SPECIFICATION FOR ZEROHAL SHEATHED MULTICORE CABLES

This amendment forms a part of Tyco Electronics/Raychem Specification WCD 2001, Issue 1 dated July 18, 1988.

COVER PAGE

"**This Specification is for Taiwan Only**": Delete this page in its entirety.

PAGE 3

"**Amendments Records**" and "**Amendments Procedure**": Delete this page in its entirety.

PAGE 12

Para. 6.1.2, **Voltage Test**: Delete and replace with the following paragraphs:

"**6.1.2 Voltage Tests**

The following voltage tests shall be made using an AC source with a frequency of 50 or 60 Hz. The voltage specified shall be applied for 15 to 30 seconds.

6.1.2.1 Voltage Withstand (Dielectric)

When tested in accordance with 6.1.2.1.1, 6.1.2.1.2 or 6.1.2.1.3 as appropriate, finished cable shall withstand the following voltages, or the voltage specified in the applicable specification sheet, as applicable, except for coaxial cables which shall be tested in accordance with their own specification sheet:

Connection	Voltage (rms)
Wire-to-wire	1500
Wire-to-shield	1500
Shield-to-shield (extruded jackets)	1000
Shield-to-shield (sealed tape jacket)	500
Shield-to-shield (unsealed tape jackets)	n/a

PAGE 12 (cont'd)

6.1.2.1.1 Wire-to-Wire

Wire-to-wire tests shall be conducted by applying the specified voltage to each conductor in turn with all the other conductors grounded. Any shields present shall be left unconnected from any conductors and from each other except as described in 6.1.2.1.2.

6.1.2.1.2 Wire-to-Shield

Wire-to-shield tests shall be conducted by applying the specified voltage to each conductor in turn with all shields grounded. When the specified voltages for wire-to-wire tests and wire-to-shield tests are identical, the tests may be combined and the common specified voltage shall be applied to each conductor in turn with all other conductors and shields connected together and grounded.

6.1.2.1.3 Shield-to-Shield

Shield-to-shield tests shall be conducted by applying the specified voltage to each shield in turn with all other shields grounded.

6.1.2.2 Voltage Withstand (Post-Environmental)

Voltage withstand (post-environmental) tests on the outer jacket shall be performed after the specified conditioning. The finished cable shall be immersed in water at room temperature for at least one hour and, while the cable is still immersed, a voltage of 2.5 kV (rms) shall be applied between all the conductors and shields, tied together, and the water bath which shall be grounded."

WCD 2001 SPECIFICATION FOR ZEROHAL* SHEATHED MULTICORE CABLES

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WCD 2001

Specification for Zerohal* Sheathed Multicore Cables

Issued 18th July 1988

* - Raychem Trademark

Table of Contents

1 Scope

This specification details the requirements for limited fire hazard cables producing low levels of noxious fumes, smoke and corrosive products when burnt. Cables shall be flame retarded and be suitable for continuous use and storage in the temperature range of -30°C to +105°C. Cables shall be suitable for use in applications where the fluids as defined in this specification are present.

The cable shall withstand normal installation techniques and shall be compatible with standard glanding, supporting, banding and clipping techniques. Cables shall be suitable for terminating using standard techniques, including heat recoverable components, using recovery temperatures up to 200°C.

This specification contains a comprehensive range of test requirements for evaluating multiconductor cables. Some tests may not therefore apply to specific cable constructions.

