ASSAM ELECTRICITY GRID CORPORATION LIMITED
Regd. Off.: BIJULEE BHAWAN (FIRST FLOOR) PALTANBAZAR; GUWAHATI - 781001
CIN: U40101AS2003SGC007238 GSTIN: 18AAFCA4973J9Z3
PHONE: 0361-2739520 Web: www.aegcl.co.in

आज़ादी का अमृत महोत्सव

Corrigendum-I

BID IDENTIFICATION NO: AEGCL/MD/Tech-313/O&M(LAR)/AAHI(A)/Bid

With reference to the above bid document for the work namely "Shifting of towers of 132KV D/C Kahilipara-Rangia Transmission line under AEGCL, for proposed AAHI Project implemented by AGIHF" against Bid Identification No. mentioned above, foundation drawings of monopole and guidelines for standard technical specification for steel monopole structure issued by CEA have been uploaded. Also, it may be noted that the bidder must submit an undertaking that the OEM of monopole shall supervise the foundation and erection work of monopole.

All other terms and conditions of the bidding document remain same.

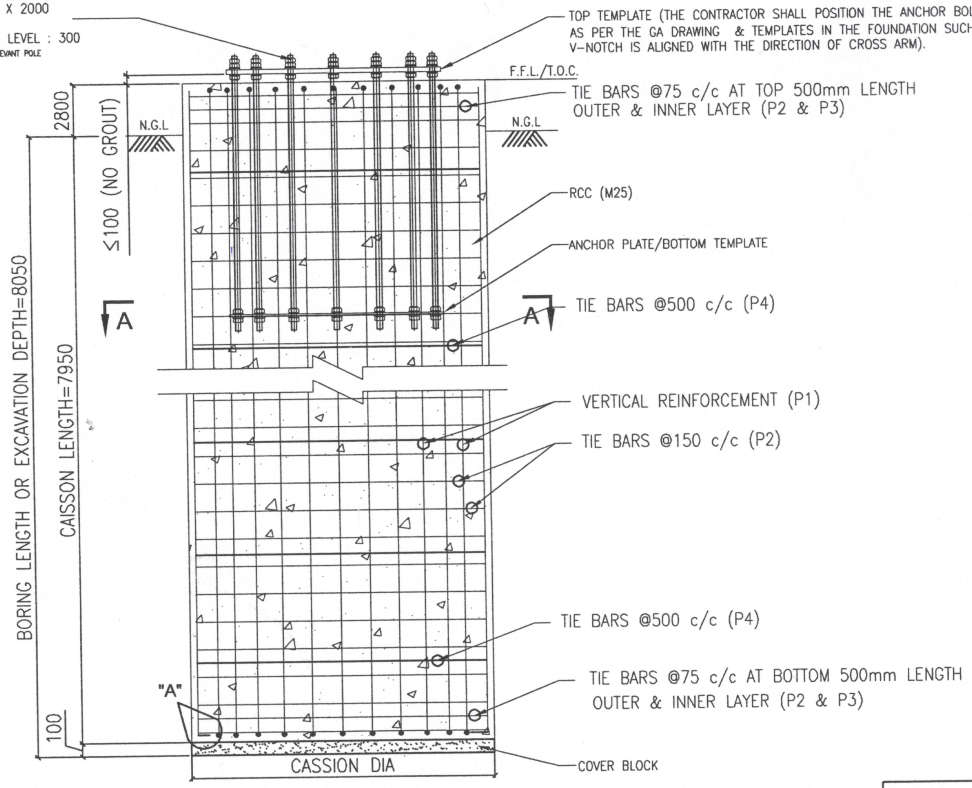
–Sd
Chief General Manager (O&M), LAR
Assam Electricity Grid Corporation Ltd
Bijulee Bhawan, Guwahati – 1

Memo No. – AEGCL/MD/Tech-313/O&M(LAR)/AAHI/33(a-b) Dtd:03.04.2024
Copy to:

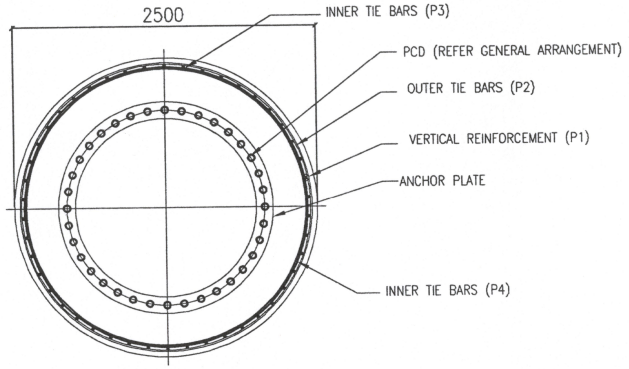
1. The DGM-IT, O/o the MD, AEGCL, for publication of the corrigendum notice in AEGCL website. (Soft copy enclosed)
2. Ref. file.

–Sd
Chief General Manager (O&M), LAR
Assam Electricity Grid Corporation Ltd
Bijulee Bhawan, Guwahati – 1

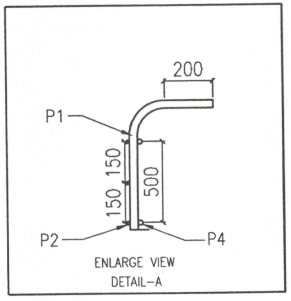
PITCH CIRCLE DIAMETER : 1846
BOLT SIZE X LENGTH : M56 X 2000
NOS. OF BOLT : 32
BOLT Lg OUTSIDE CONCRETE LEVEL : 300
ABOVE VALUES TO BE RECONFIRMED WITH RELEVANT POLE GA DRAWING (LATEST VERSION)



SECTIONAL ELEVATION



SECTION A-A



ENLARGE VIEW
DETAIL–A

SL. No.	Qty	Pole Designation	Pedestal Above GL (m)	Caisson Size		Unit Quantity		
				Dia x Length m (Below GL)		PCC (m^3)	RCC (m^3) M25	Steel (MT) Fe 500D
1	1	132KV-DC-PD(30-60D)/DE_BXA@22.9	2.8	3.0	7.50	0.71	72.81	4.22

NOTES:

1. ALL DIMENSIONS ARE IN 'MM' UNLESS OTHERWISE SPECIFIED.
2. MATERIAL AND CONSTRUCTION TO BE IN ACCORDANCE WITH IS: 456, SUPERPLASTICIZER MAY BE USED TO INCREASE THE FLOWABILITY OF THE CONCRETE.
3. THE CONCRETE GRADE FOR FOUNDATION SHALL BE OF MIX M25 AND REINFORCEMENT SHALL BE TMT BARS OF Fe 500 CONFIRMING TO IS 1786: 2008
4. CLEAR COVER TO MAIN REINFORCEMENT AT END OF MAIN BARS OF CAISSON : 75MM
5. DEVELOPMENT LENGTH FOR TENSION LDT = 50 TIMES THE DIAMETER OF BAR.
6. FOR ANY OTHER DETAILS CLAUSES OF IS-456, IEC-2006, SP-34, SP-16 AND SP-23 SHALL BE REFERRED.
7. SOIL PARAMETERS ARE CONSIDERED FROM GEOTECHNICAL REPORT REFFERED FROM LAST AEGCL PROJECT
8. 75MM SPACER TO BE PROVIDED TO MAINTAIN ENOUGH COVER TO THE REINFORCEMENT W.R.T SURROUNDING SOIL
9. LAP/ANCHORAGE LENGTH SHALL BE AS PER IS 456. NOT MORE THAN 50% BARS SHALL BE LAPPED AT ONE SECTION UNLESS SPECIFIED/SHOWN.
10. ALL HOOKS, BENDS, LAPS & SPLICES SHALL BE AS PER IS 456 & IS 2502, EXCEPT STATED OTHERWISE
11. LAP IN MAIN BARS IS NOT ALLOWED WITHIN & UP TO DEPTH OF 1.5 TO 2.0M BELOW BOTTOM MOST PART OF FOUNDATION BOLT ASSEMBLY
12. INCASE LAP IN MAIN BARS IS REQUIRED THEN ADDITIONAL 2 NOS OF RING-P4 TO BE PROVIDED IN LAP ZONE.
13. CAGE ASSEMBLY AND VERTICAL REINFORCING BARS ARE TO BE SECURELY TIDE BEFORE CONCRETING IN ORDER TO REMAIN PARALLEL TO THE CENTER LINE OF PIER.
14. BACKFILLING SHALL BE DONE WITH MURRUM AND COMPACT IN LAYER WITH WATERING.
15. PRIOR TO EXCAVATION, CHECK IF ANY UNDERGROUND UTILITIES
16. TROWEL TOP OF PEDESTAL SMOOTH.
17. STEEL REINFORCEMENT AND CONCRETE SHOULD BE PLACED IMMEDIATELY UPON COMPLETION OF THE CAISSON EXCAVATION & PCC (1:4:8). CONTRACTOR SHALL NOT ALLOW A COLD JOINT TO FORM IN THE CAISSON. PORTION ABOVE GRADE SHOULD BE FORMED, TEMPORARY CASING MAY REQUIRED TO PREVENT CAVING PRIOR TO CONCRETE PLACEMENT.
18. CONCRETE SHALL BE PLACED USING A TREMIE TO THE DEPTH INDICATED ON THE FOUNDATION DRAWING.
19. AS PER M/s. CEA GUIDELINES THE O.L.F ON FOUNDATION REACTIONS HAS BEEN CONSIDERED 1.1.
20. 100MM THICK PRECAST PCC COVER BLOCK (MIN GRADE M20) NEED TO BE INSERTED INTO HOLE DURING REINFORCEMENT CAGE PUTTING INTO HOLE.
21. CEMENT WITH BENTONITE MIXTURE (MIN SP. GRAVITY 1.2 GM/CC) SHOULD APPLY INSIDE WALL OF CYLINDER TO AVOID UNCERTAIN COLLAPSE DURING BORING.
22. INCASE ANY LAP NEEDED BASED ON SITE CONDITION/MATERIAL IS NOT INCLUDED IN BAR BENDING SCHEDULE.

