Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड़ नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"


"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartrhari—Nitisatakam
"Knowledge is such a treasure which cannot be stolen"
Indian Standard

CODE OF PRACTICE FOR DESIGN, INSTALLATION AND MAINTENANCE FOR OVERHEAD POWER LINES

PART 3 400 kV LINES
Section 1 Design

Second Reprint SEPTEMBER 2007
(Including Amendment No. 1)

UDC 621.315.17
Conductors and Accessories for Overhead Lines Sectional Committee, ETDC 60

FOREWORD

This Indian Standard (Part 3/Sec 1) was adopted by the Bureau of Indian Standards on 23 March 1989, after the draft finalized by the Conductors and Accessories for Overhead Lines Sectional Committee had been approved by the Electrotechnical Division Council.

The present strategy for development of power has necessitated a rapid development of extensive extra high voltage (EHV) network covering the whole country. After successful introduction of 220 kV system in the country, 400 kV has been adopted as the next higher system voltage after detailed techno-economic studies. For the development of 400 kV network, this code, in addition to specifying the good practices for EHV lines, gives in particular the detailed requirements for towers, conductors and other associated accessories suitable for 400 kV system.

While preparing this specification considerable assistance has been taken from the report of the Committee for Standardization of Parameters and Specifications for Major Items of 400 kV Substation Equipment and Transmission Line Materials (1984) published by the Central Electricity Authority, Department of Power, Ministry of Energy, New Delhi.

In order to cover all the system voltage(s), this standard has been prepared in the following three parts:

Part 1 Lines up to and including 11 kV,
Part 2 Lines above 11 kV and up to and including 220 kV, and
Part 3 400 kV Lines.

Each part has been further divided into two sections. Section 1 covers design aspects while Section 2 covers installation and maintenance of overhead power lines.
AMENDMENT NO. 1 JULY 1994
TO
IS 5613 (Part 3/Sec 1) : 1989 CODE OF PRACTICE FOR
DESIGN, INSTALLATION AND MAINTENANCE OF
OVERHEAD POWER LINES
PART 3 400 KV LINES

Section 1 Design

( Page 1, clause 4 ) — Insert the following and renumber subsequent clause

4.2 For the safety requirement of low flying Military Aircrafts, all the transmission lines and transmission line structures falling within the safety zone of airfields and air to ground firing ranges shall meet the requirements of Directorate of Flight Safety, Air Headquarters given in Annex B.

( Page 11, Annex B ) — Insert the following Annexure and renumber the subsequent Annexes

ANNEX B

( Clause 4.2 )

VISUAL AIDS FOR DENOTING TRANSMISSION LINES AND TRANSMISSION LINE STRUCTURES — REQUIREMENT OF DIRECTORATE OF FLIGHT SAFETY

All the Power Utilities shall comply with the following

a) The transmission lines and transmission line structures of height 45 m and above shall be notified to the Directorate of Flight Safety (DFS) Air Headquarters (Air HQ), New Delhi

b) For construction of any transmission line/structure or a portion thereof, falling within a radius of 20 km around the Defence aerodromes and air to firing ranges provisions of the Aircraft Act 1934, Section 93 as amplified by the associated Gazette Notification SO 988 Part II, Section 3, Subsection (ii) dated 1988-03-26 shall be complied with. Towards this, a No Objection Certificate (NOC) shall be obtained from the concerned aerodrome authorities.
Amend No. 1 to IS 5613 (Part 3/Sec1) : 1989

c) Within a radius of 10 km around aerodromes and air to ground firing ranges, all transmission lines and structures of height 45 meters or more shall be provided with day and night visual aids.

d) In all other areas, outside a radius of 10 km from aerodromes, only those portions of transmission lines and structures of any height identified to pose a hazard to aircraft by the Directorate of Flight Safety shall be provided with day visual aids.