2 Contents

3 Related Documents

ASTM B33-81 (1985)	Tinned, Soft or Annealed Copper Wire for Electrical Purposes.
ASTM B170-82	Oxygen Free Electrolytic Copper Wire.
ASTM B159-86	Standard Specification for Phosphor Bronze Wire.
ASTM B286-74 (1979)	Copper Conductors for Use in Hook-up Wire for Electrical Purposes.
ASTM D570-81	Test Method for Water Absorption of Plastics.
ASTM D2863-77	Minimum Oxygen Concentration to Support Candle-like Combustion of Plastics (Oxygen Index).
ASTM G21-70 (1985)	Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
BS 212 (1971)	General Requirements for Aircraft Electrical Cables.
BS G230	General Requirements for Aircraft Electrical Cables.
BS G231	Conductors for General Purpose Aircraft Electrical Cables and Aerospace Applications.
BS 1442 (1969)	Specification for Galvanised Mild Steel Wire for Armouring Cables.
BS 2316 (1968)	Radio Frequency Cables.
BS 2782 (1978)	Oxygen Index of Combustion of Plastics.
BS 4066	Tests on Electrical Cables under Fire Conditions.
BS 5099 (1974)	Spark Testing of Electrical Cables.
BS 5750 (Part 1)	Specification for Design/Development, Production, Installation and Servicing.
BS 6360 (1981)	Conductors in Insulated Cables and Cords.
BS 6469 (1984)	Methods of Test for Insulations and Sheaths of Electrical Cables.
BS 6899 (1984)	Rubber Insulation and Sheath of Electrical Cables.
DEF STAN 61-12 (Part 18)	Wires, Cords and Cables, (Equipment Wire, Limited Fire Hazard).
DGS 211 (1969)	Cables, Electrical, Silicone Rubber Insulated, for General Service.
DGS 214 (1971)	Cables, Electrical, Miscellaneous, for Special Service.
FED STD 228 (1967)	Cables and Wire, Insulation. Methods for Testing.
IEC 228 (1978)	Conductors of Insulated Cables.
IEC 96 (1970)	Radio Frequency Cables - General Requirements and Measuring Methods.
IEC 331 (1970)	Fire Resistant Characteristics of Electrical Cables.
IEC 332 (1982)	Tests on Electrical Cables under Fire Conditions.
ISO 37 (1977)	Rubber, Vulcanised - Determination of Tensile Stress - Strain Properties.

ISO 846 (1978)	Plastics - Determination of Behaviour under the Action of Fungi and Bacteria - Evaluation by Visual Examination or Measurement of Change in Mass or Physical Properties.
MIL-C-17E	Cables, Radio Frequency, Flexible and Semi-rigid.
MIL-C-915F	Cable and Cord - Electrical - for Shipboard Use.
MIL-C-85485A (1983)	Cable, Electric, Filterline, Radio Frequency Absorptive.
MIL-STD 681 (1967)	Identification Coding of Hook-up and Lead Wire.
NATO-AQAP I	Nato Requirements for an Industrial Quality Control System.
NES 518	Requirements for Limited Fire Hazard Sheathing for Electrical Cables.
NES 525	Requirements for Electrical Cables Thin Wall Insulated, Limited Fire Hazard.
NES 711	Determination of the Smoke Index of Products of Combustion from Small Specimens of Material.
NES 713	Determination of the Toxicity Index of Products from Small Specimens of Material.
NES 715	Determination of the Temperature Index of Small Specimens of Material.
SS 424 14 75	Power Cables, Flammability Testing.
VDE 0472	Recommendation for Testing Insulated Cables and Flexible Cords.

4 Quality Assurance Provisions

All Quality Assurance Provisions shall be in accordance with BS 5750: Part 1 (ISO 9001) and Nato Allied Quality Assurance Publication 1.

4.1 Quality Assurance

The supplier shall provide reasonable access to facilities for quality audit and control purposes on customer request. Any specification detailed in this document shall be the latest issue in effect unless otherwise stated in section 3 of this specification.

4.2 Test Frequency

Tests are divided in four frequency categories. These are routine, batch, quality and qualification tests.

4.2.1 Routine Tests

Performed on 100% of the production length.

4.2.2 Batch Tests

Performed on each production batch. A batch is any quantity of cable manufactured on a substantially continuous basis, under conditions which are presumed uniform.

4.2.3 Production Quality Tests

Performed on an audit basis, the repetition frequency is defined in section 7 of this specification.

4.2.4 Qualification Tests

These are performed:-

i) Prior to the first shipment of a new sheath material.

ii) Whenever any significant change is made to the materials or manufacturing process.