*A.G.L. – ABOVE GROUND LEVEL
*B.G.L. – BELOW GROUND LEVEL
*F.F.L./T.O.C. – FLOOR FINISH LEVEL/TOP OF CONCRETE
*N.G.L. – NATURAL GROUND LEVEL

REV NO.	DATE	CHECKED	DESCRIPTION
00		RM	

सत्यमेवजयते

STANDARD TECHNICAL SPECIFICATION FOR STEEL MONOPOLE STRUCTURE FOR AC TRANSMISSION LINE

GOVERNMENT OF INDIA

MINISTRY OF POWER

CENTRAL ELECTRICITY AUTHORITY

JULY 2022

सत्यमेव जयते

Standard Technical Specification for Steel Monopole Structure for AC Transmission Line

By

Power System Engineering & Technology Development Division

Central Electricity Authority

भारत सरकार

Government of India

विद्युत मंत्रालय

Ministry of Power

केंद्रीय विद्युत प्राधिकरण

Central Electricity Authority

बी.के. आर्य
अध्यक्ष
B.K. ARYA
Chairperson

सत्यमेव जयते

आज़ादी का अमृत महोत्सव

फैक्स/Fax : 011-26197267

भारत सरकार
GOVERNMENT OF INDIA
केन्द्रीय विद्युत प्राधिकरण
CENTRAL ELECTRICITY AUTHORITY
विद्युत मंत्रालय
MINISTRY OF POWER
सेवा भवन, रामकृष्ण पुरम्
SEWA BHAWAN, RAMAKRISHNA PURAM

नई दिल्ली–110066, दिनांक :
NEW DELHI-110066, Dated :

FOREWORD

The Steel Pole support structures of the transmission lines are steadily gaining acceptance in the Indian Transmission industry due to its reduced ROW, design flexibility and lower maintenance requirement. It was need of the hour that a technical specification is prepared for steel pole structures which can be adopted by the utilities.

It gives me immense pleasure to see that the Committee constituted in CEA has prepared the "*STANDARD TECHNICAL SPECIFICATION FOR STEEL MONOPOLE STRUCTURE FOR AC TRANSMISSION LINES*". I thank Members of the Committee, the Officers of CEA and the representatives of other organizations for their invaluable inputs and sincere efforts in bringing out the document. As the document has been prepared with wide consultation with the stakeholders and taking feedback from both the manufacturers & end users, it will certainly help to smoothen up the process of adoption of the available technology of Pole Structures in the Indian Transmission system.

I am certain that the adoption of this standard specification in true spirit will aid in establishing uniform practices throughout the country, will place all manufacturers at a level playing field, and benefit the utilities / Transmission Service Providers to get products of similar quality & reliability.

(B.K. Arya)

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तथा पदेन अपर सचिव भारत सरकार
केन्द्रीय विद्युत प्राधिकरण
सेवा भवन, रामाकृष्णा पुरम्

सत्यमेव जयते

गौतम रॉय
Goutam Roy

MEMBER POWER SYSTEM
& EX-OFFICIO ADDL. SECRETARY TO THE GOVERNMENT OF INDIA
CENTRAL ELECTRICITY AUTHORITY
SEWA BHAWAN, R.K. PURAM

नई दिल्ली - 110066
NEW DELHI – 110066

22nd June 2022

MESSAGE

To solve the issues of growing Right of Way (RoW) problems faced in execution of transmission line projects and congestion in existing corridor of transmission / distribution network and also for the growing demand for aesthetics in the urban metropolis, the use of monopole Steel Pole Structures has become one of the preferred solution being adopted by transmission utilities. In recent years, as a result of rapid urbanization and litigations, it is becoming difficult to erect a transmission line on lattice towers due to its larger foot print. Use of monopole structures are increasing in specific areas due to various advantages including reduced foot prints, compact design, fast erection & commissioning better aesthetics.

It is a matter of great pleasure to bring to you the "*Standard Technical Specification for Steel Monopole Structure for AC Transmission Lines*". This standard specification covers various aspects of Steel pole structures, including type of material, constructional features, Structural & Foundation Design and testing, fabrication, erection etc. among other things. For ease of stakeholders a manufacturing quality plan & field quality plan had also been made part of the specification. I am very much sure that this specification will be helpful for the transmission utilities to gain the technical insight to the technology available and will certainly give them confidence to judiciously use Steel Monopole Structures for the betterment of Indian transmission system.

(Goutam Roy)

सत्यमेव जयते

फैक्स/Fax : 011-26197267
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SEWA BHAWAN, RAMAKRISHNA PURAM
नई दिल्ली-110066, दिनांक :
New Delhi-110066, Dated:

FOREWORD

The transmission of power on overhead line will continue to dominate over other mode of power transmission due to techno-economic reasons. The self-supported lattice type towers/ compact narrow based towers are primarily used for transmission of power on overhead transmission lines. The steel tubular pole structures as an alternative to lattice structure have also gained acceptance by the utilities in India and use of such structure is increasing in some areas. Due to its lesser foot print & Right of Way (RoW), better aesthetic and more reliable under extreme weather condition (smaller bending moment at the base under heavy load condition), the acceptance/demand of Pole structures as supporting structure for overhead lines is further expected to increase in the near future.

At present, the Pole type towers are designed based on the demand of the utilities on case to case basis and any national standard covering erection and design of steel Pole type transmission structures is not available with the transmission utilities. A need was felt to prepare a standard specification of Pole type structures to help the utilities/ developers across the country to easily adapt to the available technological solution of Pole structures.

In view of above, a technical committee was constituted by CEA comprising of representatives from Power utilities, Pole structure manufacturers, representatives from EPTA, CPRI, SERC and various experts of the field for preparation of Standard Specification of Steel Monopole type Structures. The committee met at various occasions and based on the inputs received from participants and discussion held in these meetings, the draft specification on Steel Monopole structures was prepared and was placed in public domain for comments/inputs from the stakeholders. The comments/observations received on the document were further discussed in the meeting of the committee and on basis of discussions the document has been finalized.

My sincere gratitude & thanks to the members of the Committee and all the contributors, including officers from CEA. I would like to express my sincere gratitude to Mr. B. K. Arya, Chairperson, CEA for his support and guidance in accomplishment of the task. I sincerely thank Mr. Goutam Roy, Member (Power System), CEA for his unaltered supervision and counsel for preparation of the specifications. I thank Mr. Prakash Mhaske & Mr. Dinesh Chandra, Ex-Chairpersons, CEA under whose guidance this exercise was initiated and progressed steadily. My special thanks to my colleagues, Mr. S. K. Ray Mohapatra, Ex Chief Engineer (PSE&TD); Mr. Ravinder Gupta, Chief Engineer (PSPA-II), Mr. Y. K. Swarnkar, Director (PSE&TD); Mr. Baleshwar Thakur, Director (TCD); Mr. Mohit Mudgal, Deputy Director (PSE&TD); Mr. Deepak Raghuvanshi, Deputy Director (TCD) and other officers from CEA who had contributed immensely in the preparation of the document. A special gratitude & thanks to all the participating members of the Committee, representatives from State Utilities, CPRI, SERC, POWERGRID, private transmission utilities, Pole Manufacturers and the technical experts of the field for their active participation in the meetings and their invaluable contribution, support and co-operation all through.

The standardisation will help the utilities / Transmission Service Providers and manufacturers to get products of similar quality & reliability, the delivery will be faster and would establish uniform practices across the country. I am sure that this standard specification on Pole structures will be useful for all the stakeholders and would cause to achieve easier adoption of the available technology in the Indian transmission system.

A.K.THAKUR
Chief Engineer (PSE&TD)

CONTENTS

STANDARD TECHNICAL SPECIFICATION FOR STEEL MONOPOLE STRUCTURE FOR AC TRANSMISSION LINE

1.0 General

1.1 This specification covers design, engineering, manufacturing, supply, fabrication, galvanizing, proto assembly and testing, inspection before dispatch, supply of various types of steel pole structures for 66 kV and above AC Transmission Lines (for voltage level as specified by the Purchaser), conductor & earthwire/OPGW and their accessories & fittings, insulators and hardware fittings etc. at site, design of foundations, laying of foundations along with supply of complete foundation material, erection of steel pole structures, complete stringing & sagging, earthing of pole etc. The walkover, preliminary & detailed survey of line route, profiling, spotting/optimization of pole structure location, storage of material at site, soil resistivity measurement and geotechnical investigation shall also be in the scope of the Contractor.

1.2 All the raw materials such as steel, zinc for galvanizing, reinforcement steel, cement, superplasticizers and chemicals for pole foundation, earthing rod/wire, coke and salt for pole earthing etc. anchor bolts & their templates, bolts, nuts, washers, D-shackles, hangers, links, danger plates, phase plate, number plate, circuit plate, day and night visual aids/markers and painting (wherever required), anti-climbing devices, step bolts/ladder, platform and handrail (as per requirement), Bird Guard, Bird diverter (if specified by the Purchaser)etc. required for pole structure manufacture and erection shall be included in the Contractor's scope of supply. Bidder shall clearly indicate in the offer, the sources from where he proposes to procure the raw materials and the components.

1.3 The details regarding survey, route marking and pole spotting are covered in **Annexure – A.** For survey, erection of poles, stringing of conductors & earthwire/OPGW and patrolling of transmission line in difficult and inaccessible terrains, use of helicopter or Unmanned Aerial Vehicle (UAV) may be considered. The required clearance from Director General Civil Aviation (DGCA) or any other competent authority shall be obtained before taking up such activity**.**

Note: The terms “Pole” & “Monopole” has been used interchangeably in this document.

2.0 Applicable Standards

CEA (Technical Standards for Construction of Electrical Plants and Electric lines) Regulations and CEA (Measures relating to Safety & Electric Supply) Regulations shall be followed.

The design, manufacturing, fabrication, galvanizing, testing, erection procedure and materials used for manufacture and erection of steel pole structure, design and construction of foundations shall conform to the relevant Indian Standards (IS). Pole accessories e.g. anti-climbing device, phase plates, circuit plates, danger plate, day and /or night visual aids and markers (wherever required) etc. shall be as per IS 5613. The entire stringing work of conductor and earth wire shall be carried out by standard stringing practice as per relevant standards and this specification.