2. DESCRIPTION OF VISUAL AIDS

2.1 Day Marking

1) Line Markers — Coloured globules of 40-50 cm diameter made of reinforced fibre glass or any other suitable material, weighing not more than 4.5 kg each with suitable clamping arrangement and drainage holes shall be installed on the earth wire(s) in such a manner that the top of the marker is not below the level of the earth wire. Up to 400 metre span, one globule shall be provided in the middle of the span on the highest earth wire. In case of double earth wires, the globule may be provided on any one of them. For span greater than 400 metres, one additional globule may be provided for every additional 200-metre span or part thereof. Half orange and half white coloured globule should be used. A typical sketch of marker is given in Fig 1.

2) Structure Marking — The structure portion excluding cross-arms above 45 m height shall be painted in alternate bands of international orange and white colours. The bands shall be perpendicular to the vertical axis and the top and bottom bands shall be orange. There shall be an odd number of bands. The maximum height of each band shall be 5 m. A typical sketch of marking a structure is given in Fig 2.

2.2 Night Marking

2.2.1 Medium and low intensity obstacle lights as per Fig. 3 on a complex obstacle such as towers supporting overhead wires should have a night time intensity as per ICAO requirements in International Standards recommended practices. The light on top of the structure should flash at the rate of 20 sequences per minute.

2
 Amend No. 1 to IS 5613 (Part 3/Sec1) : 1989

FIG. 2  DAY MARKING ALTERNATE BANDS

(B = 5 m max.)
min. BANDS
= 3 (Odd Nos)

OVERALL STRUCTURE HEIGHT

45 m

4
FIG. 3 **Night Marking of Power Transmission Tower**

(ETD 37)
Indian Standard

CODE OF PRACTICE FOR DESIGN,
INSTALLATION AND MAINTENANCE FOR
OVERHEAD POWER LINES

PART 3  400 kV LINES
Section 1  Design

1 SCOPE

1.1 This code (Part 3/Sec 1) covers design of
400 kV transmission lines.

1.2 This code does not cover switching control,
relay protection, coordination with telecommunication
lines and radio-interference.

2 REFERENCES

2.1 The Indian Standards listed in Annex A are
necessary adjuncts to this standard.

3 TERMINOLOGY

3.1 For the purpose of this code, the definitions
given in IS 1885 (Part 30):1971 and the Indian
Electricity Rules, 1956 shall apply.

4 GENERAL

4.1 Conformity with Indian Electricity Rules and
Regulations of other Authorities — All overhead
lines shall comply with the requirements of the
Indian Electricity Act and Rules made thereunder,
and the regulations or specifications as laid down
by Railway Authorities, Post and Telegraphs,
Roadways, Navigation or Aviation Authorities,
local governing bodies, Defence Authorities, Power
and Telecommunication Coordination Committee,
Forest and Environment Authorities etc, wherever
applicable. Relevant matters requiring attention
of such authorities should be referred to them and
their approval obtained before planning the layout,
installation and construction work. Such references,
however, shall be made by the owner of the
installations and within appropriate time so as
to ensure smooth progress. The Rules No. 29, 51,
74 to 93 of the Indian Electricity Rules, 1956 are
particularly applicable.

4.2 It is essential that before proceeding with the
design, the site conditions are known as best as
possible. The available design should further be
oriented taking into account the difficulties likely
to be encountered during installation and mainte-
nance.

5 CHOICE OF ROUTE

5.1 The proposed route of line should be the
shortest practicable distance. The following
factors shall be considered in the choice of the
route:

a) Line should be approachable. Difficult and
unsafe approaches should be avoided.

b) Route should be as short and as straight as
possible.

c) Number of angle towers should be minimum
and within these, the number of heavier
angle towers shall be as small as possible.

d) Good farming areas, uneven terrains, reli-
gious places, civil and defence installations,
industries, aerodromes and their approach
and take-off funnels, public and private
premises, ponds, tanks, lakes, gardens and
plantations should be avoided as far as
practicable.

