

SPECIFICATION FOR THE DESIGN OF NEW 400 KV TRANSMISSION LINE TOWERS (L13)

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PURPOSE AND SCOPE

This document forms part of a suite of documents which define National Grid's functional and performance requirements for new plant and equipment associated with electricity.

In recent years, the non-availability of large section steel angles (305x305mm) has become critical in the event where a heavy angle tower (L6) required replacing due to condition or catastrophic failure.

Furthermore, recent growth in energy demand has led utilities including National Grid to install larger conductor systems to transmit the increased power, this in turn imposes larger loads on the existing towers. The design standards and legislative requirements that govern tower design have changed over the years and compliance with these requirements should be considered and applied in an efficient and economic manner. Retrospective modifications are considered impractical.

The design of a new tower series to be operated at 400 kV and capable of carrying the maximum electrical load needed by National Grid transmission system for a new Overhead Transmission Line (OTL) is now required.

This Specification covers the requirements applicable to the design of new double circuit (DC) tower structures, to be designated 'L13' for use on new lines and for replacement of existing L6 structures.

PART 1 - PROCEDURAL

1 GENERAL REQUIREMENTS

The design of new towers to be used on National Grid transmission system, shall meet the general electrical parameters outlined in TS 1. The design shall also comply with the requirements of BS EN 50341 Part1 and the UK National Normative Aspects (NNA) – BS EN 50423-3-9 (or BS EN 50341-3-9 – see below).

The hierarchy of functional design specifications shall be:

- BS EN 50341, as modified by:
- BS EN 50341-3-9 UK National Normative Aspects (NNA), as modified by:
- BS EN 50423-3-9 NNA for Great Britain and Northern Ireland, as modified by:
- TS 1 and 3 series, as modified by:
- The Project Specification (this document).

In all design aspects of National Grid Overhead Lines, designers shall be familiar with and understand their duties under CDM regulations. They shall also comply with any applicable legislative requirements.

1.1 Statutory Requirements

The requirements of the 2002 Electricity Safety, Quality and Continuity Regulations shall be met. Refer to TS 2.27 and ENATS 43-8 for requirements specific to ground clearances, earthing, safety signage and precautions against unauthorised access.

1.2 Design Data

1.2.1 Tower Types

The new tower range shall include: D, D30(0-10 & 10-30), D60, D90, DT, DJT and ST. Earthwire changeover towers shall also be designed at 20 and 40 degrees angle of deviation for D30 and D60 towers respectively. These shall be designated as D20EC and D40EC respectively. Tower extensions (E) and reductions (M) shall also be designed at 1.5m intervals for leg extensions and 3m intervals for body extensions. Body extensions required shall range from M6 to E18m for suspension towers and M6 to E12m for all other towers. Leg extensions shall range from -1.5 to +3m.

The design shall also consider low height towers for Suspension (LD) and 30 degrees angle of deviation (LD30).

The leg and stub angle sizes shall be constant throughout the range of extensions.

1.2.2 System Data

System design parameters shall be in accordance with TS 1 and TS 2.01.

Nominal system voltage: 400 kV

1.2.3 Design particulars

Site altitude AOD	250 m
Basic mean hourly wind speed	25 m/s
Terrain category	II
Radial ice thickness, no wind (ro)	65 mm
Radial ice thickness, in conjunction with wind (rw)	15 mm
Wind direction k_d -high wind case	1.0
-combined wind and ice case	0.85

Standard span length for standard height tower	360 m
Maximum single span length	540 m
Maximum sum of adjacent spans	805 m

Maximum weight span (normal condition)	650 m*
Maximum weight span (broken wire condition)	485 m
Min weight span suspension towers:	250 m
Tension towers	-150 m

Maximum wind span: half sum of adjacent spans

* The maximum weight span for terminal towers only shall be 500m.

1.2.4 Loading cases

The following loading cases are to be considered in the design:

- High wind in the absence of ice (at a conductor temperature of 0°C)
- Combined wind and ice (at a conductor temperature of -10°C).

- c) Heavy ice in the absence of wind (at a conductor temperature of -10°C).
- d) Construction and maintenance.
- e) Security loads (broken wire) – longitudinal and torsional:

This is defined as the static tension of two broken phase bundles or one phase and earthwire, in the same span. Correspondingly, the following failure containment loading conditions shall be assumed in the tower design. These shall be applied to both suspension and tension towers.

Suspension towers: design everyday tension, no wind or ice load. An alleviation factor of 0.7 for phase conductor to allow for insulator swing shall be used. No alleviation for earthwires.

Tension towers: 1. As above, but no alleviation factor shall be allowed.
2. Additional requirement assuming only one phase or earthwire broken. The conductor loads shall be determined on the 3 year return period wind on 3 year return period ice.

No alleviation factor shall be used on this load. The wind loading on tower structure shall consider various angles of incidence to the tower body at intervals of 15 degrees.

The unit weight of ice to be used shall be 5kN/m^3 for the heavy ice case and 9kN/m^3 for the combined wind and ice case.

Note: Avalanche, creeping snow and earthquakes shall not be considered.

1.2.5 Reliability levels

Suspension towers	2* ($\gamma_v=1.1$)
Tension towers	3 ($\gamma_v=1.2$)

* Suspension towers adjacent to habitation or at critical crossings shall be designed to reliability level 3 ($\gamma_v = 1.2$). The term “adjacent to habitation” shall be considered as being where a tower or line is located within falling distance of a dwelling, garden or any other property as detailed below. The designer shall establish the limited wind and weight spans to be used in this application.

Critical crossings shall include: - motorways, schools, housing, railways, other roads with high traffic loads or providing access to major attractions, other areas where large numbers of people congregate and major industrial plant.

1.3 Conductor System

- 1.3.1 The heaviest standard conductor system to be applied shall be a triple 700mm^2 AAAC Araucaria, in accordance with TS 3.04.20 and TS 3.04.02, having a triangular bundle configuration, apex down with $500 \times 500 \times 500$ mm centre-to-centre conductor separation.

The maximum operating temperature of the conductor shall be 90°C .

1.3.2 Sagging basis

Maximum everyday tension at 5°C of phase sub-conductor	47 kN
Maximum erection tension of phase sub-conductor at -20°C	63 kN
Overtension temperature for creep compensation, phase conductors	20°C