In case, Indian Standards are not available, International Standards shall be followed. Standards shall be latest revisions with amendments from time to time unless specifically stated otherwise in the Specification. In the event of supply of material conforming to Standards other than specified, the Bidder shall confirm in his bid that these Standards are equivalent or better to those specified. In case of award, salient features of comparison between the Standards proposed by the Contractor and those specified in this document will be provided by the Contractor to establish their equivalence.

A tentative list of applicable standards is given in **Annexure-G**.

3.0 Service and Climatic conditions

Following basic information (Table-1) shall be provided by the Purchaser:

Table-1

(a)	Name of transmission line	
(b)	Details of starting and destination point (e.g.name, substation, state, co-ordinates etc.)	
(c)	Nominal System Voltage	
(d)	Highest System voltage	
(e)	Conductor (Type, Diameter, Area, No. of strands etc.)	
(f)	No. of conductors per phase	
(g)	Earth Wire (Type, Diameter, Area, No. of strands etc.)	
(h)	OPGW (Type, Diameter, Area, No. of fibres etc.)	
(i)	No. of circuits and voltage level of each circuit (for Multi circuit & multi	

	voltage pole structure)	
(j)	Configuration (vertical/horizontal/delta)	
(k)	Terrain category	
(l)	Wind zone* and corresponding basic wind speed	
(m)	Maximum ambient temperature	
(n)	Minimum ambient temperature	
(o)	Maximum daily average temperature	
(p)	Maximum relative humidity (in %)	
(q)	Maximum annual rain fall (in mm)	
(r)	Number of rainy days/year	
(s)	Average number of thunder storm (days per annum)	
(t)	Altitude above MSL	
(u)	Atmospheric condition & Pollution level	
(v)	Seismic zone	
(w)	Type of insulator (porcelain disc/longrod, polymer or glass)	
(x)	Insulator configuration for suspension and tension (single/double/triple/quadruple/ V-string)	
(y)	No. of discs / long rods in each string • Suspension (I/V/Y; single/double) • Tension (single/double/quad)	

**Wind zone shall be as per wind map given in National Building Code 2016. In case of further revision in wind map, latest version of it shall be used.*

In addition to above, any other input required for design of Steel pole structure may be provided by the Purchaser during detailed engineering. The Purchaser may also clearly specify any constraint likely to be faced during commissioning of the transmission line due to site conditions, particularly related to electrical clearances.

4.0 Steel Monopole Structure

4.1 General Description

4.1.1 The steel pole structures can be Single circuit/Double circuit/Multi circuit/Multi circuit & multi-voltage/any other configuration, as specified by the Purchaser and shall be used for entire line or a section of line or for few locations of the line.

4.1.2 The pole for any particular location can be single pole type or dual pole type depending upon voltage level, no. of conductors per phase and no. of circuits etc.

4.1.3 The pole structures shall be self-supporting polygonal steel pole type, designed to support the line conductors with necessary insulators, earth-wires/OPGW and all fittings, hardware & accessories under all loading conditions.

4.1.4 The internal and external surface of pole structure shall be fully galvanized. The most efficient grade of structural steel and plates shall be used in order to yield the optimum cost of pole structure and foundation. The type and grade of steel shall conform to latest applicable national standards or as specified elsewhere in the specification.

4.1.5 For cross arms also, Polygonal Sections shall be used. However, if desired by Purchaser, insulated cross arms may also be used.

4.2 Type of Pole Structures

4.2.1 The poles are classified as given below in table-2:

Table-2

Type of Pole	Deviation Limit	Typical Use
Tangent Pole (say PA/DPA/MCPA/ MVPA)	0 - 2 deg.	To be used as tangent/suspension pole with suspension insulator
Tension / Angle Pole (say PB/DPB/MCPB/ MVPB)	0 deg. - 15 deg.	a) Tension/Angle Pole with tension insulator b) To be designed for anti-cascading condition
Tension / Angle Pole (say PC/DPC/MCPC/ MVPC)	0 deg. - 30 deg. / 15 deg. - 30 deg.	a) Tension/Angle pole with tension insulator b) To be designed for anti-cascading condition
Tension / Angle /Dead end Pole (say PD/DPD/MCPD/ MVPD)	30 deg.- 60 deg./ Dead end [For specific site requirement, Tension pole with 60 deg.- 90 deg.	a) Tension/Angle pole with tension insulator b) To be designed for anti-cascading condition

	Deviation with or without extra auxiliary arm may be used.]	c) Dead end with 0 deg to 15 deg deviation both on line and sub-station side (slack span) d) Complete dead end
Note: 1. P: Single Circuit Pole Structure, DP: Double Circuit Pole Structure, MCP: Multi Circuit (more than 2 circuits) Pole Structure, MVP: Multi Circuit & Multi Voltage Pole Structure 2. The angle of deviations given above are for design span. The span may, however, be increased up to an optimum limit with reducing angle of line deviation, if adequate ground and phase clearances are available.		

4.2.2 Extensions

The pole structure shall be designed for highest body extension required at the particular site maintaining adequate electrical clearances.

4.3 Spans

4.3.1 Normal Design Span

The Route of transmission line shall be clearly identified as normal section without constraint, section through forest area, and section through urban areas/populated area/approach section near substations and normal design span in these sections for various voltage level of transmission lines as indicated in the Table-3 below shall be adopted.

Table-3

AC Voltage (kV)	Normal design span (m)		
	Normal route without constraint	Forest area	Urban area/ Populated area /approach section near substation
765kV 400 kV	150 m-200 m (angle pole/pole structures) and 250 m (tangent pole/pole structures)		
230 kV 220 kV	300 m-350 m	250 m	200 m
110 kV 132 kV	300 m-325 m	200 m	150 m
66 kV	200 m-250 m	150 m	100 m

Note: *Above values are applicable for upto double circuit lines. For multicircuit (more than two circuits) lines & for Poles with very high extensions span may be less.*

4.3.2 Wind Span

The wind span is the sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.

4.3.3 Weight Span

(a) The weight span is the horizontal distance between the lowest points of the conductors on the two spans adjacent to the pole structure. For design of structures for plain terrain, the maximum weight span limits given in Table-4 below shall be considered.

Table-4

Voltage Level (kV)	Pole Type	Normal Condition		Broken wire condition	
		Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)
66	PA/DPA/MCPA/ MVPA	375	50	225	0
	(PB/DPB/MCPB/ MVPB) or (PC/DPC/MCPC/ MVPC) or (PD/DPD/MCPD/ MVPD)	375	0	225	-200
110 / 132	PA/DPA/MCPA/ MVPA	450	50	270	0
	(PB/DPB/MCPB/ MVPB) or (PC/DPC/MCPC/ MVPC) or (PD/DPD/MCPD/ MVPD)	450	0	270	-200
220 / 230	PA/DPA/MCPA/ MVPA	450	50	270	0
	(PB/DPB/MCPB/ MVPB) or (PC/DPC/MCPC/ MVPC) or (PD/DPD/MCPD/ MVPD)	450	0	270	-200
400 /	PA/DPA/MCPA/	375	50	225	0

765	MVPA				
	(PB/DPB/MCPB/ MVPB) or (PC/DPC/MCPC/ MVPC) or (PD/DPD/MCPD/ MVPD)	300	0	180	-200

Note: *Weight span limits for hilly terrain may be decided by Purchaser as per requirement.*

(b) In case the actual spotting spans at certain locations exceed the design spans, necessary action shall be taken so that factor of safety of pole is not less than that of designed/tested pole for increased loadings.

4.4 Electrical Clearance

4.4.1 Ground Clearance

Minimum ground clearance for conductor shall be maintained as per requirement of Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations. However, requirement of maintaining electrostatic & electromagnetic interference, radio interference voltage, audible noise etc. within acceptable limits becomes ruling condition specifically for transmission lines of 400 kV and above voltage class.

The minimum ground clearance from the bottom conductor shall not be less than the values indicated in the Table-5 below under maximum sag conditions i.e. at maximum temperature for conventional ACSR/AAAC conductor or at temperature as specified for High Temperature Low Sag (HTLS) conductor and still air. An allowance of 150mm shall also be provided to account for errors in stringing.

Table-5

Voltage Level	Minimum Ground Clearance
66kV	6100mm
110/132kV	6100mm
220/230kV	7015mm
400kV	8840mm
765kV	18000mm

Conductor creep shall be compensated by over tensioning the conductor at a temperature depending on conductor type in consultation with the Purchaser.

4.4.2 Live metal Clearance

The minimum live metal clearance to be provided between the live parts and steel work of pole structure for transmission lines of voltage level up to 400 kV shall be as per IS: 5613. For 765 kV lines values given in table-6 are to be adopted:

Table-6

Voltage level	Suspension Insulator	
	Swing Angle	Clearance
765kV	0^0	5600 mm (S/C) 6100 mm (D/C)
	25^0	4400 mm
	55^0	1300 mm

For computing the live metal clearances, the dimensions and configuration of suspension/tension insulators which shall actually be used shall be considered as per requirement. The design of the pole shall be such that it should satisfy all the above conditions when clearances are measured from any live point of the strings.

4.4.3 Phase to Phase Spacing

The phase to phase vertical and horizontal spacing shall be governed by the pole design/geometrical configuration as well as minimum live metal clearances required under different insulator swing angles. However, the values generally adopted are given in Table-7. If there is more than one circuit on the pole, adequate spacing shall be maintained between the circuits for maintenance of one of the circuits when other circuit is live.

Table-7

Voltage level of Line (kV)	Phase to phase spacing between conductors (mm)	
	Vertical	Horizontal
66	2000	3500
110	3200	5500
132	3900	6800
220	4900	8400
400	8000	11000
765	15000	15000

The staggering of conductors, if required, shall be as per IS: 5613.

