

CABLE TUNNELS

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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. 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 cable tunnels and relates to the initial construction and the general operation phase of the tunnel circuits. When construction or cabling works are being carried out in the tunnel (after the initial commissioning of the tunnel circuits) then a different set of circumstances will apply and specific Risk Assessments will be required with appropriate mitigation.

This document deals with the safety and reliability of cables in cable tunnels with the aim of managing risks to personnel and equipment. It is recognised that cable tunnels can be hazardous to personnel and the conditions onerous for ancillary equipment.

There are two conditions to be considered by the supplier:

- a) When the tunnel is unoccupied
- b) When the tunnel is occupied by staff or third parties carrying out inspections or construction work.

This means that it is advantageous to restrict personnel access to cable tunnels as much as possible throughout the tunnel lifetime and to design, plan and construct the tunnel to ensure all activities when access is required to the tunnel can be carried out in a structured manner using well maintained equipment. The risks to personnel need to be well managed and the principal ones are from fire, smoke inhalation, explosive failure of the cable and toxic gases.

PART 1 – PROCEDURAL

1 GENERAL REQUIREMENTS

The design of a cable tunnel containing cables, cable accessories and ancillary equipment shall be developed in consultation with and for the approval of National Grid. The cable system shall be designed to minimise the risks to personnel arising from the construction, inspection, testing, maintenance, refurbishment and eventual replacement of the power cables. A Fire Safety Engineering Solution (FSES) shall form an integral part of the overall tunnel and cable system design.

Informative: National Grid cable tunnels for circuits between substations shall not contain more than two cable circuits without them being physically segregated to ensure that no more than two circuits are in the same enclosure. If more than two cable circuits are installed in a tunnel, following a risk assessment it may be acceptable; however it shall still be considered a deviation from this specification.

Informative: Cable basements and cableways are not covered in this specification and additional fire precautions for these installations are described in National Grid TS 3.1.3.

The boundary between a cable tunnel and a cable basement or cableway should be clear from the context and National Grid Construction should be consulted if there is any uncertainty. If a tunnel shaft is located in a basement or a substation building then conditions in the basement or building (e.g. presence of equipment containing SF6) must be considered in the tunnel design (and vice versa) and the designs coordinated.

1.1 Minimisation of Routine Inspection and Testing

The cable system and any other systems within the tunnel shall be designed so as to minimise as far as reasonably practical, the period of time that personnel are required to work in the tunnel during its Asset Life.

Informative: All installed mechanical and electrical systems where reasonably practical should be designed on the basis of being located above ground (i.e. in the head houses). If equipment needs to be placed underground then, if reasonably practical should it be installed in the shafts. Only if both of these are not reasonably practical should equipment be placed in the tunnel.

1.2 Control of Safe Working

Accommodation shall be provided at each entrance to the tunnel for use by a Link Person when the tunnel is occupied. Where possible this shall be permanent accommodation but where the entrance is a manhole or similar then temporary accommodation shall be fit for purpose.

A Control Room or suitable control location shall be provided to monitor and control the various systems installed in the tunnel. The Control Room or equivalent area shall be protected from any fire risks arising from the tunnel. The room contains the appropriate control and communication facilities for the tunnel. The equipment necessary to allow safe access to and egress from the tunnel may be kept in the Control Room or elsewhere on site as appropriate.

Shaft locations for access and ventilation shall be dictated by a number of factors:

- The requirements for safe operation of the tunnels in accordance with project specific Life Safety Plan (LSP) and Risk Assessment.
- Design requirements of the tunnel (operation and maintenance considerations)
- Availability of suitable, land and associated planning consents

- Suitability of route i.e. crossing large bodies of water may require increased distance between shafts to be accommodated by appropriate assessment in the LSP

Informative: Whilst the LSP will set out the maximum safe distance between shafts (currently land based designs are in the range 4km – 5km), subject to suitable design considerations, tunnel shaft site spacing may be increased providing they facilitate the safe egress distances used in the Life Safety Plan.

Informative: The Life Safety Plan developed must include an emergency egress strategy. Self rescue sets are available with operational capacities of 30, 60 and 90 minutes but for longer durations there is a significant weight penalty.

Alternatively, where tunnel access for inspections can be aided by vehicular transport greater shaft separations can be considered, using 30 minutes as a reasonable time to escape.

Informative: The use of a vehicle for escape provides an extra degree of safety as physical exertion should not be required until the shaft stairwell has to be mounted.

2 CABLE SYSTEM DESIGN REQUIREMENTS

2.1 Cable System Design

The cable system shall be designed in line with the requirements of all appropriate National Grid technical specifications. The cable system shall be developed in conjunction with the FSES, in that the design of the cable system shall be such as to reduce overall risk to personnel to a reasonable minimum.

The cable system shall be designed so as to require minimum testing during its Asset Life. Cleats or supports shall be used for cable support in tunnels. Where cables are air cooled they shall be installed without any semi-conducting layer on the oversheath and oversheaths shall not be PVC based. Where cables are in air within the tunnel and where flame-retardant oversheath materials have not been used, flame retardant coatings shall be considered for application to the oversheath.

Site testing of the oversheath as required in National Grid TS 3.5.2 will not be required for cables on supports in air within a tunnel. A complete visual inspection of the cable oversheath shall be carried out after installation for all cables and any damage shall be reported to National Grid and repaired to National Grid's satisfaction.

Informative: This visual inspection will avoid the need for cable oversheath testing.

