

CONTENTS

| Description | Page No. |
|---|-----------------|
| Scope, specific technical requirements and quantities | 02 |
| Design basis report 33kV D/C and S/C line | 03 |
| Design basis report 11kV D/C | 03 |
| Schedule of technical deviation | 01 |

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES

1.1 SCOPE

The detailed scope of work shall be as follows:

- (i) Preparation & submission of design documents of towers and their foundations, fabrication drawings including stub, template and tower extensions, bill of material of all members, hardware etc. The detailed design & drawing work shall include, but not limited to :
 - Verification of all data, criteria and information contained in the contract documents.
 - Generation of all data, criteria and information required for the completion of work including liaison and interface with BHEL/Customer.
 - Analysis and design on standard software like STAADpro etc. and /or in house generated Excel or other programs by qualified and experience personnel. All calculations shall be prepared in a neat, sequential, comprehensive form and properly checked to ensure their correctness and completeness.
 - Design and Drawings of foundation for towers for different soil types including Dry, Wet, Partially Submerged, Fully Submerged, etc including Foundation loading data,
 - Preparation of construction drawings with sufficient detailing so that no difficulty is faced by site engineers during execution.
- (ii) Getting all the works mentioned above approved by BHEL/Customer.

1.2 SPECIFIC TECHNICAL REQUIREMENTS

The specific technical requirement shall be as per project specific input provided by BHEL from time to time after award of work.

The consultant shall interact closely with BHEL engineering group for any input/clarification and finalise details across the table. There may be certain cases when on account of revision or change of input certain design/drawing may be required to be redone. No claim on account of this shall be entertained. Only suitable time extension shall be granted on account of above.

1.3 DOCUMENTATION

All design documents including computer output shall be neatly typed, produced on A4 size paper and shall have a Cover Sheet (to be provided later)

All drawings shall be prepared in Autocad as per standard sizes i.e. A0, A1, A2 etc. and shall have a Title Block (to be provided later)

The number of copies of design documents & drawings required to be submitted shall be as follows:

At each stage of approval:

- | | | |
|-----|------------------|----------|
| i) | Design Documents | : 4 sets |
| ii) | Drawings | : 4 sets |

After final approval from customer, the following sets of fabrication drawings/shop drawings/bill of materials/CDs shall be submitted:

- | | | |
|------|------------------------------|----------|
| i) | Design Documents | : 4 sets |
| ii) | Drawings / Bill of Materials | : 4 set |
| ii) | Bill Of Materials | : 1 set |
| iii) | CDs | : 1 set |

1.3 TIME SCHEDULE

The work covered under scope of this work must be completed within two months including approval of the same from BHEL/Customer and submission of requisite documents after approval.

1.4 QUANTITIES

The quantities indicated are tentative & it may change to any extent during detailed engineering at contract stage.

| Sl. No | Item Description | UNIT | QTY |
|------------|--|----------------------------------|-----|
| 1 | Design/Drawing of Transmission Line Towers (Lattice), including Extensions | | |
| (A) | Preparation & submission of design documents, structural drawings for upto 33 kV Normal Towers including stub, template, aux. x-arm and tower extension drawings, bill of materials of all members complete as per project specific specification & directions of BHEL Engineer including their approval from BHEL/Customer. 33kV D/C Towers – DA and DC Type 33kV S/C Towers – SA and SC Type 11kV D/C Towers – DA, DB and DD Type | Per type | 7 |
| 2 | Design/Drawing of Transmission Line Tower Foundations | | |
| (A) | Preparation & submission of design documents & drawing for upto 33 kV Normal Tower based on approved loads on foundations & soil data all complete as per project specific specification & directions of BHEL Engineer including their approval from BHEL/Customer. | Per type (for each soil type) | 28 |
| 3 | Visit to Test Lab | | |
| (A) | LS Allowance per day including boarding, lodging, local conveyance, etc., all inclusive. (BHEL shall pay to & fro 1st AC fare from Bidder's headquarters to Test Lab for each visit separately). | Per day | 15 |

Bharat Heavy Electricals Ltd.