4.4.4 Mid Span Clearance

The minimum vertical mid span clearance between the earth-wire/ OPGW and the nearest power conductor under all temperatures and still air condition in the normal ruling span shall not be less than the values mentioned in the Table-8 below. Further, the tensions of the earth-wire/OPGW and power conductors shall be so coordinated that the sag of earth-wires/OPGW shall be at least 10% less than that of power conductors under all temperature loading conditions for normal ruling span.

Table-8

Voltage Level	Mid Span Clearance
66 kV	3000 mm
110 kV	4500 mm
132kV	6100 mm
220 kV / 230 kV	8500 mm
400 kV	9000 mm
765 kV	9000 mm

Note: *At restricted locations, suitable technical arrangement like Line arrestors may be adopted for further reduction in Mid-span clearance subject to verification by studies and testing.*

4.5 Crossings

(a) Power line Crossing

(i) Clearance between power lines crossing each other shall be kept in accordance with the Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations. To achieve these clearances poles with suitable extensions may be used, depending upon the merit of the prevailing site condition.

(ii) The angle of crossing shall be 90^{o} as far as possible, however, it shall not be less than 75^{o}. The crossing shall be as near the support of the line as practicable, and the support of the lower line shall not be erected below the upper line.

(iii) For crossing of power line of 400kV or above voltage class, large angle poles of deviation angle of 30-60 degree & designed for dead end condition, with required body extension, shall be used on either sides of the power line.

(iv) For crossing of power line of 110 kV, 132 kV, 220 kV and 230 kV voltage class, the tension poles (with suitable deviation angle) with required body extension shall be

used on either sides of the power line and the crossing of power lines of 66kV class shall be done with any type of poles (suspension or tension) with required body extension.

(v) In general, higher voltage line shall cross from above the lower voltage line. In unavoidable circumstances, higher voltage line can cross below the lower voltage line after due consultation with the Purchaser of the existing line provided all statutory clearances are met.

(vi) In case of crossing with tension poles proper guying shall be provided to facilitate stringing of the power line crossing sections separately on obtaining line shutdowns.

(b) Telecommunication Line Crossings

(i) For crossing of overhead telecommunication lines, Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations and guidelines of Power and Telecommunication Co-ordination Committee (PTCC) shall be followed.

(ii) The angle of crossing shall be 90 degree as far as possible. However, under exceptionally difficult situations when the angle of crossing has to be below 60 degree, the matter will be referred to the competent authority in charge of the telecommunication system.

(iii) In the crossing span, power line support will be as near the telecommunication line as possible, to obtain increased vertical clearance between the wires.

(c) Railway Crossing

All the railway crossings coming en-route the transmission line shall be identified by the Contractor and provisions of the regulation of Railways Authorities shall be followed. Approval from Railway Authorities shall be obtained before proceeding with work of railway crossing.

(d) Road Crossing :

(i) All the road crossings coming en-route the transmission line shall be identified by the Contractor and provisions of the regulation of Highway Authorities shall be followed.

(ii) At all important road crossings, the pole shall generally be fitted with tension insulator string.

(iii) At all National/State Highways, tension type poles (with deviation angle of 30-60 deg.) with tension insulator strings shall be used and crossing span shall not be more than 250 meters, unless higher span is permitted by National Highways Authority.

(e) River Crossing

(i) Minimum clearance of a power line above a river shall be as per Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations and regulations of appropriate River Authorities.

(ii) In case of major river crossing, river crossing poles shall be of suspension type along with anchor poles of tension type pole (with deviation angle of 30-60 deg.) on either side of the main river crossing poles.

(f) For river crossings or power line crossings (66kV or above), railways or road crossings (express way, national highway & state highway) minimum two sets of long rod insulators or two sets of disc insulator strings per phase shall be used.

(g) For PD/DPD/MCPD/MVPD type pole, where jumper is projecting outside of cross arm, bidder shall adopt same cross arm design as that used for dead end angle pole.

4.6 Angle of shielding

The angle of shielding is defined as the angle formed by the line joining the centre lines of the earth wire/OPGW and outer power conductor, in still air, at pole structure supports, to the vertical line through the centre line of the earth-wire/OPGW. Bidders shall design the pole in such a way that the angle of shielding does not exceed 30^{o} for 66kV/110kV/132kV/220kV/230kV lines, 20^{o} for 400kV & 765kV (S/C) line and 10^{o} for 765kV (D/C) lines.

The drop of the earth-wire clamp should be considered while calculating the minimum angle of protection. For estimating the minimum angle of protection the drop of earth wire suspension clamp along with shackle shall be taken as 150 mm.

4.7 Design of Monopole Structure

Pole structure shall be designed as per following minimum requirement:

4.7.1 Design Criteria

The pole structure shall be designed as per ASCE standard 48-19 (or subsequent revision) as applicable except otherwise specified in this specification considering loading requirement (except wind loading on body of the steel pole) as stipulated in latest versions of IS: 802. Load on the pole body due to wind shall be calculated as per IEC 60826 and relevant formula for calculation is given below for reference. For calculation of wind load, the basic wind speed shall be as per wind map given in National Building Code 2016. Manufacturers shall provide attachment points/devices at various locations on the pole body for application of wind loads during proto type testing of pole.

For pole structures to be used in the areas upto 60 km from sea coast, K_4 factor (i.e. importance factor for cyclonic region) of 1.3, as per IS: 875-3, shall also be considered for calculation of design wind speed i.e. $V_d = V_R K_1 K_2 K_3 K_4$ to be used in IS 802.

Wind Load on Cylindrical Members(Monopole) having a large diameter (d >0.2m)

The wind load in the direction of the wind on the member 'Le' long,applied at the center of gravity of the member, is equal to:

$F_{WT} = P_d * C_{dt} * G_t * d * L_e * Sin^3\theta'$

Component in transverse direction

$F_{WT, TRANS} = [P_d * C_{dt} * G_t * d * L_e * Sin^3\theta'] * Cos\theta$

Component in longitudinal direction

$F_{WT, LONG} = [P_d * C_{dt} * G_t * d * L_e * Sin^3\theta'] * Sin\theta$

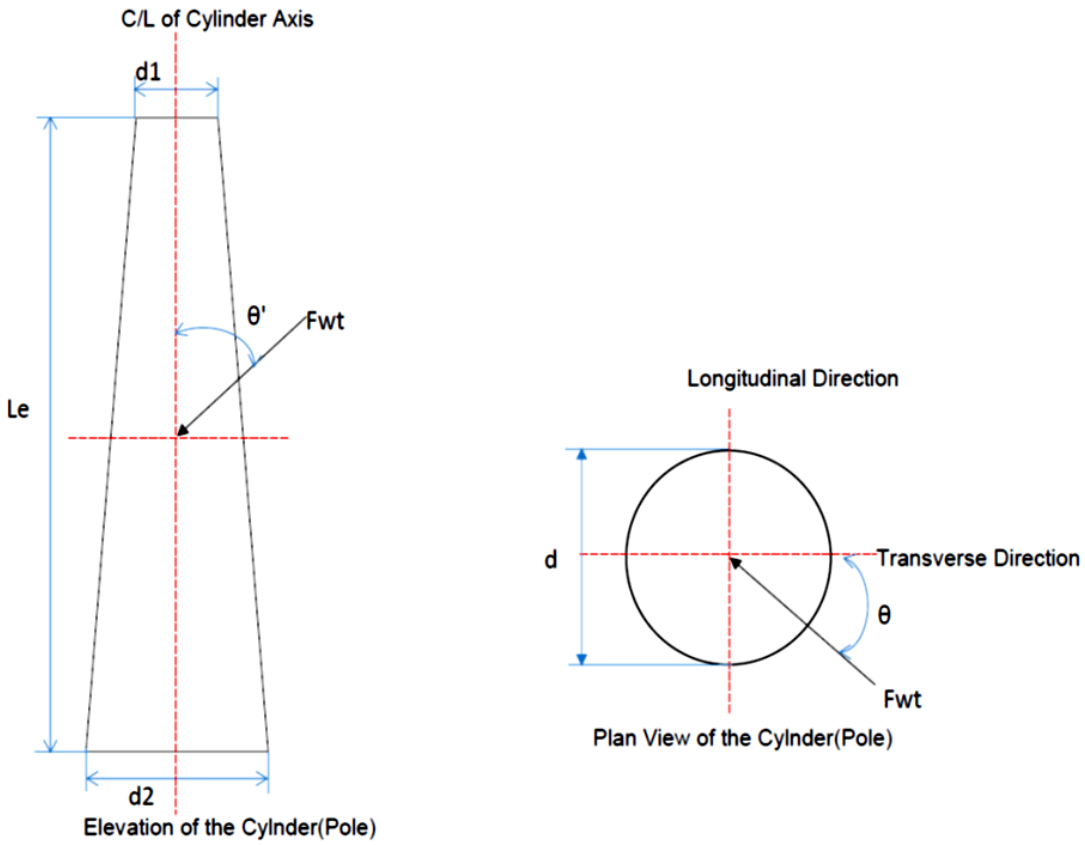


FIG.-1

Where,

F_{WT} = Wind load, in 'N'

$F_{WT, TRANS}$ = Component of wind load (Fwt) in transverse direction, in 'N'.

$F_{WT, LONG}$ = Component of wind load (Fwl) in longitudinal direction, in 'N'.

P_d = Design wind pressure, in N/m^2

C_{dt} = Drag coefficient for wind perpendicular to the axis of the cylinder, given in Table-1

G_t = Gust response factor depending upon the terrain category and height of C.G of the cylinder member above ground level. Values of 'Gt' for the three terrain categories are given in IS:802(Part-1/Sec-1). Table.6.

d = Diameter of the pole, in 'm'. For tapered poles average diameter may be considered.

L_e = Projected length of the member, in 'm'

θ' = Angle formed by the direction of wind and cylinder axis (see Fig.1)

θ = Angle of incidence of the wind direction with perpendicular to longitudinal direction (see Fig.1)

Following Drag Coefficient Values (table-9) shall be used in abovementioned formula for Polygonal Pole sections:

Table-9

Member Shape	Drag Coefficient
16-Sided Polygonal	0.9
12-Sided Polygonal	1.0
8-Sided Polygonal	1.4
6-Sided Polygonal	1.4
Square, Rectangle	2.0

A sample calculation for the loading on pole structure is attached as **Appendix-I**.