e) Cost of securing and clearing right-of-way
(ROW), making access roads and the time
required for these works should be mini-
mum.

f) Line should be as away as possible from
telecommunication lines and should not run
parallel to these.

g) Crossing with permanent objects, such as,
 railway lines and roads should be minimum
and preferably at right angles. Reference
shall be made to the appropriate railway
regulations and railways electrification rules
as well as civil authorities for protection to
be provided for railway and road crossings,
respectively.

h) A detour in the route is preferable so that it
should be capable to take care of future
load developments without major modifica-
tions.

i) Line should be away from the buildings
containing explosives, bulk storage oil
tanks, oil or gas pipelines.

5.2 In case of hilly terrain having sharp rises and
falls in the ground profile, it is necessary to
conduct detailed survey before finalizing the tower
and line design data. This will provide most economical proposition for the installation.

6 ELECTRICAL DESIGN

6.1 General

The electrical design of the lines shall be carried out in accordance with the established design practices taking into consideration the power system as a whole, and shall cover the following:

6.1.1 Transmission Voltage

The transmission voltage applicable for this standard shall be 400 kV in accordance with the recommendations of IS 12360 : 1989. Besides other considerations, the following factors should be considered before making the choice of the voltage:

a) Magnitude of the power to be transmitted,

b) Length of the line,

c) Cost of the terminal equipment, and
d) Economy consistent with the desired reliability.

6.1.2 Insulation Requirements

The insulation levels shall be selected in accordance with IS 2165 (Part 1) : 1977, IS 2165 (Part 2) : 1983 and IS 3716 : 1978.

7 STRUCTURES

7.1 Towers

The design and material of the towers shall conform to IS 802 (Part 1) : 1977.

7.1.1 In case of hot-dip galvanized structures, galvanizing shall conform to IS 2633 : 1986, IS 4759 : 1984 and IS 1367 (Part 13) : 1983. For spring washers, electrogalvanizing in accordance with IS 1573 : 1986 shall be acceptable.

7.2 Choice of Span

The following factors influence the choice of span:

a) Terrain conditions,

b) Economic construction and maintenance cost, and
c) Ease of construction and maintenance.

7.2.1 Ruling (Equivalent) Span

For erecting an overhead line, all the spans cannot be kept equal because of the profile of the land and proper clearance considerations. If this were done, adjustments of tensions would be necessary in adjacent spans since any alteration in temperature and loading would result in unequal tension in the various spans. This is obviously impracticable as a constant tension should be applied at the tensioning position and this constant tension shall be uniform throughout the whole of the section. With suspension insulators, the tension inequalities is compensated by string deflections. Therefore, a constant tension is calculated which will be uniform throughout the section. For calculating this uniform tension, an equivalent span for the whole length of the line is chosen. The ruling span is then calculated by the following formulae:

\[ L_R = \sqrt{\frac{L_1^2 + L_2^2 + L_3^2 + \ldots}{L_1 + L_2 + L_3 + \ldots}} \]

where

- \( L_R \) = ruling span,
- \( L_1, L_2, \ldots \) = different spans in a section.

Having determined the ruling span and basic tension, the sag of actual span may be calculated by the following formula:

\[ S = \left[ \frac{Actual \ span}{Ruling \ span} \right]^3 \times S_R \]

where

- \( S \) = sag for actual span, and \( S_R \) = sag for ruling span.

NOTES

1 For ready reference, tensions may be calculated for different sizes of conductors for different span lengths and at different temperatures and plotting as sag tension charts.

2 For the limitation regarding weight span and wind span, reference shall be made to IS 802 (Part 1) : 1977 as well as Appendix A of IS 5613 (Part 2) : 1983.