4.3 Acceptance Inspection

4.3.1 Test Reports

Upon completion of the cables, all test results detailed in 4.2.1 and 4.2.2 above will be kept on file and if requested will be provided.

4.3.2 Certificate of Compliance

When required by the purchase order, a Certificate of Compliance will be prepared and issued by the supplier.

4.4 Qualification Results

The supplier shall provide access to facilities for quality audit and control purpose on customer request. Examination of all qualification test data shall be available on the manufacturers premises.

5 Cable Construction and Materials

5.1 Conductors and Braiding Wires

5.1.1 Copper Conductors and Braiding Wire

Copper or copper alloy conductors, bare or plated, shall comply with BS G231 (metric), BS 4109 (AWG), or ASTM B33 (AWG) as applicable. Strands shall be clean, bright and free from surface irregularities. Constructions shall show no kinks, joints or other irregularities in the completed conductor. They shall comply with section 7 and the cable drawings described in section 9 of this specification.

5.1.2 Other Conductors and Braiding Wires

Other materials not specified in section 5.1.1 of this specification shall be defined in the drawings described in section 9 of this specification or the relevant materials specification for the particular wire type.

5.2 Wire Insulation

The insulation system shall meet all the requirements of section 7.3 of this specification. It shall be extruded to cover the conductor uniformly in one or more layers and be homogeneous, smooth and free from flaws. The insulation shall not be loose, but be capable of stripping cleanly without damage to the conductor.

5.2.1 Wire Marking

The insulation shall be capable of identification by the application of marks, stripes or bands onto the standard base colours. The colours shall be defined generally in accordance with MIL STD 681 as detailed below.

Reference Number	Colour
1	Brown
1L	Tan
2	Red
2L	Pink
3	Orange
4	Yellow
5	Green

Reference Number	Colour
6	Blue
6L	Light Blue
7	Violet
8	Grey
9	White
0	Black

An additional number after the base colour indicates a stripe or band. If more than one stripe is applied, then the first number after the base number indicates the thickest stripe on the wire.

A mark can be either a number, letter, or a combination of both. For marking and striping of wires, the preferred base colour shall be white. Any such marking requirements shall be defined in the cable drawings described in section 9 of this specification.

5.3 Fillers

Fillers may be used to provide firmness and roundness of completed cables.

Fillers used shall be selected with due consideration to the general requirements defined in section 1, Scope, of this specification.

They shall be non-hygroscopic and shall be readily removable from insulators, insulating tapes and shields without the aid of solvents, cleansers or tools.

5.4 Strength Members

Strength Members shall generally be of steel wire or aramid fibre and shall be sheathed if required. They shall show no kinks or other irregularities and shall comply with sections 7 and 9 of this specification.

5.5 Armours

Armours shall be of stainless steel wire, galvanized steel wire, phosphor bronze wire or aramid fibres. They shall comply with the cable drawings described in section 9 of this specification.

5.6 General Cable Construction

Construction of the finished cable shall be in full accordance with the cable drawing detailed in section 9 of this specification. Section 9 shall take precedence over this section in the case of conflict.

Unless otherwise specified the cable components shall be laid up such that each layer is in an alternate direction, the outer layer being a left hand lay.

The lay length of all components (including twisted pairs, triples, etc) in each layer shall generally be between eight and sixteen times the diameter over their layer and shall be laid up in such a way that the assembly has a firm, tight and circular cross-section.

5.7 Wrapping Tapes and Binders

5.7.1 Wrapping Tapes

Wrapping tapes are to be wrapped helically with nominal overlap of 30%. The tape is to be removable without damage to the insulation of the individual components within the completed cable.

5.7.2 Binders

Binders may be used over the cable layers to provide firmness and shall be of Aramid fibre or other suitable materials.

5.8 Waterblocking Compound

Waterblocking compound used in cable and shield interstices shall be compatible with all other cable materials.

5.9 Screening

Where a screen is specified, a tape may be applied over the laid up cores prior to the application of the screen, plus a tape applied over the screen if required for manufacturing purposes.

