements

This specification details the requirements for the NBC-SCE family of products. Table 4 lists the requirements for NBC-SCE.

3.2 Composition, Appearance, and Color

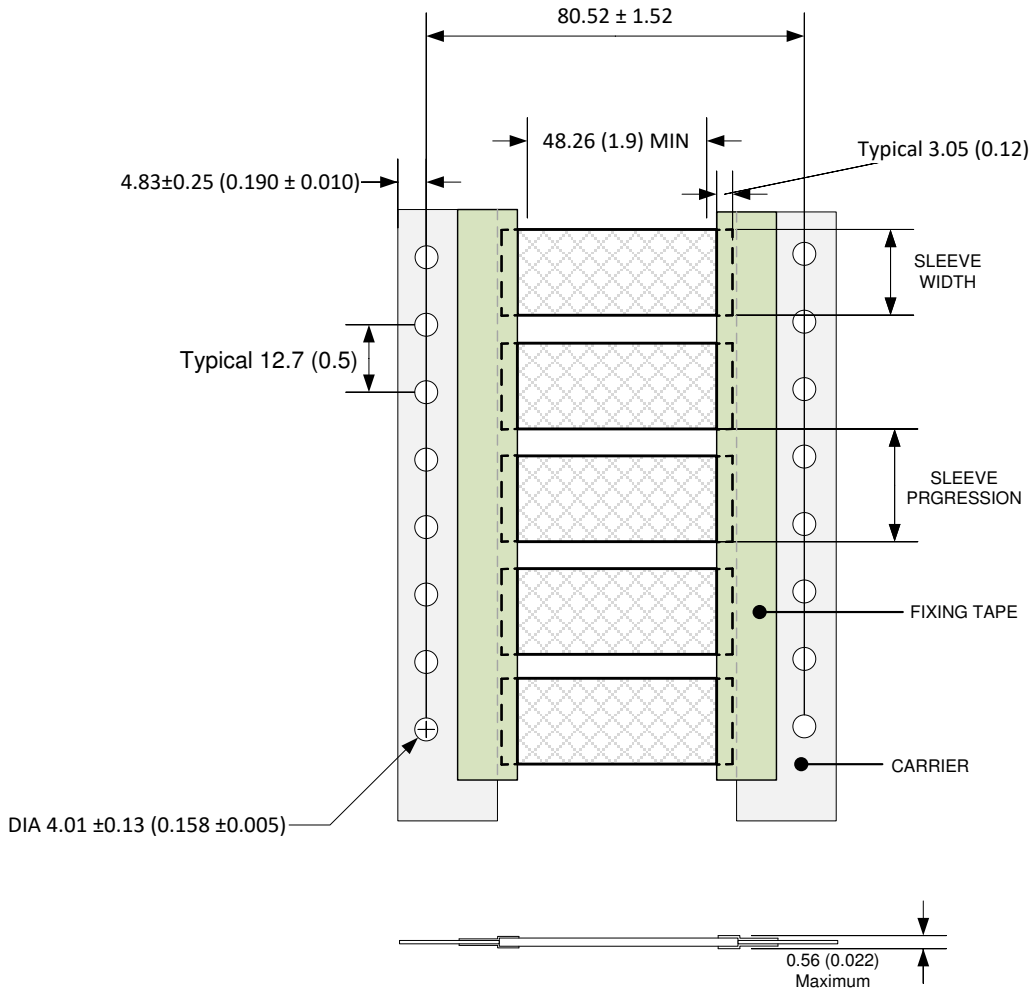
The marker shall be fabricated from crosslinked fluoropolymer tubing, flattened, and then mounted on a carrier as NBC-SCE in accordance with Figure 1.