Doc. No. TB-XXX-607-100-TL (33/11)

Technical Specification

DESIGN AND DRAWING OF 33KV & 11KV TRANSMISSION LINE TOWERS AND FOUNDATIONS

ENCLOSURE TO TECHNICAL SPECIFICATION

01.DESIGN BASIS REPORT – 33kV D/C and S/C Line

02.DESIGN BASIS REPORT – 11kV D/C

33 kV TRANSMISSION LINE AT NABINAGAR

BHEL

| Transmission Line Data | | | | |
|------------------------|---|--|---|---|
| Sr. No. | Description | Data | | |
| 1 | Line kV | 33 | | |
| 2 | No. of circuits on tower | 1 / 2 | | |
| 3 | Tower configuration | Self-supporting Lattice Type Steel Towers with Vertical Configuration | | |
| 4 | Conductor per phase | Single AAAC 100sq.mm | | |
| 5 | Earth Wire | Single Galvanised Stranded Steel Wire 7/3.66 | | |
| 6 | Tower coating | Hot-dipped galvanizing (Thickness:- 610 gms/sq.m) | | |
| | | Tower Type | Deviation Limit (in Deg) | Typical Usage |
| 7 | Tower Types | A | 0 - 2 | To be used as tangent tower |
| | | C | 0 - 60 | a) Angle tower with tension insulator string. b) Dead end with 0 deg to 15 deg deviation both on line and substation side (slack span) c) Also to be designed for anti-cascading condition. |
| | | | 0 | a) To be used as section tower b) Complete dead end c) For crossing/ anchoring with longer wind span with 0 deg deviation on crossing span side and 0 deg to 30 deg deviation on other sides. |
| | Note: The above towers can be used for longer span with smaller angle of deviations | | | |
| 8 | Extensions | +0m, +3m body extensions | | |
| 9 | Design Spans | 1) Normal Span | For all tower types | 150 m |
| | | 2) Slack span (i.e. span between end tower near substation and gantry structure) | Tower Type 'C' | 200 m |
| | | 3) Wind Span | For all tower types | 200 m (NC); 120 m (BWC) |
| | | 4a) Weight Span (max) | For tower type 'A' under Normal Condition (NC) | 225 m |
| | | | For tower types 'B' and 'C' under Normal Condition (NC) | 225 m |
| | | 4b) Weight Span (min) | For tower type 'A' under Normal Condition (NC) | 120 m |
| | | | For tower types 'B' and 'C' under Normal Condition (NC) | 160 m |
| | | 5a) Weight Span (max) | For tower type 'A' under Broken Wire Condition (BWC) | 135 m |
| | | | For tower types 'B' and 'C' under Broken Wire Condition (BWC) | 135 m |
| | | 5b) Weight Span (min) | For tower type 'A' under Broken Wire Condition (BWC) | 72 m |
| | | | For tower types 'B' and 'C' under Broken Wire Condition (BWC) | (-) 160 m |