Joints in the braiding wires are to be woven in or twisted so that the wire ends turn outwards. There are to be no joints in the complete braid.

Where minimum braid coverage is specified the minimum coverage shall be calculated from the formula:-

$$K = (2F-F^2) \times 100 \qquad (1)$$

where $$F = (NPd)/\sin a \qquad (2)$$

and $$\tan a = (6.284(D+2d)P)/C \qquad (3)$$

Where K = Coverage (%)
P = No. of picks in 1 inch
C = No. of carriers
N = No. of strands per carrier
d = Dia. of single strand (inches)
D = Effective diameter under shield (inches)
F = Filling factor
a = Braid angle

5.9.1 Component Screen Insulation

Component screen insulation, where required, shall be a homogeneous extrusion of polymeric material which shall provide adequate electrical isolation of the screens. The extruded layer shall further provide environmental and mechanical abuse resistance during service and shall be selected with due consideration to the general cable requirements defined in section 1, Scope, of this specification.

During manufacture all components are passed through a high voltage source as defined in BS 5099 and subjected to a 1.0kV ac rms, 50/60 Hz spark test (according to individual wire specification), or a 6kV dc, peak, impulse test. No breakdown of the insulation shall occur.

5.9.2 Surface Transfer Impedance (Zt)

The cable shall meet the specified Surface Transfer Impedance requirements as detailed in section 7 of this specification, or on the cable drawings described in section 9 of this specification.

5.10 Sheathing Materials

Sheathing materials shall meet all test requirements of section 7.2 of this specification.

The sheath shall be reasonably smooth so as not to degrade any cable glanding. It shall be easily removed from the finished cable without adhesion or damage to screens or cores.

Unless otherwise specified on the individual cable drawing the sheath shall be black and uniformly coloured.

5.11 Overall Dimensions

All finished diameters shall be quoted as nominal values with a tolerance of ±5% unless otherwise specified on the cable drawings described in section 9 of this specification.

All cable sheaths shall have a concentricity of 70% minimum. The concentricity shall be calculated as the ratio of the maximum to minimum wall thickness of the sheath material.

The minimum sheath wall at any point shall be calculated. For outer sheath it shall be (0.85 x nominal wall - 0.1mm) and for inner sheath it shall be (0.80 x nominal wall - 0.1mm).

5.12 Cable Marking

Components and sheaths shall be identified as specified on the cable drawings described in section 9 of this specification. Any sheath marking shall be durable and able to withstand normal handling without loss of legibility.

5.13 Cable Tests

Cables shall meet all the requirements specified in section 7 and in the drawings described in section 9 of this specification.

6 Tests and Test Methods

6.1 Tests on Completed Cables

6.1.1 Spark Test (Screened Cables Only)

This test shall be carried out in accordance with BS 5099.

During manufacture 100% of all screened and sheathed cables shall be passed through a high voltage source. The applied voltage level varies with sheath thickness and is defined in BS 5099. Faults in the sheath shall be removed by cutting back to a maximum of 500mm each side of the fault.

6.1.2 Voltage Test

This test shall be carried out in accordance with NES 525, clause 0503.

The completed cable shall be subjected to a 1.5 kV ac rms voltage applied between cores or core and screen, as applicable. The voltage shall be maintained for 5 minutes. The cable shall meet the requirements of section 7.1 of this specification.

6.1.3 Insulation Resistance

This test shall be carried out in accordance with BS 6899 on a 5m sample of collectively screened cable.

The sample is immersed in water for 12 hours at $20^{o}C \pm 5^{o}C$ with a length of 250mm at each end of the cable protruding above the water. A dc voltage of 500 ± 50v is applied between the screen and the water and the insulation resistance measured 1 minute after the application of the voltage. The insulation resistance constant (K) is calculated from the equation below:-

$$K = LR/(1000 \log (D/d)) \qquad \text{M ohms.km}$$

Where D = dia. over sheath (mm)
d = dia. over screen (mm)
L = immersed length of cable (m)
R = insulation resistance of cable (M ohms)

6.1.4 Cable Heat Shock and Shrinkage

2 x 300mm lengths of completed cable shall be placed in an air-circulating oven for the times and temperatures specified in section 7 of this specification. After cooling to room temperature, the shrinkage of the sheath away from the ends of the cable shall be measured and added together. The total shrinkage shall not exceed that specified in section 7.1 of this specification.