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

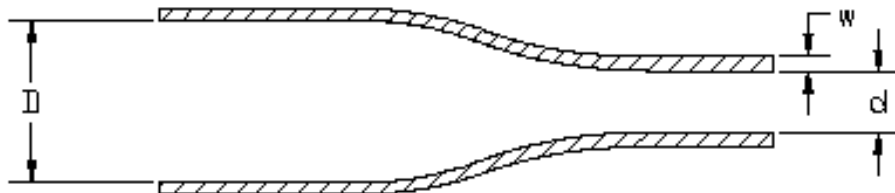
The marker sleeves shall be white unless otherwise specified.



Figure 1. NBC-SCE Sleeve format



Heat Shrink Product in as Supplied "D" (Expanded) and in the Recovered State "d".





3.3 Product Dimension

Table 1. Product dimensions

| NBC-SCE | | | | | |
|------------------|--|---|---|---|-----------------------------------|
| Part Description | Minimum Supplied Inside Diameter mm (inches) D | Maximum Recovered Inside Diameter mm (inches) d | Wall Thickness after Recovery mm (inches) w | Minimum Sleeve Flattened Width mm (inches) | Sleeve Progression mm (inches) |
| NBC-SCE-1/8 | 3.18 (.125) | 1.58 (.063) | 0.38 ± 0.08 (.015 ± .003) | 5.84 (.23) | 12.70 ± 0.64 (.500 ± .025) |
| NBC-SCE-3/16 | 4.75 (.187) | 2.38 (.094) | 0.38 ± 0.08 (.015 ± .003) | 8.00 (.315) | 12.70 ± 0.76 (.500 ± .030) |
| NBC-SCE-1/4 | 6.35 (.250) | 3.18 (.125) | 0.38 ± 0.08 (.015 ± .003) | 10.7 (.42) | 16.9 ± 0.89 (.667 ± .035) |
| NBC-SCE-3/8 | 9.53 (.375) | 4.76 (.188) | 0.38 ± 0.08 (.015 ± .003) | 15.5 (.610) | 25.4 ± 0.89 (1.00 ± .035) |
| NBC-SCE-1/2 | 12.70 (.500) | 6.35 (.250) | 0.38 ± 0.08 (.015 ± .003) | 20.3 (.80) | 29.6 ± 1.00 (1.167 ± .040) |
| NBC-SCE-3/4 | 19.0 (.750) | 9.53 (.375) | 0.38 ± 0.08 (.015 ± .003) | 30.5 (1.20) | 42.3 ± 1.00 (1.67 ± .040) |
| NBC-SCE-1 | 25.40 (1.000) | 12.7 (.500) | 0.43 ± 0.10 (.017 ± .004) | 40.4 (1.59) | 50.80 ± 1.00 (2.00 ± .040) |
| NBC-SCE-1-1/2 | 38.1 (1.500) | 19.0 (.750) | 0.43 ± 0.10 (.017 ± .004) | 60.3 (2.37) | 72.0 ± 1.00 (2.83 ± .040) |

4 TEST METHODS

4.1 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.

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±5°C. Specimens will be removed from the oven and allow to cool to 23±3°C for at least 4 hours before continuing. Where required by the test method, testing shall be done on continuous lengths of the tubing material. 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±2°C.



4.2 Workmanship

Visually examine three samples for workmanship using normal vision and without magnification. The sample shall be free from flaws, defects, pinholes, bubbles, seams, cracks, or inclusions.

4.3 Print Performance

4.3.1 Mark Adherence

Three fully recovered sleeves shall be prepared as detailed in Clause 4.1 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.

4.3.2 Solvent Resistance

Twelve fully recovered sleeves shall be prepared as detailed in Clause 4.1 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.

4.3.3 Fluid Resistance

The test method shall be as specified in TE 109-121012. Prepare three fully recovered markers as detailed in Clause 4.1. 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 $45\pm 5\text{min}$. 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 evaluated in accordance with TE 411-121002.

4.4 Physical Tests

4.4.1 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 4.1 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.



4.4.2 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 ± 5 mm per minute shall be used.

4.4.3 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.