4.7.2 Design Temperature

The following temperature range for the conductors and ground wires shall be adopted for line design.

a) Minimum temperature (deg C): To be specified by Purchaser as per site requirement
b) Every day temperature of conductor: 32 deg C
c) Max. temperature of
   i) Conductor (deg C): As per Conductor used (As per relevant IS for ACSR/AAAC/AL59 conductor and as per manufacturer's data for HTLS & other new generation conductors until IS is available for them).
   ii) Earth-wire exposed to sun: 53 deg C

Note: *For region with colder climates (-5 deg C or below), everyday temperature to be considered as 15 deg. C.*

4.7.3 Normal Loading Conditions

4.7.3.1 The loads on pole structure, conductor, earthwire/OPGW and insulators under different loading conditions viz. Reliability Conditions (Normal Condition), Security Conditions (Broken Wire Condition), Safety Conditions, Anti cascading condition etc. shall be calculated as per latest version of IS: 802 or as specified in this specification considering various combinations of design temperatures & wind loads and loading trees/diagrams/charts shall be prepared. However, due to symmetry of pole structures, the narrow front wind requirements under security condition may be neglected. Further the Reliability level as per following Table-10 shall be considered for design of pole structure of transmission lines:

Table-10

66 kV to 400 kV Transmission lines with one / two circuits and one / two conductors per phase	Reliability level 1 corresponding to 50 years return period
(a) 66 kV to 400 kV Transmission lines with more than 2 circuits; (b) 400 kV Transmission lines with more than two conductors per phase; (c) 765 kV transmission lines	Reliability level 2 corresponding to 150 years return period
(a) Special type pole structures; (b) Tall River crossing (>600 m span) pole structures; (c) Pole structures whose full scale prototype can not be tested due to limitation of testing facility in India	Reliability level 3 corresponding to 500 years return period

4.7.3.2 Any other design criteria and loading condition proposed by the Standing Committee of experts for investigation of transmission pole failure or any other task force constituted by the Government shall also be considered for designing of pole structure.

4.7.3.3 The loading trees/diagrams/charts shall be submitted to the Purchaser for approval. The pole structure designs shall be developed by the Contractor as per the approved loading trees/diagram/charts.

4.7.3.4 For calculating vertical loads on the pole structure, the weight of suspension insulator and tension insulator shall also be considered for each phase conductor depending on the requirement.

4.7.3.5 In case pole structure designed for symmetrical configuration of circuits is used for stringing of circuit(s) on one side of the pole, it shall be ensured that pole is suitable for such scenario.

4.7.3.6 Negative directional wind shall be considered for single circuit poles.

4.7.4 Maximum Tension

4.7.4.1 Max tension shall be based on either

a) At 0 deg C (or at a temperature below 0 deg C if so specified by the Purchaser) with 36% full wind pressure, or

b) At 32 deg C with full wind pressure;
whichever is more stringent.

4.7.4.2 Sag tension calculations are to be carried out by the Contractor considering conductor & earthwire/OPGW parameters & specified conditions and spans.

4.7.4.3 The conductor/earthwire/OPGW tension at everyday temperature and without external load should not exceed the following percentage of the ultimate strength of the conductor (table-11):

Table-11

(a)	Initial unloaded tension	35%
(b)	Final unloaded tension	
	(i) below 400kV	25%
	(ii)400 kV and above	22% (conductor) 20% (earthwire/OPGW)

4.7.4.4 The ultimate tension of conductor and earthwire under everyday temperature and 100% design wind pressure, or minimum temperature and 36% design wind pressure shall not exceed 70 per cent of their ultimate tensile strengths. Similarly, the ultimate tension of OPGW under everyday temperature and 100% design wind pressure, or minimum temperature and 36% design wind pressure shall not exceed 40 per cent (upto 60% if verified through relevant tests) of the ultimate tensile strength of OPGW.

4.8 Electro-mechanical strength of insulator

Electro-mechanical strength of insulator shall be selected such that:

a) under 100% design wind loading conditions, the load on insulator string shall not exceed 70 % of its electro-mechanical strength;
b) under everyday temperature and nil wind conditions, the load on insulator string shall not exceed 25% of its electro-mechanical strength.

4.9 Conductor and Earth-wire Configuration

4.9.1 Conductor configuration shall be as specified by the Purchaser as per its requirement.

4.9.2 Single earthwire shall be used for transmission lines up to 220 kV and two earthwires shall be used for transmission lines of 400 kV and higher voltage classes.

4.9.3 The earthwire shall be OPGW or galvanized stranded steel (GSS) or Aluminium Alloy Conductor Steel Reinforced (AACSR) type, as specified by the Purchaser.

4.10 Deflection Criteria (for both suspension and tension Pole structure)

The maximum deflection of 5% (under ultimate load condition) of the height of pole shall be considered in the design where there is no restriction at site. However maximum deflection during testing shall not exceed 8% after testing for 10 critical load cases. Deflection during every day loading conditions should not exceed 2%. However, in any situation, the required electrical clearances at site has to be maintained as per Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations.

4.11 D/T and W/T Ratio for Design of pole Structure

While designing the pole structure, the D/T ratio and W/T ratio (D: Diameter of section, W: Width of side, & T: Thickness of sheet), as applicable in line with ACSE 48-19 (or its latest version), shall be maintained properly to avoid buckling and ovality of the individual sections of the pole structure under load during transportation and handling.

5.0 Design Calculation and Drawing

5.1 The detailed design calculations and drawings for different type of pole structure for the transmission line along with design of different type of foundation for the same are required to be furnished to the Purchaser along with the bid. The line diagrams of pole structures and foundations are also to be furnished. The bidder shall also furnish basic assumptions and criteria of pole structure design so that design calculations, even if computerized, could be checked.

5.2 After award of contract, the Contractor shall submit detailed design of all polygonal pole structures with all extension along with stress diagram/computer output together with sample calculations, calculations for deflection, and foundation design and drawing etc., anchor bolt templates and loading/rigging arrangement of pole testing to enable the Purchaser to make a preliminary check regarding structural stability of pole before tests.

5.3 The Contractor shall also submit one copy of reproducible of all drawings & Bill of Materials after final approval.

5.4 The drawings of accessories of pole structure like number plate, danger plate, phase plate, circuit plate, step bolt, anti-climbing

device, pole plate and earthing arrangement, bird guard, D-shackle, aviation day and night markers/painting on pole etc. shall be prepared by the Contractor and shall be submitted to the Purchaser for approval.

5.5 After approval of design by the Purchaser/Consultant, the Contractor shall develop structural drawings including all details of cross arms, joints and attachments based on approved design and furnish hard & soft copies of the drawings for scrutiny at Purchaser's end. If the design/drawings are corrected by the Purchaser, the Contractor shall submit revised designs/drawings within 15 (fifteen) days of issue of corrections. The Contractor shall develop computer aided structural drawings and prepare bills of materials and shop drawings of Pole structure. After thorough scrutiny and upon satisfaction about the soundness/correctness of joints and the drawing as a whole, the Purchaser shall convey his acceptance to the Contractor.

5.6 Upon receiving the acceptance of structural drawing from the Purchaser, the Contractor shall develop shop drawings for Pole structure and fabricate them as per the drawings for the purpose of proto assembly and inspection. During proto-assembly inspection, Purchaser may depute their Engineer for checking the conformity. However, the overall responsibility of ensuring the correctness of the shop & structural drawings and the proto assembly shall lie with the Contractor. At this stage if any modification is required to be carried out on the fabrication shop drawings or on the structural drawings, the same shall be properly incorporated with prior intimation to the Purchaser.

5.7 Subsequent to the successful proto assembly of the Pole structure, the pole shall be tested as per IS: 802 and as specified by the Purchaser. The test shall be carried out in presence of Purchaser's and Contractor's representatives.

5.8 At the time of proto assembly and/or proto testing, if any modification are required to be carried out, the same shall be incorporated by the Contractor and the revised structural drawings, bills of materials and shop drawings shall be submitted to the Purchaser within 15 days of completion of testing of poles for approval. After approval, the Contractor shall submit copies of drawings/BOMs and 2 sets of shop drawings. Soft copies of Structural & Shop drawings and BOM's shall also be submitted in CD/DVD/Pen drive for use on computer.

5.9 The right of design shall be with the Purchaser. All drawings therefore shall be duly marked with the following:

WARNING: THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH PURCHASER. UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM THE PURCHASER IN WRITING.

5.10 **Loading Trees:** Loading trees shall be prepared by the Contractor for design purposes. The loading trees shall summarize various aspects regarding loading and shall govern the design besides requirements stipulated in IS: 802.

5.11 After successful testing of pole structure and subsequent approval of design, drawing and bill of materials, the Contractor shall furnish the soft copies and 4 sets of hard copies of following design calculations, drawings and bill of material to the Purchaser within fifteen (15) days of approval:

(a) Detailed design calculation including pole deflection calculations and drawing for pole structure & foundations.
(b) Detailed structural drawings indicating dimension details of sections and cross-arms, sizes of plates and anchor bolt assembly details along with hole to hole distance, joint details etc.
(c) Bill of materials indicating cutting and bending detail against each part.
(d) Shop drawings showing all details relevant to fabrication.
(e) All the drawings for the pole hardware & accessories.

5.12 While submitting the designs, structural drawings, bill of materials and any other drawings pertaining to the subject transmission line, the Contractor shall clearly indicate on each drawing Specification No., Name of the transmission line and project, Name of Purchaser, letter reference No., revision No., and dates on which the submissions are made.

5.13 The drawings shall be prepared to the appropriate scale as per the relevant standards. Not To Scale (NTS) drawings shall not be accepted.

6.0 General Construction

6.1 Pole Structure

6.1.1 Steel grades having designated yield strength less than or equal to that of IS: 2062 grade E450 or equivalent are to be used in Pole structures, which includes pole shaft, cross arms & arm brackets, base plate etc. The quality of steel shall be BR/B0/C type as per IS 2062. Not more than three grades of steel shall be permitted for use. Steel plates below 6 mm size exclusively used for packing

plates/packing washers produced as per IS: 1079 (Grade-HR0) are also acceptable.