The design of the insulated sheath system shall minimise the need for Sheath Voltage Limiters (SVLs) or any other device that may require periodic testing.

Informative: To minimise tunnel access, alignment of testing requirements with routine civil inspections is preferred.

2.2 Ratings

Thermal ratings shall meet the requirements in National Grid TS 2.5.

2.3 Earthing

Where an earth continuity conductor (ECC) is provided it shall meet the short-circuit rating requirements in National Grid TS 1. The ECC shall be of such construction as to minimise maintenance requirements over the Asset Life of the cables. Ideally the ECC shall be totally maintenance-free.

Informative: National Grid does not require that solidly bonded joints in the middle of a cross bonded sheath system are earthed. The need for an ECC or earth at joint positions shall be critically examined.

The metalwork in the shafts shall be earthed to the local earth mat.

2.4 Magnetic Fields

Magnetic fields produced by cables in tunnels shall be assessed at the design stage for compliance with relevant exposure limits in force in the UK. Full details of the relevant exposure limits and the conditions for this assessment are set out in TGN(E) 253.

2.4.1 Occupational Exposures

Currently the applicable exposure limits are the 1998 guidelines from the International Commission on Non-Ionising Radiation Protection (ICNIRP) for time-varying fields. The design of the cables will ensure that the head and trunk of the employee shall not exceed the occupational exposure limits of this guidance. Cable tunnels will be designed so that occupational exposure limits will not be exceeded in areas where unconstrained access is required, such as in tunnel and basement stairwells, entrances and walkways. Cable tunnels shall be designed so that the occupational exposure limits are not be exceeded in the central 0.6 meters of the tunnel to allow free access.

Informative: If staff are required to work on or close to live cables then a specific risk assessment will be performed as documented in TGN(E) 253.

2.4.2 Public Exposures

For areas where members of the public have free access the ICNIRP 1998 public exposure guidelines shall be applied in line with EU recommendation 1999/519/EC3. The magnetic fields will be assessed 1 metre above ground level and should not exceed the 1998 ICNIRP public basis restriction where time of exposure is significant.

2.5 Reduction of Risk to Personnel

Cable system joints are likely to pose a greater risk than the cable to personnel and therefore the cable system design shall consider maximum possible drum lengths of cable to reduce the number of joints. In addition, staggering joint bays where two circuits are installed shall be considered so as to reduce risk to personnel who may be working on any joint repair or tunnel ancillary equipment.

2.6 Cable System Safety

The cable system shall be protected at any position where there is significant risk of damage due to the movement of materials within the tunnel and access shafts.

3 TUNNEL DESIGN FEATURES

Egress shafts shall be provided with independently ventilated stair wells rather than vertical ladders; unless a Risk Assessment shows that other methods are more appropriate.

Shafts shall be fitted out so that a clear lift is available from shaft bottom to ground level for the movement of equipment and for emergency access and evacuation of injured personnel by stretcher.

Where stairwells are to be used for emergency egress of injured personnel on a stretcher, the stairwell shall be designed to facilitate this emergency egress. Where it is not practical to evacuate an injured person up a staircase, for example due to tunnel depth or shaft dimension constraints then a suitable alternative proven method of evacuation shall be included at the tunnel design stage.

Informative: Vertical lifting up stairwells of injured personnel strapped to a stretcher shall not be permitted. The solution could be the use of a portable stair climbing device where the patient can be seated keeping manual handling / lifting to a minimum.

3.1 Water Ingress Criteria

The tunnel primary lining and shafts shall be substantially watertight, with no identifiable flow of water penetrating the lining. The water ingress will be accepted as compliant if:

- At each sump the average daily water leakage rate from the tunnel or shafts draining to that sump shall not exceed 0.1 litres/m² of tunnel or shaft surface measured on a pro rata basis over a 24 hour period.

Notwithstanding satisfactory compliance with these criteria, where there are discernible flows of water entering the tunnel or shafts at points that can be visually located, the contractor shall take such necessary measures to stop such ingress. In particular it shall be ensured that the cable supports remain dry and that water does not drip onto the cables.

No allowance for evaporation of water under service conditions shall be made when assessing infiltration through the complete lining.

3.2 Drainage

Sumps shall be provided at appropriate shaft positions to collect any water seepage. Appropriate means of disposal for waste water shall be provided.

Tunnels shall be designed with a fall which will be adequate to drain water to the sumps at the shafts.

All sumps shall be provided with pumps which are adequate to deal with water having significant amounts of suspended solids. All pumps shall be provided with appropriate water level alarms to give early indication of failure.

Informative: Any water discharge licences that are required should be obtained as part of the project and be in place prior to handover.

3.3 Vehicular Access

The need for a tunnel vehicle shall be considered for each specific tunnel based on a Risk Assessment.

Where a maintenance/access vehicle is suspended from a running track the maintenance and inspection requirements for the track shall be reduced to a reasonable minimum consistent with the tunnel fabric inspection requirements. Provision shall be made for removing the vehicle from the tunnel.

Where a maintenance and access vehicle is provided which does not run on rails, the contractor shall demonstrate how the safety of the driver, other staff and the cable system can be ensured during normal access and in the event of fire or other emergency.

Informative: The vehicle should have a proven reliable power source and battery charging system (if battery operated) taking into account frequency of use. There should also be a means of returning a vehicle to a power source if the batteries have failed. Options that could be considered to move the vehicle are, for example:

- *A mechanical operated drive*
- *A dual power source*