7.3 Typical Structure Configuration

7.3.1 The typical tower configuration for single circuit and double circuit transmission lines is shown in Fig. 1.

7.4 Tower Loadings

7.4.1 Normal Condition

a) Transverse loads

1) Wind on wires,
2) Wind on insulators,
3) Line deviation, and
4) Wind on tower.

b) Vertical loads (uplift or down thrust)

1) Weight of wires;
2) Weight of ice, if any;
3) Weight of insulators and accessories; and
4) Erection load.
Fig. 1 Typical Tower Configuration for Single Circuit and Double Circuit Transmission Lines
IS 5613 (Part 3/Sec 1) : 1989

NOTES

1 If there is no uplift on the wires as observed by applying the sag template in accordance with Appendix A of IS 5613 (Part 2/Sec 2) : 1976 the tension of the wires acts downwards. If there is uplift, the tension of the wires acts upwards and has to be considered for design of tension tower.

2 The ice on the conductor is classified as glazed (ice), rime, wet snow and hoar frost. The unit weight of glaze (ice), rime (soft/hard), wet snow and hoar frost shall be taken as 900 to 920 kg/m², 300 to 900 kg/m², 300 to 900 kg/m² and 300 kg/m², respectively. The ice coating on structure themselves may be ignored for design purpose.

c) Loads due to unbalanced tensions, unbalanced tension on angle towers.

7.4.2 Broken Wire Conditions

a) As in 7.4.1 and (b) above, modified for broken wire effect, and

b) Longitudinal loads.

7.5 Tower Accessories

7.5.1 Number Plates

These shall conform to Fig. 2.

7.5.2 Danger Notice Plates

These shall conform to IS 2551 : 1982

7.5.3 Phase Plates

These shall be in sets of red, yellow and blue colours and shall conform to Fig. 3.

7.5.4 Circuit Plates

These shall conform to Fig. 4.

NOTES

1 Lettering should be in red enamelled on white background.

2 The rear side of the plate shall be enamelled black.

3 The plate shall be of minimum 1/6 mm thick mild steel sheet.

4 For number plate, numbering shall be in the sequence of tower numbers as per specification.

5 'SC' represents first letter of starting and ending place of line respectively.

All dimensions in millimetres.

FIG. 2 NUMBER PLATE
7.5.7 Arrangements shall be provided for fixing the accessories (covered in 7.5.1 to 7.5.5) to the tower at a height between 2.5 and 3.5 mm above ground level.

7.5.8 Bird Guards
These shall be saw tooth type and shall be fixed over the suspension insulator strings (see Fig. 7). Bird guards shall be used for type 1 strings only.

7.6 Towers

8 POWER CONDUCTORS AND ACCESSORIES

8.1 Power Conductors
Conductor for EHV transmission lines shall conform to IS 398 (Part 5): 1982.

8.2 Accessories for Power Conductors
The various accessories associated with the power conductors shall conform to the following Indian Standards:

9 EARTH CONDUCTOR AND ACCESSORIES

9.1 Galvanized steel wires shall be used for ground wires. For 400 kV lines, the size of ground wire shall be 7/3.66 mm having a minimum tensile strength of 95 kg/mm². The purity of steel shall be as follows:
- a) Sulphur and phosphorus contents not exceeding 0.045 percent each, and
- b) Carbon content not exceeding 0.55 percent.

9.2 Ground Wire Accessories

9.2.1 Mid-Span Compression Joints
The material for mid-span compression joint shall be galvanised mild steel.

9.2.2 Suspension Clamps
The material for suspension clamps shall be malleable cast iron/forged steel. Minimum failing load shall be not less than the breaking load of the ground wire. The slip strength shall be not less than 25 to 30 percent of the breaking load of the ground wire.
NOTES
1. Letting should be in red enamelled on white background.
2. Rear side of the plate shall be enamelled black.
3. One set consists of 2 such plates with markings 'I' and 'II' for dueble circuit tower only.
4. The material of the plate shall be of mild steel having minimum thickness 1.6 mm.

All dimensions in millimetres.