6.1.2 Pole shall be continuously tapered from top to bottom with uniform slope. However, when required straight sections (without tapered) may be designed/used as extensions.

6.1.3 Steel grade of weldable quality only shall be selected. The grades of steel shall be selected to meet the design requirements & climatic conditions keeping in view the overall optimum weight of the pole structure and availability of material.

6.1.4 The sheets/plates of monopole shall be from primary steel producers such as TATA/SAIL/JSW/ RINL/ POSCO/ ArcelorMittal Nippon Steel India/ Jindal Steel/ only. If the sheets/plates can not be directly procured from these sources, the same can be procured from dealer/distributors subject to condition that the original maker of the steel are aforementioned suppliers and same should be traceable. The manufacturer shall provide necessary documents for the same.

6.1.5 Quality Control Order issued by Ministry of Steel, as applicable, shall be followed.

6.2 Anchor Bolts

Anchor bolts shall generally conform to IS: 5624. The size, grade & numbers of anchor bolts and its thread & nuts selection should be compatible with the required strength as per design. The anchor bolts for the pole shall be provided with top and bottom templates to form cage. This is to get a proper alignment of bolts during casting of foundation. Anchor bolts shall be completely galvanized.

6.3 Fasteners: Bolts, Nuts and Washers

6.3.1 All bolts and nuts shall conform to IS: 12427. All bolts and nuts shall be galvanized as per IS: 1367 (Part-XIII)/IS: 2629 and shall have hexagonal head and nuts, the heads being forged out of the solid steel rods & shall be truly concentric, and square with the shank, which must be perfectly straight.

6.3.2 The foundation bolts shall be of minimum 16 mm diameter and of property class 6.8/8.8 and the connection bolts shall be of minimum 12 mm and of property class 8.8 specified in IS: 1367 (Part-III). Nuts of property class matching with the property class of mating bolt as specified in IS: 1367 (Part-VI) shall be used.

6.3.3 Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling

process to obtain in good & reliable mechanical properties and effective dimensional control. The shear strength of bolts shall be as per applicable standard. Bolts should be provided with washer in accordance with IS: 1363 (Part-I) to ensure proper bearing.

6.3.4 All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit firm gripping of the members. It shall be ensured that the threaded portion of each bolt protrudes not less than 3 mm when fully tightened. All nuts shall fit and tight to the point where the shank of the bolt connects to the head.

6.3.5 To obviate bending stress in bolts or to reduce it to minimum, no bolt shall connect aggregate thickness of more than three (3) times its diameter.

6.3.6 Bolts at the joints shall be staggered so that nuts may be tightened with spanners without fouling.

6.3.7 Nuts should be double chamfered as per the requirement of IS: 1363 Part- III. It should be ensured by the manufacturer that nuts should not be overlapped beyond 0.4 mm oversize on effective diameter of bolts. The nuts shall be forged and tapped after galvanizing and then lubricated.

6.3.8 The bolts and nuts shall be free from forging & threading defects such as cuts, splits, burrs, bulging, taper, eccentricity, loose fit etc.

6.3.9 Flat and tapered washers shall be provided wherever necessary.

6.3.10 Spring washers shall be provided for insertion under all nuts. These washers shall be of steel and shall be electro-galvanized, positive lock type and 3.5 mm in thickness for 16 mm dia bolt and 4.5 mm for 24 mm bolt. In place of spring washer, double nut or lock nut may be provided with flat washer.

6.3.11 The surface of the washers shall be free of scales and burrs. The washers shall be coiled without any kinks (except for the shape with turned-up ends). The ends of the washer shall be so served as to prevent tangling.

6.3.12 The spring washers after coiling shall be suitably heat treated so as to result in the finished washer having hardness 43 to 50 HRC when tested in accordance with IS: 1586.

6.3.13 To ensure effective in-process Quality Control it is essential that the manufacturer have all the testing facilities for tests like weight of zinc coating, shear strength, other testing facilities etc. in-house. The manufacturer should also have proper Quality Assurance

System which should be in line with the requirement of this specification and IS: 14000 series Quality System standard.

6.4 Pole Structure Accessories

6.4.1 Ladders and Step Bolts

(a) A ladder along with protection rings (caged ladder) of suitable design (preferable) shall be provided to climb on the pole structure. Step bolts or combination of step bolts and ladder may be provided if so specified by the Purchaser. For access to earth wire peak and horizontal access on cross arms, step bolts/suitable designed hooks/side railings can also be provided. Detailing for providing step bolts/hooks/ladders etc. shall be done so that all parts of pole structures are accessible and installation & maintenance of insulators, hardware assemblies, conductors etc. is possible.

(b) The ladder or step bolts shall extend from about 2.5 meters above the ground level to the top of the pole.

(c) The step bolts, if provided, shall conform to IS: 10238 and shall be of not less than 16 mm diameter & 175 mm long and spaced not more than 450 mm apart. The head diameter shall be 35 mm. The step bolt shall be fixed on two sides of polygon of the pole structure in alternate step arrangement. Each step bolt shall be provided with two hexagon nuts on one end to fasten the bolt securely to the pole and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 kN.

6.4.2 Insulator Strings and Earthwire Clamps Attachments

(a) Insulators assemblies as approved by the Purchaser shall be used by the Contractor for Suspension and Tension pole structures. For specific application, the Purchaser may consider use of insulated cross arm in place of conventional cross arm.

(b) For the attachment of suspension insulator string, a suitably dimensioned swinging hanger on the pole, if required, shall be provided so as to obtain specified clearances under respective swinging conditions of the strings.

(c) The hanger, extension links, D-shackles etc. as required and considered in the design of the pole, shall be of same strength as that of corresponding electromechanical strength/ ultimate tensile strength of insulator string. The design and supply of hanger, extension links, D-shackles are also in the scope of the Contractor.

(d) At tension pole structures, strain plates of suitable dimensions on the underside of each cross-arm tip and suitable plate at the top of earth-wire peak should be provided for taking the hooks or D-Shackle of the tension insulator strings or earth-wire tension clamps, as the case may be. Full details of the attachments shall be submitted by the Contractor for Purchaser's approval before starting the mass fabrication.

6.4.3 Earthwire/OPGW Clamps

Suspension and tension clamps conforming to IS 5613 shall be provided by the Contractor. For Suspension and tension clamp for attachment of earthwire/OPGW the Contractor shall supply U–bolts, D–Shackles etc. for attachment of clamp to the pole structure. These items shall be of same rating/strength as that of corresponding rating/Ultimate tensile Strength of earthwire suspension/tension clamp.

6.4.4 Anti-climbing Device

Barbed wire or spike type anti-climbing device shall be provided and installed by the Contractor for all pole structures. The height of the anti-climbing device shall be provided approximately 3 m above ground level. The barbed wire shall conform to IS: 278 (size designation A1). The barbed wires shall be given chromating dip as per procedure laid down in IS: 1340.

6.4.5 Danger plate, Number plate, Circuit plate and Phase plate

(a) Each pole shall be fitted with a number plate, danger plate and a set of phase plates per circuit. The arrangement for fixing these accessories shall not be more than 4.5 m above the ground level.
(b) The number plate, phase plate and circuit plate shall be as per IS 5613.
(c) The letters, figures and the conventional skull and bones of danger plates shall conform to IS: 2551 and shall be in a signal red on the front of the plate.
(d) The corners of the number, danger and circuit plates shall be rounded off to remove sharp edges.
(e) The letters of number & circuit plates shall be red enameled with white enameled background.

6.4.6 Bird Guards

To prevent birds perching immediately above the suspension insulator strings (I-Type/V-Type) and fouling the same with droppings, suitable bird guards shall be provided at cross-arm tips

of all suspension poles. Saw type bird guard conforming to IS: 5613 or other bird guard as approved by the Purchaser shall be provided. The bird guard arrangement shall be such that it shall either prevent bird from perching in position where they are liable to cause damages or ensure that if birds do perch, droppings will fall clear of the insulator string. Suitable provision of cleat/plate to be provided on all suspension poles facilitating installation of bird guard after stringing.

6.4.7 Aviation Requirement

The day and/or night visual aids and markers for denoting transmission line or structures as per requirements of Directorate of Flight Safety or International Civil Aviation Organization shall be provided.

6.5 Pole Structure Fabrication

6.5.1 The Pole Structure along with cross arms, earthwire peaks, base plate and joints shall be fabricated by the Contractor as per the design developed by the Contractor and approved by the Purchaser/ Consultant.

6.5.2 The fabrication of Pole structure shall be in conformity with the following:

(a) Except where hereinafter modified, details of fabrication shall conform to good industry practices and relevant standards.

(b) Connections by means of slip joints or flange joints are both acceptable on mutual agreement as per the site requirements and conditions. Joints shall be so designed and fabricated that eccentricity is avoided as far as possible.

(c) Pole section, if made with telescopic slip joints, shall be suitable for easy assembly either in air or on the ground at the construction site. Overlapping shall not be less than 1.5 times the largest inside diameter of the female section. The taper of each section at a slip joint should match the taper of the adjacent section.

(d) On slip joints, diameter of the inner and outer part of the pole structure shall be controlled to ensure smooth assembly of the monopole structure.

(e) In case of flange joints, the flanges welded to pole sections will be joined with Bolts & Nuts.

(f) The cross arms shall be connected to the monopole by means of suitable flanges welded on the body and cross arms.

(g) The Pole structures shall be accurately fabricated to connect together easily at site without any undue strain on the structure.

(h) The diameter of the hole for bolts shall be equal to the diameter of bolt plus 1.5 mm.

(i) The structure shall be designed so that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depression are likely to hold water. The top end of the pole, earth-wire peaks and cross arms shall be suitably sealed with cover plate bolted to the structure.

(j) Maximum size of individual fabricated/welded piece shall be so selected to facilitate easy handling transportation and erection of pole structure. Any other specific restriction on length due to site condition should be specified by the Purchaser beforehand. The limits of weights & dimensions of individual components shall be finalized at the time of design development and approval.

