

A.C. LAND BASED CABLE WITH EXTRUDED INSULATION FOR RATED VOLTAGES ABOVE 33 KV ($U_m = 36$ KV)

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PURPOSE AND SCOPE

This specification forms part of a suite of documents that define National Grid requirements for new plant. The Level 2 Specifications for cable systems, TS 2.5, covers major requirements and there is a series of Level 3 Specifications covering various specific requirements.

This document is a Level 3 Specification giving the requirements for single core A.C. land based cables with extruded insulation and their accessories with a rated voltage above 33 kV ($U_m = 36$ kV).

PART 1 – PROCEDURAL

1 GENERAL REQUIREMENTS

1.1 Cable

1.1.1 Conductor

The maximum D.C. resistance for conductors with cross-sectional areas up to 2500 mm² shall be as specified in IEC 60228 and for conductors with cross-sectional areas in excess of 2500 mm² shall be determined from the D.C. resistivity of the conductor material at 20°C.

1.1.2 Semi-conducting Screens

Both the conductor screen and the insulation screen shall be extruded and bonded to the insulation.

1.1.3 Layers Between Extruded Core and Metal Sheath or Screen

Bedding tapes or water-blocking tapes between the semi-conducting screen and the metal sheath or screen shall be conducting or semi-conducting.

1.1.4 Metal Sheath

The cable shall be constructed with a metal layer to act as a radial moisture barrier.

Where the cable is to be installed in an environment that can be subject to water, if the cable is for rated voltages above 150 kV ($U_m = 170$ kV), or the conductor screen stress is greater than 8 kV/mm or the insulation screen stress is greater than 4 kV/mm, the metal sheath shall be either seamless or the seam shall be checked to ensure the integrity of the metal sheath during manufacture. The method of checking the seam shall be acceptable to National Grid.

Where a cable is to be installed into a nominally dry environment a laminate sheath may be used. Where the cable is for a rated voltage at 150 kV ($U_m = 170$ kV) or lower and the conductor screen stress is less than 8 kV/mm and the insulation screen stress is less than 4 kV/mm, a laminated sheath may be used in a wet or dry environment.

1.1.5 Water Barriers

Water barriers shall be provided to prevent longitudinal water penetration along the conductor and along the interface between the insulation screen and the metal sheath.

1.1.6 Oversheath

Note: The oversheath provides electrical and mechanical protection for the sheath.

The protective oversheath shall be seamless and shall be sealed to the metal sheath to prevent the passage of moisture along the interface between the two components.

The oversheath shall be free from imperfections, lumps and indentations.

To reduce the penetration of moisture through the oversheath it shall be able to comply with the requirements of the Vapour Transmission Test specified in the type test requirements below.

Note: The rate of corrosion of sheath materials is highly dependent on the chemical behaviour of all components. Research suggests that oversheath materials with high vapour transmission capability provide poorer protection against corrosion than those with low vapour transmission capability.

The oversheath shall not be constructed of materials that may cause unnecessary hazards in the event of fire.

These requirements will exclude the use of currently available polyvinyl chloride (PVC) materials.

The oversheath shall be covered with a conducting or semi-conducting layer to enable the oversheath test while the cable is on the drum. For cables in installations that do not allow the ground to carry the return current during an oversheath test, the conducting or semi-conducting layer shall be able to carry the return current. The conductive or semi-conductive layer shall be such that it shall be visually apparent in daylight when the layer is removed if required during jointing or the supplier shall use a method of work such that it is demonstrated that the layer has been removed.

These requirements will exclude the use of colloidal graphite as a conductive layer for cables installed in air or ducts.

The oversheath shall be indelibly marked with a legend in accordance with Table 1. The legend shall run along the cable in two or more lines, equally spaced around the circumference of the cable, and the distance between the end of one legend and the start of the next legend shall not be greater than 150 mm. The characters shall be at least 10 mm in height. Any additional information marked on the sheath, such as the manufacturer's name shall not affect the spacing between repetitions of the legend.

System Voltage (kV)	Legend
66	Electric Cable 66 000 V
132	Electric Cable 132 000 V
275	Electric Cable 275 000 V
400	Electric Cable 400 000 V

Table 1 – Cable Oversheath Legends

Note: Oversheaths may be constructed of multiple layers provided the above requirements are met.