After measurement of shrinkage, the sample shall be bent around a mandrel whose diameter is 10 times the cable diameter. After straightening, it shall be visually inspected with normal vision and shall meet the requirements of section 7.1 of this specification.

6.1.5 Cold Bend

A 1.5m specimen of finished cable shall be straightened and placed in the cold chamber. If necessary, the specimen may be secured to keep it straight during the conditioning. The chamber shall be lowered to a temperature of -30°C at a rate not to exceed 50°C per minute. The specimen shall be conditioned at this temperature for 4 hours. At the end of this period, the specimen shall be removed from the chamber and immediately bent 180° around a mandrel. The mandrel diameter shall be 12 times the nominal cable diameter, rounded up to the nearest 12.5mm for mandrel diameters smaller than 100mm and rounded up to the nearest 25mm for mandrel diameters greater than 100mm. The time required for bending around 180° of the mandrel shall be 0.5 of a minute at a uniform rate of speed. The specimen shall then be removed from the mandrel without straightening and visually examined without magnification for cracks.

6.1.6 Capacitance Unbalance

Capacitance and capacitance unbalance shall be measured in accordance with MIL-C-17, paragraph 4.8.10 and 4.8.12. Unless otherwise specified, this test shall be performed at 1kHz. A 2m (minimum) sample shall have all shields removed for 25mm from each end. The centre conductor and screen shall be attached to a capacitance bridge and the capacitance values recorded. The sample length shall be defined as the length of the shielded cable. The value obtained shall comply with the requirements of section 7.1 of this specification.

6.1.7 Surface Transfer Impedance (Zt)

This test shall be generally performed in accordance with IEC 96, MIL-C-85485A or BS 2316.

A suitable length of the cable under test is mounted in the test apparatus. A current at the test frequency is passed through the outer coaxial circuit. Due to a transfer of energy through the screens a voltage can be detected on the wire. The ratio of measured voltage to applied current is defined as the Surface Transfer Impedance (Zt). The values obtained shall not exceed the maximum values quoted in section 7.1 of this specification.

6.1.8 Impedance (Zo)

6.1.8.1 Coaxial Cables with Zo between 40 - 60 ohms at greater than 10MHz

This test shall be carried out in accordance with MIL-C-17E, paragraph 4.8.7.

A precision air line of the same nominal characteristic impedance as the sample under test shall be connected between the TDR and the sample. The characteristic impedance of the sample shall be measured in comparison with the precision air line. The value obtained shall comply with section 7.1 of this specification.

6.1.8.2 Coaxial Cables with Zo less than 40 ohms or greater than 60 ohms at greater than 10 MHz

This test is derived from MIL-C-17E, paragraphs 4.8.7 and 4.8.11.

A minimum of 2m of cable shall be connected to a spectrum analyser and the capacitance measured between the conductor and the grounded screen. The characteristic impedance shall be calculated from this value and the velocity of propagation, and shall comply with section 7.1 of this specification.

6.1.8.3 Coaxial Cable with any Impedance at less than 10MHz

This test is derived from MIL-C-915F and MIL-C-17E.

Using a 1MHz bridge, the capacitance shall be measured. The end of the sample under test shall be shorted and the inductance measured at the same frequency. The characteristic impedance at the specified frequency shall be calculated from the following formula:-

$$Zo = \sqrt{\frac{L}{C}}$$

and shall meet the requirements of section 7.1 of this specification.