(k) All similar parts shall be made strictly inter-changeable. All steel sections before any work is done on them, shall be carefully leveled, straightened and made true to detailed drawings by methods which will not injure the materials so that when assembled, the adjacent matching surfaces are in close contact throughout.

(l) In case of restriction due to size of hot dip galvanizing bath, pole segments shall be fabricated & galvanized as per following table and shall be seamlessly welded.

Table-12

Sr. No.	Outer Diameter of pole segment (in mm)	Max. permissible no. of fabricated parts per pole segment
1.	Upto 600	1
2.	600≤ D<1200	2
3.	1200≤D<1800	3
4.	1800≤D	4

(m) No sharp/rough edges shall be permitted in the entire structure.

(n) Suitable provisions shall be kept in design and detailing of pole structure for easy erection at site using conventional as well as

mechanized methods. Detailed erection procedure/manuals shall be prepared and submitted by the Contractor.

(o) Design and detailing for providing ladders/step bolts/hooks etc. shall be done so that such provision would facilitate accessibility to all parts of pole structures and installation & maintenance of insulators, hardware assemblies, conductors etc. can be done easily. Design detailing for provision of other accessories viz. Anticlimbing device, Danger plate, Number plate, Phase plate etc. shall also be done.

(p) At base plate and other intermediate flange connections the plate shall be perfectly levelled to ensure uniform and gap free connection.

(q) Lifting and handling of monopole during galvanization, fabrication etc. shall be done in such a way that each panel of monopole is perfectly straight. Also, spider bracings may be used inside the pole to arrest distortion or bending during handling.

6.5.3 Material Cutting, Forming & Bending

(a) The required material cutting, forming and bending operations shall be carried out generally in accordance with ASCE standard 48-19 (or subsequent revision) "Design of Steel transmission Pole Structures".

(b) Before any cutting work is started, all steel shall be carefully straightened & trued by pressure and not by hammering. They shall again be trued after cutting & welding etc.

6.5.4 Drilling and Punching

(a) Holes for bolts shall be drilled or punched with a jig or made with plasma/gas but drilled holes shall be preferred.

(b) Holes must be perfectly circular and no tolerance in this aspect is permissible.

(c) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8 mm, i.e., the allowable taper in a punched hole should not exceed 0.8 mm on diameter (Not applicable for template holes and lifting holes).

(d) Holes must be square with the plates and have their walls parallel.

(e) All burrs left by drills or punch shall be removed completely. When the pole members are in position the holes shall be truly opposite to each other. Drilling or reaming to enlarge holes shall not be permitted.

6.5.5 Welding

(a) Welding being the key process of pole manufacturing, the manufacturer should have ISO 3834-2 certification for quality of welding.

(b) All welding shall be in accordance with the latest revision of American Welding Society Structural Welding Code (ANSI/AWS D1.1). Welding terms and symbols should comply with the AWS definitions and symbols.

(c) Care should be exercised with respect to welding procedures, qualification of welders/operators, electrodes, preheat, notch toughness and minimum yield of the electrodes to ensure conformance with the requirements of the ANSI/AWS D 1.1 code. Preheating shall be done according to the ANSI/AWS code or the steel producer's recommendations, or both. The welding shall be done by the shield metal-arc, gas shielded flux core, gas shield metal arc or submerged-arc processes. The storage of welding consumables (welding wire, electrodes, fluxes and gases) shall be in accordance with AWS D1.1 and as per manufacturer's recommendations. These details shall be included in MQP (Manufacturing Quality Plan) to be prepared and submitted by the Contractor.

(d) Circumferential and longitudinal welds within the slip joint area of pole sections should be ultrasonically inspected in accordance with AWS D1.1. Longitudinal welds in pole sections where visual inspection is not adequate, magnetic particle tests or dye penetration test should be conducted in accordance with AWS D1.1.

(e) Pole shaft-to-base plate, and pole shaft-to-flange shall be full penetration welds. Arm shaft-to-arm bracket shall be partial penetration groove weld with fillet overlay, sized to develop the full strength of the shaft. Longitudinal seam welding of pole shaft (not in slip joint area) shall be partial penetration (min. 60%) from outer side.

(f) Warping of base plate due to exposure to extreme heat during welding shall be avoided.

6.5.6 Erection mark

Each individual member shall have an erection mark conforming to the component number given to it in the fabrication drawings. This mark shall be made with marking dies of 16 mm size before galvanizing and shall be legible after galvanizing. Purchaser may specify erection mark format as per its requirement.

7.0 Quantities and weight

(a) The provisional quantities required (including provisional spare for pole structure quantity) shall be mentioned by the Purchaser. The final quantities of pole structure including spare pole structures shall be confirmed by the Purchaser based on the requirement of quantities of various pole structures after completion of detailed survey.

(b) The Purchaser reserves the right to order the final quantities including required quantities of spares.

(c) The rate quoted by the bidder for pole structure / structure parts supply is deemed to be inclusive of galvanizing charges & the cost of zinc.

(d) The Contractor is to supply up to 2.5% extra fasteners to take care of losses during erection.

(e) Payment of the pole structures shall be made on per structure basis as per the unit rates in the contract irrespective of any change in weight of structure estimated by the bidder at the time of the bidding vis-à-vis weight of structure as per actual tested and approved design.

8.0 Galvanizing

8.1 The pole manufacturer has to submit in writing the suitability of its galvanizing facility/bath where the pole sections are to be galvanized.

8.2 Fully galvanized poles structures and anchor plate excluding template shall be used for the transmission lines. Galvanizing of the pole structure shall conform to IS: 2629 and IS: 4759. All galvanized members shall withstand tests as per IS: 2633. For fasteners, the galvanizing shall conform to IS: 1367 (Part-13). Spring washers shall be electro-galvanized as per service grade 4 of IS: 1573.

8.3 The galvanizing shall be done after all fabrication work is completed, except that the nuts may be tapped or re-run after

galvanizing. Threads of bolts and nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of threads of bolts and they shall be capable of developing full strength of the bolts.

8.4 All fabrication work on pole sections (including welding of base section with base plate) shall be completed in all respect before hot dip galvanization. No cutting, grinding, welding, fabrication etc. shall be allowed on any pole sections after hot dip galvanization is over except sections that will use metallizing.

8.5 The zinc coating shall be adherent, reasonably uniform, smooth, continuous and free from imperfections such as black/bare spots, ash rust strains, bulky white deposits/wet storage strains and blisters.

8.6 The fabricated pole structure parts shall have a minimum overall mass of Zinc coating and average zinc coating thickness as given below (table-13):

Table-13

	Minimum mass of zinc coating (g/m^2)	Average coating thickness of zinc coating (micron)
For plates and sections below 5 mm	460	65
For plates and sections of 5 mm and above	610	87

8.7 For installation in coastal areas (upto 20 km from sea coast), the fabricated pole parts shall have a minimum overall mass of Zinc coating and average zinc coating thickness as given below (table-14):

Table-14

	Minimum mass of zinc coating (g/m^2)	Average coating thickness of zinc coating (micron)
For plates and sections below 5 mm	610	87
For plates and sections of 5 mm and above	900	127

8.8 The Contractor shall also take guidelines from the recommended practices for hot dip galvanizing laid down in IS 2629 while deciding and implementing galvanizing procedure. The mandatory requirements however, are specified herein. The surface preparation for fabricated pole structure parts for hot dip galvanizing shall be carried out as indicated herein below:

(a) **Degreasing & Cleaning of Surface:** Degreasing and cleaning of surface, wherever required, shall be carried out in accordance with IS 2629. After degreasing the article shall be thoroughly rinsed. However, if acidic degreasers are used, rinsing is not required.

(b) **Pickling:** Pickling shall be done using either hydrochloric or sulphuric acid as recommended in IS 2629. The actual concentration of the acids and the time duration of immersion shall be determined by the Contractor depending on the nature of material to be pickled. Suitable inhibitors also shall be used with the acids to avoid over pickling. The acid concentration, inhibitors used, and maximum allowable iron content shall form part of plant standard to be formulated and submitted to Purchaser along with Quality Assurance Program.

(c) **Rinsing:** After pickling, the material shall be rinsed, preferably in running water to remove acid traces, iron particles or any other impurities from the surface. Two rinse tanks are preferable, with water cascading from the second tank to the first to ensure thorough cleaning. Wherever single tank is employed, the water shall be periodically changed to avoid acid contamination, and removal of other residues from the tank.

(d) **Fluxing:** The rinsed article shall be dipped in a solution of Zinc ammonium chloride. The concentration and temperature of the flux solution shall be standardized by the Contractor depending on the article to be galvanized and individual circumstances. These shall form part of plant standard to be formulated and submitted to – Purchaser along with Quality Assurance Program. The specific gravity of the flux solution shall be periodically monitored and controlled by adding required quantity of flux crystals to compensate for drag-out losses. Free acid content of the flux solution also shall be periodically checked and when it is more than two (2) grams of free acid per litre of the solution, it shall be neutralized by adding ammonia solution or by addition of zinc spelter. Alternatively, PH value should be monitored periodically and maintained between 5.0 to 5.5.

(e) **Drying:** When dry galvanizing is adopted the article shall be thoroughly dried after fluxing. For the purpose of drying, the

Contractor may use hot plate, air oven or any other proven method ensuring complete drying of the article after fluxing and prior to dipping in the molten zinc bath. The drying process shall be such that the article shall not attain a temperature at which the flux shall get decomposed. The article thus dried shall be galvanized before the flux coating picks up moisture from the atmosphere or the flux layer gets damaged or removed from the surface. The drying procedure, time duration, temperature limits, time lag between fluxing, drying, galvanizing etc. shall form part of plant standard to be formulated and submitted to Purchaser along with Quality Assurance Program.

(f) **Quality of Zinc:** Any one or combination of the grades of zinc specified in IS 209 or IS 13229 or other comparable international standard shall be used for galvanizing. The Contractor shall declare the grade(s) of zinc proposed to be used by them for galvanizing. The molten metal in the zinc bath shall contain minimum 98.5 % zinc by mass. It shall be periodically measured and recorded. Zinc aluminium alloy shall be added as per IS 2629.