4.5 Thermal Testing

4.5.1 Heat Shock

The test method shall be as specified in TE 109-121007. Six sleeves shall be prepared as detailed in section 4.1. Specimens shall be conditioned for 4 hours at $275\pm 3^{\circ}\text{C}$ ($527\pm 7^{\circ}\text{F}$) 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 4.3.1.

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 NBC-SCE-1/4 size tubing is 19.1mm.

4.5.2 Heat Ageing

The test method shall be as specified in TE 109-121008. Six sleeves shall be prepared as detailed in section 4.1. Specimens shall be conditioned for 168 hours at $225\pm 2^{\circ}\text{C}$ ($437\pm 7^{\circ}\text{F}$) 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 4.3.1.

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 NBC-SCE-1/4 size tubing is 19.1mm.



4.5.3 Thermal Cycling

The test method shall be as specified in TE 109-121057. Six recovered samples should be prepared for testing as detailed in section 4.1. Specimens shall be conditioned for six cycles of thirty minutes at $-196\pm 5^{\circ}\text{C}$ and then thirty minutes at $200\pm 5^{\circ}\text{C}$ in an air circulating oven. After the final cycle 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 NBC-SCE 6.4 size tubing is 19.1mm.

4.5.4 Low Temperature Flexibility

The test method shall be as specified in TE 109-121006. Six fully recovered sleeves shall be prepared as detailed in section 4.1. Specimens shall be conditioned for 4 hours at $-55\pm 2^{\circ}\text{C}$ in a cold chamber. After conditioning, and whilst still at -55°C , half of the samples shall be immediately tested for resistance to bending. Mandrel diameter for NBC-SCE-1/4 size tubing is 19.1mm.

Three 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 4.3.1. The marking shall be examined for legibility using normal reading vision. Print contrast shall be evaluated in accordance with TE 411-121002.

4.6 Environmental Tests

4.6.1 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 150mm^2 surface area of product in each tube. Use a printed sample 10mm long. After the test, mirrors should be assessed for corrosion.

4.6.2 Fungus Resistance

Specimens shall be prepared as detailed in section 4.1. Specimens shall be tested in accordance with ASTM G 21.



4.7 Fire Safety

4.7.1 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.

4.7.2 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 to create the required test specimens. Samples are conditioned for at least 24 hours at 23°C before fire testing.

4.8 Electrical Tests

4.8.1 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.

4.8.2 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.

4.9 Nuclear Test – Radiation Resistance

Three specimens shall be subjected to gamma radiation for a total dosage of 10 MRads at a rate of less than 0.5 MRads per hour. The specimen shall be measured for tensile strength and ultimate elongation in accordance with section 4.4.2.



5 RELATED DOCUMENTS

Table 2: Related Standards

| | |
|---------------------|--|
| ASTM D2671: 1999 | Standard Test Methods for Heat-Shrinkable Tubing for Electrical Use |
| 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 |
| 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 |
| SAE AS5942: 2014 | Marking Of Electrical Insulating Materials |
| ASTM G21 - 15 | Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi |

Table 3: TE 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 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 | --- |
| 109-121054 | Thermal Cycling using liquid Nitrogen | --- |
| 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.



6 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.

7 STORAGE CONDITIONS

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.

8 PACKAGING

NBC-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°C (14°F) to 40°C (104°F), and 50±30% RH.

9 SHELF LIFE¹

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

¹ Storage life is a guideline based on 30+ years of experience. TE Connectivity cannot provide any test data to validate this statement.