FIG. 4 CIRCUIT PLATE
9.2.3 Tension Clamps

The body of compression type tension clamps shall be of stainless steel grade 07G19N19 conforming to appropriate part of IS 1570, (EN58A) grade or equivalent with brinell hardness not exceeding 200. The minimum falling load and minimum slip strength shall be not less than 95 percent and 90 percent, respectively of the breaking load of the ground wire.

9.2.4 Earthing Bonds

Tinned copper stranded wire of 37/7/0.47 mm shall be used for earthing bonds. The bond shall be tested by applying a pull of 300 kg between the two ends of the bonds, the stranded cable shall not come out of the connecting less and none of its strands shall be damage.

10 EARTHING

10.1 All metal supports and metallic fittings attached thereto, shall be permanently and efficiently earthed.

10.2 Earthing in each case shall conform to the requirements given in Section 2 of this standard and also to IS 3043 : 1987.

11 MAXIMUM WORKING TENSION

11.1 Where the actual span is different from the ruling span, the maximum working tension shall not exceed the tension for which the towers are designed.

11.2 For any difference between the conductor tension in adjacent line sections, the relevant section tower shall be checked for its capacity to withstand the resulting unbalanced longitudinal loads together with the other existing loadings according to design specifications and the position of the tower.

11.3 The still air ground wire sag shall not exceed 90 percent of the power conductor sag within the specified range of temperature so as to ensure that the minimum shield angle is maintained and the minimum specified mid-span clearance is not encroached upon (see 14.1.3).
11.4 For long spans (where sag exceeds 6 percent of the span length) and spans with steep slopes, the tension at supports exceeds the horizontal conductor tension obtained by the usual sag-tension calculations. If support tension exceeds 50 percent of the rated ultimate tensile strength of conductor, the specified safety factors for sag-tension calculations shall be suitably increased.

11.5 For general theory of sag and tension calculation, reference shall be made to 7 of IS 5613 (Part 1/Sec 1): 1985. An example of sag and tension calculations for ACSR conductors is given in Appendix A of IS 5613 (Part 2/Sec 1): 1985.

12 INSULATORS AND FITTING
12.1 Disc Insulators
Standard disc insulators of ball and socket type conforming to IS 731:1971 and IS 3188:1980 shall be used. For 400 kV lines, use of discs of the size of 255/280 x 145 mm of 120 kN electromechanical strength for suspension string and 280 x 170 mm of 160 kN electromechanical strength for tension string is recommended.

The insulator string shall have enough number of insulator discs so that adequate conductor to tower clearances is achieved and the string should
be able to withstand the flashover characteristics estimated for over-voltage conditions.

12.2 Insulator String Hardware

12.2.1 Suspension Clamp

Free centre or armour grip suspension type to clamps shall be used so as to ensure reliability against mechanical strength and conductor vibration. The material of the body shall be gravity die cast, high strength corrosion resistant aluminium alloy.

12.2.2 Tension Clamp

The compression type of tension clamps shall be used. The outer sleeve of the clamps shall be of EC grade aluminium tube formed by extrusion process and inner sleeve shall be of galvanized low carbon forged steel. The clamp shall be able to withstand a minimum failing load of 95 percent of the breaking load of the conductor.

12.2.3 Arcing Horns on Tower Side

These shall be loop or ball ended type and shall be made out of galvanized mild steel tube/rod.

12.2.4 Grading/Corona Ring

These shall be made of aluminium alloy tube/galvanized mild steel tube.

13 FOUNDATIONS

14 CLEARANCES

14.1 The minimum clearances shall meet with the requirements given in following clauses.

14.1.1 Minimum ground clearance from lowest point of power conductor shall be 8 840 mm.

NOTE — Extra allowance may be made to provide for creep, undulation in terrain, etc.

14.1.2 Minimum mid-span vertical clearance between power conductor and ground wire in still air at normal design span shall be 9 000 mm.

14.1.3 The earth wire sag shall be not more than 90 percent of the corresponding sag of power conductor under still air conditions for the entire specified temperature range.

