

CABLE SYSTEMS

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PURPOSE AND SCOPE

The specifications for new plant, equipment, apparatus and services for use on the National Grid transmission system are contained in a three-level hierarchy of documents. Level 1, TS 1, covers ratings and general requirements. This level 2 specification for cable systems, TS 2.5, covers general cable requirements and there is a series of level 3 specifications covering various specific requirements.

This document is a level 2 specification giving the requirements for single core land or subsea cable systems for AC or DC rated voltages at and above 11 kV. Additional requirements for different types of cable and associated equipment, apparatus and services are given in Level 3 Specifications.

PART 1 – PROCEDURAL

1 GENERAL REQUIREMENTS

The supplier shall be responsible for ensuring the satisfactory performance of all aspects of the cable system design, which shall meet the requirements in each appropriate Level 3 Specification.

Throughout the life cycle of the cable system, that is the acquisition, installation, inspection, testing, operation, cleaning, maintenance, repair, and disposal, these shall be facilitated by the inclusion of suitable features. Features shall facilitate the health and safety of those concerned at each stage.

1.1 Cable and Cable Accessories

Requirements for fluid filled cables above 33 kV are specified in TS 3.5.1.

Requirements for AC cables with extruded insulation above 33 kV are specified in TS 3.5.2.

Requirements for AC cables with extruded insulation at 11 kV and 33 kV are specified in TS 3.5.14.

Requirements for MIND HVDC cables up to 800 kV are specified in TS 3.5.15.

1.2 Cable System

1.2.1 General

For fluid filled cable systems, and extruded cable systems above 132 kV, the supplier must offer a complete cable system. The system must comprise of at least:

- Cable
- A termination
- A joint
- Bonding and earthing equipment for AC cable systems with rated voltages of 66 kV or above
- Cable temperature monitoring sensors for AC and DC cable systems with rated voltages above 132 kV
- Cable hydraulic system for fluid filled cables

1.2.2 Sheath Losses

To reduce sheath losses in AC cable systems, special bonding arrangements may be adopted. The requirements for insulated sheath cable systems are specified in TS 3.5.4.

Sheath voltage limiters (SVLs) may be used. Requirements for SVLs are specified in TS 3.5.3.

1.2.3 Fibre-Optic Temperature Sensors

All AC and DC cable circuits above 132 kV, unless the circuit will never use dynamic current rating such as a capacitor bank connection, shall be constructed or installed with optical fibres for use as part of a distributed temperature sensing or dynamic rating system which may, or may not, be installed as part of the cable works. The requirements for cable temperature monitoring are specified in TS 3.5.5.

1.2.4 Installation

Land installation requirements for power and auxiliary cables are specified in TS 3.5.7.

Submarine installation requirements shall be specified on a project basis.

The thermal resistivity and method of preparation of any backfills used shall be disclosed.

1.2.5 Cable Cooling Systems

Requirements for piped water cable cooling systems are specified in TS 3.5.8.

1.2.6 Cable Oil Pressure Gauges and Switches

Requirements for cable oil pressure gauges and switches (for fluid filled cables) are specified in TS 3.5.9.

1.2.7 Cables Tunnels

Requirements for cable tunnels are specified in TS 3.5.12.

1.3 Cable System Impressed Working Requirements

Note: Currents and voltages may be present on the conductor and sheath of cables when they are out of service. NSI 5 provides requirements for the safe operation and maintenance of cable circuits considering these currents and voltages.

The cable system shall be designed to facilitate maintenance in accordance with NSI 5.

At cable terminations the arrangement shall allow an earth to be applied to the cable system when the cable system is disconnected from the rest of the National Grid system.

Note: The above requirement may require a spigot to be connected to the cable termination to allow portable earths to be connected to the cable system when the cable system is disconnected from the rest of the National Grid system.

1.4 Cable Termination Arrangements

Circuits using two cables per phase shall consider cable termination compound arrangements that facilitate the operation of the circuit with only one of the cables per phase should one of the other cables fail. The arrangement would generally require manual reconfiguration of cable termination compound busbars.

Note: Overhead lines can cause induced currents to flow in cable systems that are connected to the overhead lines when the cable system is out of service.

Where cable systems are directly connected to overhead lines and induced currents are possible, an earth switch shall be connected between the cable system and the overhead line. Where electrical supplies are not present, the earth switch is not required to be motorised. Remote indication of the primary contact position is not necessary if facilities do not exist to relay the information.

Note: The requirements in PS(T) 6 for all earth switches to be motorised and have remote indications do not apply for these earth switches.

For information regarding the use of Surge arrestors at cable terminations refer to PS(T) 21.