| Transmission Line Data | | | | | | | | | | | | | | | | | | | | | | | |
|--|--|---|-------------------------|---------------------------------|--|---|--|--|---|--|---|---|----|-----|-----------------------|---|-----|-----------------------|---|-----|----------------------|---|-----|
| 10 | Conductor and earth Wire Tensions | 1) Between the towers = As per sag tension calculations. 2) For Slack span = 400 kg conductor and 300kg for earthwire | | | | | | | | | | | | | | | | | | | | | |
| 11 | Insulators | Disk Type | | | | | | | | | | | | | | | | | | | | | |
| 12 | Electrical Clearances | 1) The minimum ground clearance from lowest point of power conductor = not to be less than 5350 mm (5200 mm ground clearance + 150 mm sag error) at maximum sag condition i.e. at conductor temperature of 75 ⁰ C with no wind. 2) Minimum mid-span vertical clearance between power conductor and ground wire in still air, at any temperature for normal design span shall not to be less than 1500 mm. 3) The earth wire sag to be at least 10% less than the corresponding sag of power conductor under all temperature loading conditions. 4) Shielding angle = 30 ⁰ maximum For estimating the minimum angle of protection the drop of earth wire suspension clamp alongwith shackle shall be taken as 150mm. 5) All other electrical clearances shall be as per the relevant statutory regulations and as per tech spec. 6) Minimum clearances from live parts to tower body: <table><tr><th>Type of Insulator Sting</th><th>Swing from Vertical (in Degree)</th><th>Minimum Clearance (in mm)</th></tr><tr><td>Jumper</td><td>10, 20, 30</td><td>330</td></tr><tr><td>Single Suspension String</td><td>0, 15, 30, 45, 60</td><td>330</td></tr><tr><td>Double Suspension String</td><td>30</td><td>330</td></tr><tr><td>Single Tension String</td><td>0</td><td>330</td></tr><tr><td>Double Tension String</td><td>0</td><td>330</td></tr><tr><td>Pin Insulator String</td><td>0</td><td>330</td></tr></table> | Type of Insulator Sting | Swing from Vertical (in Degree) | Minimum Clearance (in mm) | Jumper | 10, 20, 30 | 330 | Single Suspension String | 0, 15, 30, 45, 60 | 330 | Double Suspension String | 30 | 330 | Single Tension String | 0 | 330 | Double Tension String | 0 | 330 | Pin Insulator String | 0 | 330 |
| Type of Insulator Sting | Swing from Vertical (in Degree) | Minimum Clearance (in mm) | | | | | | | | | | | | | | | | | | | | | |
| Jumper | 10, 20, 30 | 330 | | | | | | | | | | | | | | | | | | | | | |
| Single Suspension String | 0, 15, 30, 45, 60 | 330 | | | | | | | | | | | | | | | | | | | | | |
| Double Suspension String | 30 | 330 | | | | | | | | | | | | | | | | | | | | | |
| Single Tension String | 0 | 330 | | | | | | | | | | | | | | | | | | | | | |
| Double Tension String | 0 | 330 | | | | | | | | | | | | | | | | | | | | | |
| Pin Insulator String | 0 | 330 | | | | | | | | | | | | | | | | | | | | | |
| 13 | Temperatures of Conductors and Earth Wire | <table><tr><th>Parameter</th><th>Value</th></tr><tr><td>Minimum Ambient Temperature</td><td>0⁰C</td></tr><tr><td>Average Ambient Temperature or Every Day Temperature</td><td>32⁰C</td></tr><tr><td>Maximum Temperature for Conductor</td><td>75⁰C</td></tr><tr><td>Maximum Temperature for earth Wire</td><td>53⁰C</td></tr></table> | Parameter | Value | Minimum Ambient Temperature | 0 ⁰ C | Average Ambient Temperature or Every Day Temperature | 32 ⁰ C | Maximum Temperature for Conductor | 75 ⁰ C | Maximum Temperature for earth Wire | 53 ⁰ C | | | | | | | | | | | |
| Parameter | Value | | | | | | | | | | | | | | | | | | | | | | |
| Minimum Ambient Temperature | 0 ⁰ C | | | | | | | | | | | | | | | | | | | | | | |
| Average Ambient Temperature or Every Day Temperature | 32 ⁰ C | | | | | | | | | | | | | | | | | | | | | | |
| Maximum Temperature for Conductor | 75 ⁰ C | | | | | | | | | | | | | | | | | | | | | | |
| Maximum Temperature for earth Wire | 53 ⁰ C | | | | | | | | | | | | | | | | | | | | | | |
| 14 | Wind Loads | Design wind pressure on tower, conductor, earth wires and insulators - considering wind zone 4 with wind speed (Vb) of 47m/sec, reliability level 1 with return of 50 years, risk coefficient "K1" with 1.07 value and terrain category 2 in accordance with IS: 802 (Part 1/Sec 1) and IS: 875 (Part 3) Note: Notwithstanding the values of the above mentioned parameters, the design wind pressure so computed at any point shall not be taken less than 1500 N/sqm for all class of structures, ie A, B & C, as defined in IS: 875 (Part 3) | | | | | | | | | | | | | | | | | | | | | |
| 15 | Broken Wire Condition (Security Condition) | All tower under this condition shall be designed for maximum wind condition. | | | | | | | | | | | | | | | | | | | | | |
| 16 | Soil and Corresponding Foundation Types* | <table><tr><th>Types of foundations</th><th>Locations</th></tr><tr><td>Foundation for Normal Dry Soil Condition</td><td>To be used for locations where normal dry cohesive or non-cohesive soils are met.</td></tr><tr><td>Foundation for Wet Soil Condition</td><td>i) Where sub-soil water is met at 1.5 meters or more below the ground level. ii) Which are in surface water for long periods with water penetration not exceeding one meter below the ground level e.g. the paddy fields.</td></tr><tr><td>Foundation for Partially Submerged Soil Condition</td><td>To be used at locations where sub-soil water table is met between 0.75 meter below the ground level.</td></tr><tr><td>Foundation for Fully Submerged Soil Condition</td><td>To be used at locations where sub-soil water table is met at less than 0.75 meter below the ground level.</td></tr></table> | Types of foundations | Locations | Foundation for Normal Dry Soil Condition | To be used for locations where normal dry cohesive or non-cohesive soils are met. | Foundation for Wet Soil Condition | i) Where sub-soil water is met at 1.5 meters or more below the ground level. ii) Which are in surface water for long periods with water penetration not exceeding one meter below the ground level e.g. the paddy fields. | Foundation for Partially Submerged Soil Condition | To be used at locations where sub-soil water table is met between 0.75 meter below the ground level. | Foundation for Fully Submerged Soil Condition | To be used at locations where sub-soil water table is met at less than 0.75 meter below the ground level. | | | | | | | | | | | |
| Types of foundations | Locations | | | | | | | | | | | | | | | | | | | | | | |
| Foundation for Normal Dry Soil Condition | To be used for locations where normal dry cohesive or non-cohesive soils are met. | | | | | | | | | | | | | | | | | | | | | | |
| Foundation for Wet Soil Condition | i) Where sub-soil water is met at 1.5 meters or more below the ground level. ii) Which are in surface water for long periods with water penetration not exceeding one meter below the ground level e.g. the paddy fields. | | | | | | | | | | | | | | | | | | | | | | |
| Foundation for Partially Submerged Soil Condition | To be used at locations where sub-soil water table is met between 0.75 meter below the ground level. | | | | | | | | | | | | | | | | | | | | | | |
| Foundation for Fully Submerged Soil Condition | To be used at locations where sub-soil water table is met at less than 0.75 meter below the ground level. | | | | | | | | | | | | | | | | | | | | | | |