6.1.9 Vertical Flammability Test

This test shall be carried out in accordance with the general principles of SS 424 14 75 (Swedish Chimney Test) for class F3, except that the samples shall be taken from multiconductor cables. A 850mm cable sample is mounted vertically in the test rig. A tray of alcohol is ignited beneath the sample and allowed to burn for the prescribed time. On extinguishing the fuel source the sample is allowed to burn undisturbed until it ceases to burn naturally. The cable sample shall show no visible damage within 300mm of its upper end. (For cables up to 10mm diameter, this test shall be carried out using the appropriate number of cable samples twisted together, as defined in SS 424 14 75).

6.1.10 Breaking Load of Strength Members

The breaking load of a single end of the strength member shall be tested by mounting a 250mm sample in the test machine and stretching at a separation speed of 8 ± 2mm/minute to breaking point. The load required to break the sample shall not be less than that specified in the cable drawings described in section 9 of this specification. (This test shall be performed as an incoming material quality check unless otherwise stated on the individual cable drawing).

6.1.11 Breaking Load of Armour Wires

A tensile test machine with a jaw separation of 50 ± 10mm/minute shall be used. The single strand shall be clamped in the test machine and the load to break measured. From this value, the tensile strength shall be calculated and shall comply with the relevant material specification for the wire type. (This test shall be performed as an incoming material quality check unless otherwise stated on the individual cable drawing).

6.1.12 Sheath Tensile Strength and Elongation

This test shall be carried out in accordance with NES 525, clause 0504.

A test sample shall be cut from the cable sheath. The sample shall be clamped centrally in the test machine grips and stretched to breaking point. The test shall be carried out

at a temperature of 20°C ± 5°C. The maximum load and elongation shall be recorded. The tensile strength and ultimate elongation shall be calculated from the results obtained and shall meet the requirements of section 7.1 of this specification.

6.1.13 Sheath Tear Resistance

This test shall be carried out in accordance with NES 525, clause 0505.

A test sample 50mm long by 6.4mm wide shall be cut longitudinally from the cable sheath and cut down the middle to a distance of 3.9mm from one end. The cut halves shall be clamped centrally in the test machine and separated at a speed of 500mm/minute. The load required to tear the sample is measured. The tear resistance is obtained by dividing the maximum load measured by the sample thickness and is expressed in N/mm. The value obtained shall exceed the minimum value quoted in section 7.1 of this specification.

6.1.14 Water Blocking

This test shall be carried out in accordance with MIL-C-915F, clause 4.7.33. A 1.5m cable sample shall be suitably terminated to a pressurised water supply. The water pressure shall be 0.17 ± 0.03N/mm^2 and shall be applied for 6 + 0.25, - 0.0 hrs. Any water leaking during this test period shall be collected and the volume measured. The volume of water collected shall not exceed the quantity given in section 7.1 of this specification.

6.2 Tests on Sheath Material

6.2.1 Water Uptake

This test shall be carried out in accordance with ASTM D570. The prepared samples shall be immersed in distilled water for 672 hours at 70°C. After the test, surface water shall be wiped off and the water uptake calculated as a percentage increase in weight over the pre-immersion value. The weight uptake shall not exceed the values specified in section 7.2.2 of this specification.

6.2.2 Hydrolytic Stability

This test shall be carried out in accordance with ASTM D3137. Dumbells cut to ISO 37, type 2, shall be suspended in a suitable container of distilled water at a temperature of 85°C ± 1°C, for a period of 96 hours. The container shall then be cooled to ambient temperature, and the samples removed and conditioned for 16 to 24 hours at ambient temperature and a relative humidity of 50%. The tensile strength shall be measured after the test and be compared with the initial values. The minimum retention shall exceed the values quoted in section 7.2.2 of this specification.

6.2.3 UV Stability

This test shall be performed in accordance with ASTM G53. The prepared samples are mounted in the QUV meter for 1000 hours using a continuous cycle of 18 hours at 40°C UV exposure followed by 6 hours at 40°C water vapour exposure. After exposure the tensile strength and ultimate elongation of the samples shall be measured and shall meet the requirements of section 7.2.2 of this specification.