14.1.4 Minimum clearance from line parts to tower body and cross-arm members in the case of 400 kV lines shall be in accordance with Table 1.

14.2 Clearance Between the Overhead Line and the Railway Track

14.2.1 Clearance between the overhead line and railway track shall be in accordance with the Regulations for Electricals Crossings of Railway Tracks laid down by the Railway Authorities.

14.2.1.1 Vertical clearances

The minimum height above rail level of the lowest portion of any conductor of a crossing, including grand wire, under conditions of maximum shall be as follows:

| Wind Pressure
kg/m² | Insulator String | Jumper String |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Swing</td>
<td>Maximum Swing</td>
<td>Normal Swing</td>
</tr>
<tr>
<td>Switching Surge</td>
<td>Over-Voltage</td>
<td>Power Frequency</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>43</td>
<td>21°(15°)</td>
<td>42°(30°)</td>
</tr>
<tr>
<td>45</td>
<td>22°(15°)</td>
<td>44°(30°)</td>
</tr>
<tr>
<td>52</td>
<td>24°(15°)</td>
<td>48°(30°)</td>
</tr>
</tbody>
</table>

Clearances 3 050 1 860 3 050 (1 860) (3 050)

mm

NOTE — The values given in the brackets are the revised values. It is proposed to ultimately retain the revised values only and delete the old values.

ANNEX A

(Clauses 2.1)

LIST OF REFERRED INDIAN STANDARDS

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 398</td>
<td>Specification for aluminium conductors for overhead purposes</td>
</tr>
<tr>
<td>(Part 5) : 1982</td>
<td>Aluminium conductors—galvanized steel — reinforced for extra high voltage (400 kV and above)</td>
</tr>
<tr>
<td>IS 456 : 1978</td>
<td>Code of practice for plain and reinforced concrete (third revision)</td>
</tr>
<tr>
<td>IS 731 : 1971</td>
<td>Specification for porcelain insulators for overhead power lines with a nominal voltage greater than 1 000 V (second revision)</td>
</tr>
<tr>
<td>IS 802</td>
<td>Code of practice for use of structural steel in overhead transmission line towers</td>
</tr>
<tr>
<td>(Part 1) : 1977</td>
<td>Loads and permissible stresses</td>
</tr>
<tr>
<td>(Part 2) : 1978</td>
<td>Fabrication, galvanizing, inspection and packing</td>
</tr>
<tr>
<td>(Part 3) : 1978</td>
<td>Testing</td>
</tr>
<tr>
<td>IS 1367</td>
<td>Technical supply conditions for threaded steel fasteners</td>
</tr>
<tr>
<td>(Part 13) : 1983</td>
<td>Hot dip galvanized coatings on threaded fasteners (second revision)</td>
</tr>
<tr>
<td>IS 1570 (in parts)</td>
<td>Schedules for wrought steels</td>
</tr>
<tr>
<td>IS No.</td>
<td>Title</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>IS 1573 : 1986</td>
<td>Electroplated coatings of zinc on iron and steel (second revision)</td>
</tr>
<tr>
<td>IS 2121</td>
<td>Specification for conductors and earth wire accessories for overhead power lines</td>
</tr>
<tr>
<td>(Part 1) : 1981</td>
<td>Armour rods, binding wires and tapes (first revision)</td>
</tr>
<tr>
<td>(Part 2) : 1981</td>
<td>Mid-span joints and repair sleeves (first revision)</td>
</tr>
<tr>
<td>IS 2165</td>
<td>Insulation co-ordination (Part 1) : 1977</td>
</tr>
<tr>
<td>(Part 2) : 1983</td>
<td>Phase to phase insulation co-ordination, principles and rules (second revision)</td>
</tr>
<tr>
<td>IS 2633 : 1986</td>
<td>Methods of testing uniformity of coating of zinc coated articles (second revision)</td>
</tr>
<tr>
<td>IS 3188 : 1980</td>
<td>Characteristics of string insulator units (first revision)</td>
</tr>
</tbody>
</table>