| Transmission Line Data | | | | | |
|---|-----------------------|---|--|--|--|
| | | Foundation for Black Cotton Soil (Wet) Condition | To be used at locations where soil is clayey type, not necessarily black in colour which shrinks when dry and swells when wet, resulting in differential movement extending to a maximum depth of about 3.5 meters below ground level. For designing foundations, for such locations, the soil is to be considered sub-merged in nature. | | |
| | | Foundation for Fissured Rock Condition | i) To be used at locations where decomposed or fissured rock, hard gravel kankar, limestone, laterite or any other soil of similar nature is met. Under cut type foundation is to be used for fissured rock locations. ii) To be used at fissured rock locations, where water table is met below ground level. | | |
| | | Foundation for Hard Rock Condition | The locations where chiseling, drilling and blasting is required for excavation hard rock type foundations are to be used. For these locations rock anchoring is to be provided to resist uplift forces. | | |
| | | Other type of foundations | i) Intermediate conditions under the above classifications to effect more economy. ii) For locations where special foundations (well type or piles) are necessitated. | | |
| 17 | Soil properties* | Weight of soil | Nature of soil | Weight (kg/cum) | |
| | | | Dry | 1440 kg/cum | |
| | | | In presence of surface water | 940 kg/cum | |
| | | | In presence of soil water | 940 kg/cum | |
| | | Soft rock | Ultimate bearing capacity | 62500 kg/sqm | |
| | | | Unit weight of earth | 1440 kg/cum | |
| | | | Angle of repose | 20 deg | |
| | | Hard rock | Limit bearing capacity | 125000 kg/sqm | |
| | | | Ultimate bond between concrete and steel for M15 grade concrete | 10 kg/sqm | |
| | | Properties of soil | | | |
| | | Type of soil | Limit bearing capacity (kg/sqm) | Angle of repose (deg) | |
| | | Normal dry soil | 24000 | 20 | |
| | | Wet earth in the presence of sub soil water | 12000 | 10 | |
| | | Wet earth in the presence of sub surface water | 12000 | 10 | |
| | | Wet black cotton soil | 12000 | 0 | |
| * The soil parameters and types of foundations shall be finalized as per geotechnical investigations; governing parameters shall be followed. | | | | | |
| 18 | Properties of RCC | The cement concrete used for the foundations shall be of grade M20 with 20mm coarse aggregate. | | | |
| | | Reinforcement shall be Fe 500 HYSD TMT bars conforming to IS 1786 and Technical Specification. | | | |
| | | Unit weight of concrete | | | |
| | | Type of concrete | Weight of dry region kN/cum (kg/cum) | Weight in presence of sub-soil water kN/cum (kg/cum) | |
| | | Concrete | 21.96 (2240) | 12.16 (1240) | |
| | | Reinforced | 23.54 (2400) | 13.73 (1400) | |
| 19 | Design of foundations | Structural design of the foundations shall be done by limit State method. | | | |
| | | Partial safety factor shall be considered: 1.5 for concrete and 1.15 for steel. | | | |
| | | The overload factor for foundations shall be considered as 1.1 i.e. the reaction except due to dead loads on foundations shall be increased by 10 per cent. | | | |