6.2.4 Fungus Resistance

This test shall be performed in accordance with ASTM G21 using samples prepared to ISO 37. The samples shall be placed in suitable sized glass containers onto the surface of the prepared agar layer. The surface of both the agar and the sample shall be inoculated with the prepared spore suspension and the dish covered with a glass cover. The complete sample shall be incubated at 28°C to 32°C, at a relative humidity of 85% for 28 days. The fungus growth shall be recorded weekly. On completion the tensile strength and ultimate elongation shall be measured in accordance with ISO 37, and growth rating established in accordance with paragraph 9.3 of ASTM G21. The values obtained shall meet the requirements of section 7.2 of this specification.

7 Test Requirements

When tested in accordance with section 6 of this specification, the component wires, sheath material and finished cable shall meet the requirements defined in tables 7.1, 7.2 and 7.3 below.

7.1 Tests on Completed Cable

Property/Test	Clause	Requirements	Test/Frequency
Spark Test (Screened Cables Only)	6.1.1	No failures	Routine
Constructional details	5.6	See section 9	Batch
Voltage Test	6.1.2	No breakdown	Batch
Dimensions	5.11	See section 9	Batch
Concentricity	5.11	70% min	Batch
Sheath Tensile Strength and Elongation	6.1.12	10Mpa min 200%	Batch
Sheath Tear Strength	6.1.13	5N/mm min	Batch
Screen Coverage	5.9	85% min	Batch
Heat Shock and shrinkage 4hrs at 150°C ± 3°C	6.1.4	No cracks or flowing, 3mm max	Batch
Capacitance Unbalance	6.1.6	See section 9	Batch
Waterblocking	6.1.14	See section 9	Batch
Impedance (Zo)	6.1.8	See section 9	Batch
Insulation Resistance	6.1.3	0.1M ohms km	Monthly
Cold Bend -30°C ± 3°C	6.1.5	No cracks	Monthly
Surface Transfer Impedance (Zt)	6.1.7	See table 7.1.1	Monthly
Vertical Flammability	6.1.9	No propagation to top of chimney	Qualification
Breaking Load of Strength Members	6.1.10	See section 9	Quality
Breaking load of Armour Wires	6.1.11	See section 9	Quality

7.1.1 Optimised Screening Levels

Cables having optimised braids specified on the cable engineering drawing described in section 9 shall meet the surface transfer impedance limits detailed below.

Type of Screen	Diameter Under Screen (mm)	Surface Transfer Impedance Zt @ 30 MHz (maximum)
Single Optimised Braid	up to 7.5	100 milli ohms/metre
	7.6 and up	50 milli ohms/metre
Double Optimised Braid	up to 7.5	10 milli ohms/metre
	7.6 and up	5 milli ohms/metre
Superscreened (2 Braids & 1 Wrap)	up to 7.5	100 micro ohms/metre
	7.6 and up	50 micro ohms/metre
Double Superscreened (3 Braids & 2 Wraps)	All sizes	10 micro ohms/metre

7.2 Tests on Sheath Material

The sheath material shall be approved to and meet the full test requirements of the latest issue of UK Naval Engineering Standard 518 (NES 518), MIL-C-24640 and MIL-C-24643. Requirements at issue date of this specification for NES 518 are summarised in table 7.2.1. Approval certificates shall be made available upon request.

7.2.1 Tests to NES 518

Property/Test	NES Clause	Requirements
a. Tensile Strength b. Elongation at Break	0403	8 MPa min 200% min
Tear Resistance	0404	5 N/mm min
Thermal Endurance	0405, 0406	40000 hours at 85°C
Accelerated Ageing	0407	As agreed between manufacturer and MOD
Critical Oxygen Index	0408	29 min
Temperature Index	0409	250°C min
Toxicity Index	0410	5 max
Halogen Content	0411	Negative result for halogens
Smoke Index	0412	20 max
Resistance to Fluids	0413	See section 7.2.1.1
Ozone Resistance	0414	No cracks
Cold Elongation	0415	20% min elongation
Heat Shock	0416	No cracks
Insulation Resistance Constant	0417	0.1M ohms.km