Note: Consideration shall be given to using an oversheath constructed of multiple layers with the outer layer of the oversheath a different colour to the inner layer(s).

1.2 Drumming

Each drum shall bear a distinguishing number, securely marked on the outside of the flange. Particulars of the cable, including voltage, cable type, length, conductor size, number of cores, finish, length number, gross and net weight shall be clearly shown on one flange of the drum. The direction for rolling shall be indicated by an arrow.

1.3 Cable Connections into Metal-enclosed Equipment

Connections to gas-insulated metal-enclosed switchgear shall comply with IEC 62271-209.

The termination assembly shall incorporate sheath sectionalising insulation. The termination shall be suitable for the fixing of short circuit straps as defined TS 3.5.4.

1.4 Cable Terminations With External Oil Tanks

Cable terminations that use external oil tanks shall have a visual indication of the amount of oil or pressure in the tank.

There is no requirement for alarms to be attached to the visual indication, associated switches, pressure connections, or cable connections.

Note: Currently the typical designs of terminations that compensate for oil expansion inside the termination have no provision for visual indication of the oil level.

1.5 Outdoor Cable Terminations

Outdoor cable terminations shall not use porcelain insulators for the main high voltage insulator.

2 PERFORMANCE REQUIREMENTS

2.1 Conductor Thermal Cycling

The cable and accessories shall be capable of following daily conductor temperature variations between ambient and the normal design temperature.

2.2 Maximum Conductor Temperatures

The maximum conductor operating temperatures shall be as specified in IEC 60840 or IEC 62067 as applicable.

2.3 Cable Flexibility

The cable shall be able to satisfactorily complete the Bend Test specified in IEC 60840 or IEC 62067 as applicable.

2.4 Electrical Performance

The cable dielectric shall withstand the electrical voltage impulses described in Table 2 and Table 3 without any breakdown or permanent damage. T_1 , T_p and T_2 are defined in accordance with the recommendations of IEC 60060-1.

Duration Parameter	Lightning Impulse Voltage (kV_p) (μs)	Switching Impulse Voltage (kV_p) (μs)
Front Time (T_1) / Time to Peak (T_p)	3 ± 2	250 ± 50
Time to Half-Peak-Value (T_2)	50 ± 10	2500 ± 1500

Table 2 – Impulse Duration Values

System Voltage (kV)	Lightning Impulse Voltage (kV)	Switching Impulse Voltage (kV)
66	325	N/A
132	650	N/A
275	1050	850
400	1425	1050

Table 3 – Impulse Voltage Withstand Capability for Main Insulation

In particular the performance of the cable and accessories shall not limit the number of switching operations of the circuit it is connected to.

Note: Some circuits will have a large number of switching operations. For example cables and accessories used to connect capacitor banks can expect a number of switching operations each day.

2.5 Fire Performance

Where major parts of the cable system are installed in air, for example within tunnels or other confined spaces, the cable shall be designed to meet fire performance test requirements as specified in section 4.

Where only small parts of the cable system are installed in air, alternative methods such as fire suppression or flame retardant coating applied to the oversheath shall be considered.

3 PREQUALIFICATION TEST REQUIREMENTS

The supplier shall have successfully completed Prequalification Tests if the cable has a rated voltage above 150 kV, or is designed to operate at a conductor screen stress is greater than 8 kV/mm, or the insulation screen stress is greater than 4 kV/mm.

The Prequalification Test shall have been conducted as described in IEC 60840 or IEC 62067 as applicable and performed on a complete system, which contained cable and all appropriate accessories.

The range of cables that a prequalification test applies to shall be the same as specified in clause 4.2 of this document.

The test arrangement shall be representative of installation arrangements that may be used on the National Grid system. These shall include rigidly fixed systems buried, flexible systems installed in air, systems installed in unfilled ducts and transition arrangements.

Note: It is understood that the number of prequalification tests is minimised. Generally tests will cover cables of other designs, unless there is a substantial change in the cable system with respect to material, processing, design, and design levels. Substantial change is defined as that which might adversely affect the performance of the cable system. However any deviation from clause 4.2 will still be declared as non-compliant and agreed with National Grid.