| Sr. No. | Description | Data | | |
|--|--|--|--|---|
| 1 | Line kV | 11 | | |
| 2 | No. of circuits on tower | 2 | | |
| 3 | Tower configuration | Self-supporting Lattice Type Steel Towers with Vertical Configuration | | |
| 4 | Conductor per phase | Single ACSR 'Zebra' | | |
| 5 | Earth Wire | Single Galvanised Stranded Steel Wire 7/3.66 | | |
| 6 | Tower coating | Hot-dipped galvanizing (Thickness:- 610 gms/sq.m) | | |
| | | Tower Type | Deviation Limit (in Deg) | Typical Usage |
| 7 | Tower Types | A | 0 - 2 | To be used as tangent tower with suspension insulators |
| | | B | 2 - 15 | To be used as angle tower with tension insulators |
| | | C | 15 - 30 | To be used as angle tower with tension insulators |
| | | D/DE | 30 - 60 | To be used as angle tower with tension insulators |
| | | | 0 - 30 | To be used as dead end tower with 0 deg to 30 deg deviation on both line and substation side (slack span) with tension insulators |
| Note: The above towers can be used for longer span with smaller angle of deviations based on design chart. | | | | |
| 8 | Extensions | +0m, +3m body extensions | | |
| 9 | Design Spans | 1) Normal Span | For all tower types | 120 m |
| | | 2) Slack span (i.e. span between end tower near substation and gantry structure) | for D/DE | 100 m |
| | | 3) Wind Span | For all tower types | 132 m (NC); 80 m (BWC) |
| | | 4a) Weight Span (max) | For all tower types | 180 m (NC); 110 m (BWC) |
| | | 4b) Weight Span (min) | For Tower Type 'A' under Normal Condition (NC) | 78 m |
| | | | for Tower Types 'B', 'C', 'D/DE' | (-) 78 m |
| 10 | Conductor and earth Wire Tensions | 1) Between the towers = As per sag tension calculations. | | |
| | | 2) For Slack span = 500 kg conductor and 400kg for earthwire | | |
| 11 | Insulators | Disk Type Porcelain | | |
| | Insulator String type | Pilot | Single Suspension | Single & Double Tension |
| | Size of disc insulator (mm) | 280 x 145 | 280 x 145 | 280 x 145 |
| | Min. creepage distance of each disc (mm) | 430 | 430 | 430 |
| | No of standard discs | 1 x 1 | 1 x 1 | 1 x 1 (Single Tension) and 2 x 1 (Double Tension) |
| | Electro-mechanical strength of insulator string (kN) | 120 | 120 | 1 x 120 (Single Tension) and 2 x 120 (Double Tension) |