TABLE 4: GENERAL REQUIREMENTS FOR IDENTIFICATION PRODUCTS

| PROPERTY | TEST METHOD | UNITS | REQUIREMENTS | RW-2514 SECTION |
|---|--|-------|------------------------------------|-----------------|
| PRINT PERFORMANCE | | | | |
| Print Quality | | --- | Legible, minimum print contrast C8 | 4.1. |
| Mark Adherence | TE 109-121012 100 rubs, 1kg load, eraser | --- | Legible, minimum print contrast C3 | 4.3.1. |
| Solvent Resistance Solution A Solution B Solution C Solution D | TE Document 109-121014 100 strokes, toothbrush | --- | Legible, minimum print contrast C3 | 4.3.2. |
| Fluid Resistance, Followed by Mark Adherence 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 solution Tap water 5% Sodium chloride solution 1% Teepol detergent Aviation Gasoline (100/30) | TE 109-121012 24 hours immersion at 23 ± 2°C, followed by 20 rubs at 1kg load | --- | Legible, minimum print contrast C3 | 4.3.3. |
| PHYSICAL TESTING | | | | |
| Workmanship | Normal or corrected vision at a distance of 14 inches. | --- | In accordance with section 4.2 | 4.2. |
| Dimensions | TE 109-121003 | mm | Table 1 | 4.4.1. |
| Longitudinal Change | TE 109-121003 | % | 0 to -20 | 4.4.1. |
| Tensile Strength | TE 109-121002 | MPa | 24 Minimum | 4.4.2. |
| Ultimate Elongation | TE 109-121002 | % | 200 Minimum | 4.4.2. |
| Specific Gravity | TE 109-121015 | --- | 1.8 max | 4.4.3. |



| PROPERTY | TEST METHOD | UNITS | REQUIREMENTS | RW-2514 SECTION |
|--|--|--------|--|-----------------|
| THERMAL TESTING | | | | |
| Heat Shock 4 hours at 275°C Mandrel Bend Mark Adherence | TE 109-121007 | | No damage to the marker and print | 4.5.1. |
| | TE 109-121012 50 rubs, 1kg | --- | Legible, minimum print contrast C3 | |
| Heat Ageing 168hrs at 225°C Mandrel Bend Mark Adherence | TE 109-121008 | | No damage to the marker and print | 4.5.2. |
| | TE 109-121012 50 rubs, 1kg | --- | Legible, minimum print contrast C3 | |
| Thermal cycling 6 cycles of: 1/2 hour at -196°C then 1/2 hour at 200°C Mandrel Bend Mark Adherence | TE 109-121046 | | | 4.5.3. |
| | 90° bend around a 19.1mm mandrel TE 109-121012 50 rubs, 1kg load, eraser | --- | No damage to the marker and print Legible, minimum print contrast C3 | |
| Low Temperature flexibility 4 hours at -55°C, followed by: Mandrel Bend Mark Adherence | TE 109-121006 | | | 4.5.4. |
| | 90° bend around a 19.1mm mandrel TE 109-121012 50 rubs, 1kg load, eraser | --- | No damage to the marker and print Legible, minimum print contrast C3 | |
| ENVIRONMENTAL TESTING | | | | |
| Copper Mirror Corrosion 16 Hours at 200°C | TE 109-121009 | % | Damaged area of copper mirror, 8 maximum | 4.6.1. |
| Fungus Resistance | ASTM G 21 | --- | Rating of 1 or less | 4.6.2 |
| ELECTRICAL TESTING | | | | |
| Dielectric Strength | TE 109-121005 | MV/m | 20 Minimum | 4.8.1. |
| Volume Resistivity | TE 109-121017 | Ohm cm | 1 x 10 ¹² minimum | 4.8.2. |
| FIRE SAFETY | | | | |
| Fire Propagation, 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. | 4.7.1. |
| Surface Flammability, Flame Spread Index (Is) | ASTM E 162 | --- | 35 Maximum | 4.7.2. |



| PROPERTY | TEST METHOD | UNITS | REQUIREMENTS | RW-2514 SECTION |
|--|--------------------------------|----------|---------------------------|-----------------|
| NUCLEAR | | | | |
| Radiation Resistance 10Mrad at 0.5Mrad/hr Followed by: Tensile Strength Ultimate Elongation | TE 109-121002 TE 109-121002 | MPa % | 24 minimum 150 minimum | 4.9.1. |

TABLE 5: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 |

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