**ANNEX B**

*(Clause 7.6)*

**TECHNICAL PARTICULARS FOR TYPICAL TOWERS FOR 400 kV LINES**

**B-1 GENERAL**

**B-1.1 Configuration**

**B-1.2 Type of Towers**

Horizontal
a) Suspension towers (0-2°)
b) Small angle tension towers (2-15°)
c) Medium angle tension towers (15-30°)
d) Large angle tension towers/dead end towers (30-60°/dead end)

**B-1.3 Normal Span**

400 metres

**B-1.4 Wind Span**

Equal to normal span
B-1.5 Weight Span

Maximum
Minimum

1.5 × normal span
0.80 × normal span

NOTE — The cross arms for medium and heavy angle towers shall be suitable for a weight span of 3 times the normal span.

B-1.6 Maximum Temperature of Current Carrying Power Conductor Exposed to Sun

75°C

B-1.7 Maximum Temperature of Groundwire Exposed to Sun

53°C

B-1.8 Maximum Wind Pressure and Minimum Temperature Conditions

As in Fig. 1 of IS 802 (Part 1) : 1977

B-2 CONDUCTORS

B-2.1 Number of Subconductors per Phase

Two

B-2.2 Spacing Between Subconductors

450 mm

B-2.3 Bundle Arrangement

Horizontal

B-3 EARTHWIRE

B-3.1 Number of Earthwires

Two

B-3.2 Shielding Angle

20°

B-4 INSULATOR STRINGS

B-4.1 Maximum Length of Suspension Strings from Shackle Attachment at Hanger to Centre Line of Conductor

3850 mm

B-4.2 Maximum Length of Tension Strings from Tower Attachment to Compression Dead-End Attachment

5600 mm

5450 mm, *Min*

B-5 HANGER

300 mm

B-6 CLEARANCES

B-6.1 Minimum Ground Clearance from Lowest Point of Power Conductor

8840 mm*

B-6.2 Minimum Clearance from Live Parts to Tower Body and Cross-Arm Members

As in Table I

B-6.3 Minimum Mid-Span Vertical Clearance Between Power Conductor and Ground Wire in Still Air

9000 mm

B-7 BROKEN WIRE CONDITION

B-7.1 Suspension Towers

Any groundwire or bundle whichever is more stringent for a particular member

B-7.2 Tension Towers

Any groundwire or bundle whichever is more stringent for a particular member

B-8 LOADINGS

B-8.1 Loadings shall be Determined for the Two Loading Combinations Given Below:

a) Combination I

b) Combination II

Corresponding to maximum wind at mean annual temperature

Corresponding to 2/3 maximum wind at the minimum temperature.

*Extra allowance may be made to provide for creep, undulation in terrain, etc,
### B-8.2 Transverse Loads

#### B-8.2.1 Windloads

<table>
<thead>
<tr>
<th>Condition</th>
<th>Normal Condition</th>
<th>Broken Wire Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) On conductors and groundwires on full projected areas</td>
<td>Corresponding to full wind span of bundled conductors and groundwire</td>
<td>Corresponding to 50 percent of intact span and 10 percent of broken span of bundled conductor/groundwire</td>
</tr>
<tr>
<td>b) On towers</td>
<td>On 1.5 times the projected areas of towers</td>
<td></td>
</tr>
<tr>
<td>c) On insulator strings:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Suspension</td>
<td>100 kg</td>
<td>100 kg</td>
</tr>
<tr>
<td>2) Tension</td>
<td>300 kg</td>
<td>300 kg</td>
</tr>
</tbody>
</table>

#### B-8.2.2 Deviation Loads

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
</table>
| Transverse component tension of bundled conductors and groundwire | a) Suspension Towers

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
</table>
| Transverse component corresponding to 50 percent of the tension of bundled conductors or 100 percent of the tension of groundwire | b) Tension Towers