| | | | | |
|----|---|--|------------------------------------|---|
| 12 | Electrical Clearances | 1) The minimum ground clearance from lowest point of power conductor = not to be less than 4750 mm (4600 mm ground clearance + 150 mm sag error) at maximum sag condition i.e. at conductor temperature of 75°C with no wind. | | |
| | | 2) Minimum mid-span vertical clearance between the conductors & conductor and ground wire in still air, at any temperature for normal design span shall not to be less than 1500 mm. | | |
| | | 3) The earth wire sag to be at least 10% less than the corresponding sag of power conductor under all temperature loading conditions. | | |
| | | 4) Shielding angle = 30° maximum For estimating the minimum angle of protection the drop of earth wire suspension clamp along with shackle shall be taken as 150mm. | | |
| | | 5) All other electrical clearances shall be as per the relevant statutory regulations and as per tech spec. | | |
| | | 6) Minimum clearances from from live conductor to earthed metal parts: | | |
| | | Type of Insulator Sting | Swing from Vertical (in Degree) | Minimum Clearance (in mm) |
| | | Jumper | 0, 10, 20, 30 | 330 |
| | | Single Suspension String | 0, 15, 30, 45, 60 | 330 |
| | | Double Suspension String | 30 | 330 |
| | | Single Tension String | 0 | 330 |
| | | Double Tension String | 0 | 330 |
| 13 | Temperatures of Conductors and Earth Wire | Parameter | | Value |
| | | Minimum Ambient Temperature | | (-) 2.8°C |
| | | Average Ambient Temperature or Every Day Temperature | | 32°C |
| | | Maximum Temperature for Conductor | | 75°C |
| | | Maximum Temperature for earth Wire | | 53°C |
| 14 | Wind Loads | Design wind pressure on tower, conductor, earth wires and insulators: considering wind zone 4 with wind speed (Vb) of 47m/sec, reliability level 1 with return of 50 years, risk coefficient "K1" with 1.0 value and terrain category 2 in accordance with IS: 802 (Part 1/Sec 1). | | |
| 15 | Loading Conditions | As per IS 802 (Part I Sec 1) | | |
| 16 | Properties of RCC | The cement concrete used for the foundations shall be of grade M25 with 20mm coarse aggregate. | | |
| | | Reinforcement shall be Fe 500 D HYSD TMT bars conforming to IS 1786. | | |
| | | Unit weight of concrete | | |
| | | Type of concrete | Weight in dry region (kg/cum) | Weight in presence of sub-soil water (kg/cum) |
| | | Plain Cement Concrete | 2400 | 1400 |
| | | Reinforced Cement Concrete | 2500 | 1500 |
| 17 | Design of foundations | Structural design of the foundations shall be done by limit State method. | | |
| | | Partial safety factor shall be considered 1.5 for concrete and 1.15 for steel. | | |
| | | The overload factor for foundations shall be considered as 1.1. | | |

| Annexure: Wire Properties | | |
|---|------------|------------|
| Description | Conductor | Earth Wire |
| Material /Name | ACSR Zebra | GSW |
| Stranding (Aluminium) | 54/3.18 | - |
| Stranding (Steel) | 7/3.18 | 7/3 66 |
| Diameter (mm) | 28.62 | 10.98 |
| Cross Sectional Area (mm ²) | 484.5 | 73.61 |
| Ultimate Tensile Strength (Kg) | 13284.4 | 7700 |
| Unit Weight (Kg/m) | 0.162 | 0.574 |
| Modulus of Elasticity (Kg/mm ²) | 7034 | 19000 |
| Coefficient of Linear Expansion(°C) | 1.93E-05 | 1.15E-05 |

SCHEDULE OF TECHNICAL DEVIATION.

BHEL ENQUIRY. NO:

BIDDER:OFFER REFERENCE:

6.1 Deviations

Tick

☐ YES

☐ NO

If yes,

| S.No. | Deviation | Clause No. |
|-------|-----------|------------|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |

(Signature & Seal of Bidder)