2 PERFORMANCE REQUIREMENTS

2.1 Operation

The system conditions under which the cable system shall be capable of operating are specified in TS 1.

2.2 Cable System Life

Cable systems, including auxiliary equipment such as fibre optic cables or hydraulic equipment associated with oil-filled cables, shall be designed for an operating life of 40 years.

2.3 Short-Circuit Rating

The cable system design shall ensure that for AC systems the full declared three-phase and single-phase short-circuit currents can be carried for the durations in Table 1 without the cable system sustaining any permanent damage. The short-circuit capability shall be calculated for operation at the maximum conductor temperature.

System Voltage (kV)	Duration of Short-Circuit (s)
132	3
275	1
400	1

Table 1 – Maximum Short-Circuit Durations

Note: Commonly specified short-circuit rating requirements may be found in TS 1 and National Grid will provide these requirements in the Enquiry Document.

Short circuit levels for HVDC cable projects should be calculated on a project basis.

2.4 Thermomechanical Movement of Cables

The design of the cable system shall not be compromised by the effects of conductor thrust and relative movement arising from the thermomechanical behaviour of all components, including those that may be supplied by another manufacturer. Where the supplier identifies that modifications or special design are required, full details shall be submitted with any tender.

2.5 Operational

The supplier shall ensure that the conductor temperature does not exceed its normal design value for the range of load and normal operating conditions specified in the National Grid Enquiry Document.

2.6 Rating Calculations

The declared current ratings shall apply to all components of the cable system and the method and all design parameters used to calculate current ratings shall be disclosed.

The location of the component that limits the current rating shall be clearly identified in all tender submissions.

Note: further guidance on current rating calculation is given in Appendix B

2.6.1 Continuous Rating Calculations

IEC 60287 shall be used for all continuous rating calculation, with the exception of forced-ventilated tunnel applications where the method described in Electra 143 and 144 shall be used. Additionally the recommendations given in CIGRE Technical Brochure No. 272 “Large Cross-sections and composite screens design” shall be used.

Where IEC 60287 is not considered applicable for any reason or where an extension to IEC 60287 is required full disclosure of the calculation shall be given.

2.6.2 Cyclic and Emergency Rating Calculations

The method of calculating cyclic and emergency ratings shall be declared when such ratings have been provided.

Note: IEC 60853-2 may be used where applicable for cyclic and emergency rating calculations are required. The computational method recommended by CIGRE and published in Electra 87 may be used where applicable when cyclic and emergency rating calculations are required. The cyclic and emergency ratings may be calculated using other methods provided full disclosure of the methods is provided. Emergency ratings for periods shorter than 10 min, where IEC 60853-2 is not applicable, may be calculated using the equations quoted in Appendix A where applicable if the equations give a higher value than IEC 60853-2. Where use of the equations in Appendix A yield values lower than the IEC 60853-2 10 minute values, the IEC 10 minute values may apply to the shorter durations.

2.6.3 Cyclic Loading

The standard National Grid load cycle shall be taken as 6 h at peak value and 18 h at 60% of peak value. Cyclic ratings shall be calculated for repetitive use of this load cycle. Alternative or additional load cycles may be specified in the National Grid Enquiry Document.

2.7 Design Parameters

Design parameters for typical installations are given in this section.

Note: further guidance on design parameters is given in Appendix B.

2.7.1 Seasonal Ambient Temperatures

The cable ambient temperatures in Table 2 shall be used where site specific data is unavailable. Any values other than those in the Table 2, such as those from site survey results, shall be agreed with National Grid. For cables in buried troughs or buried ducts the ambient conditions will depend on depth and National Grid can advise if the values in the Table do not cover the situation. See Appendix B for more guidance on Current Rating.

Cable Installation Method	Ambient Temperature (°C)			
	Winter (Dec to Feb)	Normal Cold (Mar, Apr, Nov)	Normal Hot (Sep, Oct)	Summer (May to Aug)
Directly Buried or Ducts	10	10	15	15
Filled Surface Trough	10	15	25	35
Unfilled Surface Trough External Ambient Air	10	20	20	30
In Air	10	20	20	30
Forced-Ventilated Tunnel Mean Ambient Inlet Air *	5	10	10	20
Forced-Ventilated Tunnel Maximum Outlet Air	50	50	50	50
Tunnel Maximum Air When Personnel In Tunnel *	35	35	35	35
Naturally-Ventilated Tunnel Maximum Air *	20	25	30	35
Subway Installation With Other Services Maximum Air *	20	25	30	35
Subsea installations	Project specific data shall be derived from seabed surveys which will be provided in the enquiry document			

Table 2 – Cable Ambient Temperature Conditions