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse component corresponding to 100 percent of the tension of bundled conductor/groundwire</td>
<td></td>
</tr>
</tbody>
</table>

### B-8.3 Vertical Loads

#### B-8.3.1 Due to Conductors

<table>
<thead>
<tr>
<th>Condition</th>
<th>Normal Condition</th>
<th>Broken Wire Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Suspension towers</td>
<td>Equal to maximum/minimum weight span of bundled conductors</td>
<td>60 percent of maximum/minimum weight span of bundled conductors</td>
</tr>
<tr>
<td>b) Tension towers</td>
<td>Equal to maximum weight span of bundled conductors (downward or upward)</td>
<td>60 percent of maximum weight span of bundled conductors (downward or upward)</td>
</tr>
</tbody>
</table>

#### B-8.3.2 Due to Groundwires

<table>
<thead>
<tr>
<th>Condition</th>
<th>Normal Conditions</th>
<th>Broken Wire Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Suspension towers</td>
<td>Equal to maximum/minimum weight span of groundwire</td>
<td>60 percent of maximum/minimum weight span of groundwires</td>
</tr>
<tr>
<td>b) Tension towers</td>
<td>Equal to maximum weight span of groundwire (downward or upward)</td>
<td>60 percent of maximum weight span of groundwires (downward or upward)</td>
</tr>
</tbody>
</table>

#### B-8.3.3 Due to Insulator and Conductor Accessories

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equivalent to weight of insulator strings, spacers, dampers, etc.</td>
<td></td>
</tr>
</tbody>
</table>

### B-8.4 Longitudinal Loads

#### B-8.4.1 Due to Power Conductor

<table>
<thead>
<tr>
<th>Condition</th>
<th>Normal Condition</th>
<th>Broken Wire Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Suspension towers</td>
<td>Nil</td>
<td>50 percent of the tension of bundled conductors</td>
</tr>
<tr>
<td>b) Tension towers</td>
<td>Equal to the tension of bundled power conductors for dead-end towers only</td>
<td>Equal to the components of tension of the bundled power conductors corresponding to the relevant angles of deviation</td>
</tr>
</tbody>
</table>
B-8.4.2 Due to Groundwire

---

**Normal Condition**

- a) Suspension towers: Nil
- b) Tension towers: Equal to the tension of groundwire for dead-end tower

**Broken Wire Condition**

- Equal to the tension of groundwire
- Equal to the components of tension of groundwire corresponding to the relevant angles of deviation

B-8.5 Erection Loads

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**Normal Condition**

- 150 kg
- 350 kg

**Broken Wire Condition**

- 150 kg
- 350 kg

---

**Note** — The design of towers shall be based on the loading combination and condition which is more stringent for the particular member.

B-9 PERMISSION STRESSES, SLENDERNESS RATIOS, MINIMUM THICKNESS, NOT EFFECTIVE AREAS, ETC

As in IS 802 (Part 1) : 1977

B-10 FACTORS OF SAFETY

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**B-10.1 Towers**

- a) Normal condition: 2.0
- b) Broken wire condition: 1.5

**B-10.2 Foundations**

- a) Normal condition: 2.2
- b) Broken wire condition: 1.65

**B-10.3 Conductors and Earthwire**

For maximum of tensions corresponding to 2/3 maximum wind pressure at minimum temperature or maximum wind pressure to the mean annual temperature such that the initial unloaded tensions at the mean annual temperature do not exceed 35 percent of their ultimate tensile strengths and the final unloaded tensions at the mean temperature do not exceed 22 percent of ultimate strength of the conductor and 20 percent of the ultimate strength of groundwire.

**B-11 TESTS**

As in Part 2 of this standard
Bureau of Indian Standards

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This Indian Standard has been developed from Doc: No. ETDC 60 (2967)

Amendments Issued Since Publication

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<th>Amendment No</th>
<th>Date of Issue</th>
<th>Text Affected</th>
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