4 TYPE TEST REQUIREMENTS

4.1 General

Type tests shall be carried out on new cable systems, cables and accessories as applicable with regard to the range of type tests described in clause 4.2 of this specification. Details and results of the type tests shall be recorded on a test report.

The test report shall include:

- a) A schematic diagram of the test assembly detailing the cable lengths, accessories and the position of any thermocouples etc.
- b) The cable construction, typically a drawing.
- c) An A3 or A4 sized drawing of every accessory. The drawing shall have a number, modification reference and date.

Note: National Grid expects test parameters and the result measurements to be recorded in addition to a pass or fail statement.

4.2 Range of Type Tests

National Grid may accept, but only by agreement, that type tests applied on one cable system may be considered valid for other cable systems. The validity of a type test is generally in accordance with the range indicated within IEC 60840 and IEC 62067 except as indicated below.

Cable oversheath tests on a cable system may be valid for cables of a different construction if the same oversheath material is used, the metal sheath is the same (tests on corrugated aluminium sheaths may be extended to smooth sheath designs) and the overall diameter of the tested cable is larger.

Type tests of protective coverings for sheath sectionalising joints may be valid for joints without sheath sectionalising insulation but not vice versa.

Type tests of a protective covering for accessories may be valid for approximately the same size or smaller and for equal or lower test voltages provided the design (in particular the minimum clearances) and materials are unchanged.

4.2.1 Change to Cable Conductor Material or Design

The electrical type test of a cable with a particular type of conductor material or design may be valid for other conductor materials or designs provided that either of the following testing is carried out on a cable with the proposed cable conductor:

- a) Bend test followed by an electrical type test at the same or higher voltage and the same or higher electrical stress or
- b) Bend test followed by a visual examination of the conductor and a visual inspection of the conductor screen using the following procedure:
a 300 mm length of cable shall be cut out from the midpoint of the cable, stripped of its metal sheath and any non-bonded screening material and cut to create three 25 mm long test samples. The conductor shall be removed from the three test samples and the ends of each shall be prepared to give a smooth finish. The three samples shall be heated until the insulation becomes transparent. The conductor screen shall be visibly smooth and uniform with no significant distortions.

Other tests such as the water penetration test and A.C. resistance test may be needed for the new conductor design.

4.2.2 Cable Sheath

The electrical type test of a cable with one type of metal sheath may be valid for other types of metal sheath provided that either of the following testing is carried out on a cable with the proposed cable sheath having the largest diameter:

- a) Bend test followed by an electrical type test at the same or higher voltage and the same or higher stress or
- b) Bend test followed by a visual examination of the sheath and the visual examination of the insulation screen using the following procedure:
a 300 mm length of cable shall be cut out from the midpoint of the cable, stripped of its metal sheath and any non-bonded screening material and cut to create three 25 mm long test samples. The conductor shall be removed from the three test samples and the ends of each shall be prepared to give a smooth finish. The three samples shall be heated until the insulation becomes transparent. The insulation screen shall be visibly smooth and uniform with no significant distortions.

Other tests such as the water penetration test and the cable oversheath test may be needed for the new sheath design.

4.2.3 Cable Accessories

For cable accessories used on cable systems with rated voltages up to 150 kV and a conductor screen stress is less than 8 kV/mm and an insulation screen stress is less than 4 kV/mm, electrical type tests of an accessory using cable made on one manufacturing line with one type of material may be valid for the accessory used on a different cable from a different manufacturing line with different materials provided that the type tests still meet the other requirements of section 4.2.

4.3 Type Tests to IEC 60840 or IEC 62067 or Alternative Type Tests

The cable system shall be subject to the tests and requirements specified in IEC 60840 or IEC 62067 as applicable except:

- a) Tests of the outer protection for buried joints shall be to clause 4.3.1 of this specification.

Note: National Grid expects all type tested cables and accessories to be discharge free during partial discharge tests and will require evidence of investigations and explanations of any partial discharge detected, even if below the declared sensitivity of the test.

Note: Where major parts of the cable system are installed in air, the cable shall meet the test requirements for cables under fire conditions in IEC 60332-1-2.