7.2.1.1 Fluid Resistance to NES 518

Fluid	Test Temp.	Test Time (days)	% Retn. Tensile Strength	% Retn. Ultimate Elongn.	Volume Swell (%)
Fuel Oils					
Nato - F76	20°C ± 3°C	28	60 min	60 min	25 max
Dieso 47/20	20°C ± 3°C	28	60 min	60 min	25 max
DEF STAN 914/3	20°C ± 3°C	28	60 min	60 min	25 max
Hydraulic Fluids					
0X-30	50°C ± 3°C	28	60 min	60 min	15 max
0X-50	50°C ± 3°C	28	60 min	60 min	10 max
Lubricating Oils					
OMD-113	50°C ± 3°C	28	60 min	60 min	10 max
0X-38	50°C ± 3°C	28	60 min	60 min	50 max
Waters					
De-ionised	50°C ± 3°C	28	80 min	80 min	10 max
De-ionised with 3.5% NaCl	50°C ± 3°C	28	80 min	80 min	10 max

7.2.2 Additional Cable Requirements

Property/Test	Clause	Requirements	Test Frequency
Water Uptake	6.2.1	4% max	Qualification
Hydrolytic Stability	6.2.2	No visual cracks, 60% min reten. of TS and UE	Qualification
UV Stability	6.2.3	No visual cracks, 60% min reten. of TS and UE	Qualification
Fungus Resistance	6.2.4	Growth rating $\leq$ 1. 80% min retention of T/S and Elongation	Qualification

7.3 Cable Components - Definitions

This specification defines the test criteria for the insulation systems used on components within multiconductor cables. Conductors may vary depending on specific wire designs.

Cable components are defined as:

Primary Wire	Any insulated conductor using standard AWG conductor or metric equivalent. (Size number).
Power Wire	Any insulated conductor with conductors complying with IEC 228, class 5 or 6.
Coaxial Component	Any component having controlled impedance and capacitance requirements.
Fibre Optic	Any component consisting of a single fibre with appropriate protective layers.
Special Component	Any component not defined above, shall be specified on the individual drawings described in section 9 of this specification.

7.3.1 Tests on Primary Wires

Component wire insulation shall be approved to and meet the full test requirements of UK DEF STAN 61-12 (Part 18)/latest issue. Approval certificate shall be made available upon request.

7.3.2 Power Wires

Power wires shall meet the full test requirements of the individual specification sheet as described in section 9 of this specification. In addition the wires shall meet any additional test requirements described in section 9 of this specification.

7.3.3 Coaxial Cables

Coaxial cables shall meet the full test requirements of the individual specification sheet as described in section 9 of this specification. In addition the wires shall meet any additional test requirements described in section 9 of this specification.

7.3.4 Fibre Optics

Fibre Optic components shall meet the full test requirements of the individual specification sheet as described in section 9 of this specification. In addition the wires shall meet any additional requirements described in section 9 of this specification.

7.3.5 Special Components

Any special component shall be defined in section 9 of this specification and shall meet all the test requirements detailed in that section.

8 Packaging

The finished cable shall be spooled in discrete lengths onto spools for shipping. Each length shall be fault free and the open ends capped to prevent ingress of moisture.

Each reel shall bear a label showing:

(i) Manufacturer's name

(ii) Cable description

(iii) Cable batch number

(iv) Order number

(v) Length of each discrete cable length

9 Specific Cable Constructions

The cable construction shall be defined by an engineering proposal drawing prepared by the supplier. Component wires and constructions may be detailed directly onto the cable drawing or referenced to a separate specification control drawing.

If additional materials not specified within this specification are used, then they shall be defined in the individual engineering proposal drawing or specification control drawing as applicable. In either case, the drawing shall also reference the applicable specification(s) to which it is supplied, and any additional test requirements specific to that product.

Some cable requirements outlined in section 7.1 of this specification vary with cable construction. In these cases the requirements shall be detailed on the engineering proposal drawings.

In the event of conflict between this specification and the engineering proposal drawing, the engineering proposal drawing shall take precedence.