(g) **Dipping Process:** The temperature of the galvanizing bath shall be continuously monitored and controlled. The working temperature of the galvanizing bath shall be maintained at 450+/- 10 degree C .The article should be immersed in the bath as rapidly as possible without Compromising on safety aspects. The galvanizing bath temperature, immersion angle & time, time duration of immersion, rate of withdrawal etc. shall be monitored and controlled depending upon the size, shape, thickness and chemical composition of the article such that the mass of zinc coating and its uniformity meets the specified requirements and the galvanized surface is free from imperfections and galvanizing defects.

(h) **Post Treatment:** The article shall be quenched in water. The quench water is to be changed/drained periodically to prevent corrosive salts from accumulating in it. If water quenching is not done then necessary cooling arrangements should be made. The galvanized articles shall be dipped in dichromate solution containing sodium dichromate and sulphuric acid or chromic acid base additive at a predetermined concentration and kept at room temperature to retard white rust attack. The temperature of the chromate solution shall not exceed 65 degree C. The articles shall not be stacked immediately after quenching and di-chromating. It shall be ensured that the articles are dry before any further handling operation.

(i) **Storing, Packing and Handling:** In order to prevent white rust formation sufficient care should be exercised while storing

handling and transporting galvanized products. The articles shall be stored in an adequately ventilated area. The articles shall be stored with spacers in between them and kept at an inclination to facilitate easy drainage of any water collected on the articles. Similar care is to be taken while transporting and storing the articles at site. The Contractor shall prepare a detailed galvanizing procedure including Flow Chart with control parameters and all plant standards as required above and submit to Purchaser for approval as part of Quality Assurance Plan. Whenever, galvanizing of any portion of pole structures is carried out in two or more parts, Zinc Metallizing/cold galvanizing or Zinc Rich Paint, (Pre- mixed type paint, based on organic/inorganic binders specially formulated for steel surfaces may be used after welding of parts so as to have equivalent thickness of specified zinc coating. The dried film of Zinc Rich Paint should contain a minimum of 92 percent Zinc Dust by mass is allowed as per Section -11 of American Welding Society standard AWS WZC/D19.0-72

(j) **Repair Method:** Repair of damaged & uncoated area of hot dip galvanized coating shall be in accordance with ASTM A780 or Equivalent standard.

8.9 Thermal (zinc) metallizing

(a) Procedure:

i) Surface Cleaning:

- The surface shall be cleaned by suitable clean cotton waste where the Zinc Metalizing to be applied to remove traces of oil & paint.
- Rust, Mill Scale, Welding Slag & other foreign particles shall be removed by the Shot Blasting/Manual Grinding/Wire Brush.

ii) Use of Equipment:

- The safety & operation instruction provided in the instruction manual for specific make of machine shall be followed.
- Equipment shall not be operated above recommended pressure & flow.

iii) Equipment Handling:

- The equipment should be maintain in first class condition.
- It should be ensured that the gun is pointed away from person & away from material that will burn.
- All air lines, compressor, regulators etc. should be inspected regularly for leaks & loose connections.

iv) Method of Application:

- Suitable size of single zinc wire shall be fed into spray gun. Zinc purity shall be 99.9%.
- Appropriate pressure of Acetylene & Oxygen (or any other gases as required by manufacturer) cylinder to be maintained as per manufacturer recommendation.
- Combination of above gases (e.g. Acetylene & Oxygen) generates the flame and it melts the zinc wire & compressed air blows melted metal onto desire surface.
- Distance & Angle of Spray Gun should be maintained to get the desired bonding of zinc coating with surface.
- Take up the gas lighter and open the gas head valve all the way (straight up).
- Pause for about 3 seconds.
- Close the valve half way until feel it click into the lightning stop.
- Spark the lighter in front of the nozzle
- Immediately open the valve all the way as soon as the gun lights.
- Single layer application of spray will give 45-60 microns.
- Zinc coating can be increases by application of number of layers.
- Apply zinc layers until a uniform, thoroughly wet appearances is obtained.
- To shut the gun down, turn off the gas head valve.

(b) <u>Inspection after Metallizing:</u>

- Visual inspection for smooth finish i.e. free from lumps, loosely adherence particles.
- Check Dry Film Thickness (DFT) Meter/Elcometer as per requirement.

9.0 Pole structure Foundations

The type of foundation for pole structure shall be designed based on a geotechnical investigation of the soil.

9.1 Geotechnical Investigations

These specifications provide general guidelines for geotechnical investigation of normal soils. Marshy locations and those affected by salt water or saltpetre shall be treated as special locations and the corresponding description in these specifications shall apply. Any other information required for such locations shall be obtained by

Contractor and furnished to Purchaser. Detailed Geotechnical Report shall be submitted to the Purchaser.

9.1.1 Scope

(a) The scope involves soil sampling and tests, the details of which vary according to pole location, in order to develop recommendations concerning foundation types regarding bearing capacity, uplift resistance and settlement constraints, as described hereafter. Detailed soil investigation shall be carried out at various pole locations. Selection of location for conducting the soil investigation and the depth of such test pit/bore holes may be decided in consultation with the foundation designer. Bore log data including depth of the ground water table at each pole location shall be furnished. Contractor shall also collect data regarding variation of subsoil water table along the proposed line route. Based on the soil parameters, Contractor shall recommend the foundation type suitable for each location as qualified herein and as approved by the Purchaser. The Purchaser may modify the field exploration campaign both prior to and during the exploration process based on the actual findings.

(b) The work shall include mobilization of all necessary tools & equipment and provision of necessary engineering, supervision and technical personnel, skilled & unskilled labour, etc. as required to carry out the entire field investigation as well as laboratory tests, analysis & interpretation of data collected and preparation of the Geotechnical Report. The aforementioned work shall be supervised by a graduate in Civil Engineering having at least 5 years of site experience in geotechnical investigation work.

(c) Contractor shall make its own arrangements to establish the coordinate system required to position boreholes, tests pits and other field test locations as per the drawings/sketches supplied by Purchaser. Contractor shall determine the Reduced Levels (RL's) at these locations with respect to benchmarks used in the detailed survey. Two reference lines shall be established based on survey data/details.

(d) Contractor shall provide at site all required survey instruments to the satisfaction of the Purchaser so that the work can be carried out accurately according to specifications and drawings.

(e) Contractor shall arrange to collect the data regarding change of course of rivers, major natural streams and nalas, etc., encountered along the transmission line route from the best available sources and shall furnish complete hydrological details

including maximum velocity discharge, highest flood level (H.F.L.), scour depth, etc. of the concerned rivers, major streams and nalas (canals).

(f) The field and laboratory data shall be recorded on the proforma recommended in relevant Indian Standards. Contractor shall submit to Purchaser copies of field bore logs (one copy each to Purchaser's Site Office and Design Office) and all the field records (countersigned by the Purchaser) soon after the completion of each borehole/test.

(g) Whenever Contractor is unable to extract undisturbed samples, it shall immediately inform the Purchaser. Special care shall be taken for locations where marshy soils are encountered and Contractor in such cases shall ensure that specified number of vane shear tests are performed and the results correlated with other soil parameters.

(h) The soft copy of all field records and laboratory test results shall be sent to Purchaser on regular basis. Purchaser may observe, at all times, the laboratory testing procedures.

(i) The Contractor shall interact with the Purchaser to get acquainted with the different types of structures envisaged and in assessing the load intensities on the foundation for the various types of poles in order to enable him to make specific recommendations for the depth, founding stratum, type of foundation and the allowable bearing pressure.

(j) After reviewing Contractor's geotechnical investigation report, Purchaser will discuss with Contractor's Geotechnical Engineer and finalize the report.

(k) Contractor shall carry out all the works expressed and implied in Clause 9.1.1 of these specifications in accordance with requirements of the specification.

9.1.2 General Requirements

(a) Wherever possible, Contractor shall research and review existing local knowledge, records of test pits, boreholes, etc., types of foundations adopted and the behavior of existing structures, particularly those similar to the present project.

(b) Contractor shall make use of information gathered from nearby quarries, unlined wells, excavations, etc. Study of the general topography of the surrounding areas will often help in the delineation of different soil types.

(c) Contractor shall gather data regarding the removal of overburden in the project area either by performing test excavations, or by observing soil erosion or landslides in order to estimate reconsolidation of the soil strata. Similarly, data regarding recent landfills shall be studied to determine the characteristics of such landfills as well as the original soil strata.

(d) The water level in neighboring streams and water courses shall be noted. Contractor shall make enquiries and shall verify whether there are abandoned underground works e.g. worked out ballast pits, quarries, old brick fields, mines, mineral workings, etc.

(e) It is essential that equipment and instruments be properly calibrated at the time of commencement of the work. If the Purchaser so desires, Contractor shall arrange for having the instruments tested/ calibrated at an approved laboratory at its cost and shall submit the test reports to the Purchaser. If the Purchaser desires to witness such tests, Contractor shall arrange for the same.

9.1.3 Specific Requirements for Geotechnical Investigation

(a) Bore holes shall be executed to specified depth of minimum 20 m. If refusal strata is reached (i.e. Standard Penetration Test (SPT)-N value is more than 100 continuously for 5 m depth) with characteristics of rock, the bore hole may be terminated at shallower depth i.e. at 5 m in refusal strata, with prior approval of the Purchaser.

(b) Laboratory testing shall be conducted on all soil samples to determine grain size distribution, liquid limit and plastic limit of the different soil strata encountered.

(c) Geotechnical Report must furnish the following:

(i) Location map indicating bore hole number with respect to the pole location
(ii) Safe Bearing Capacity (SBC) or Ultimate Bearing Capacity (UBC) with factor of safety
(iii) Natural moisture content, specific gravity and bulk unit weight
(iv) Cohesive Soil: Effective Unit Weight, Un-drained Shear Strength (Cu)/Cohesion, Plasticity, Strain factor etc.
(v) Cohesion-less Soil: Effective Unit Weight, N Value, Angle of internal friction, P-Y Modulus etc.
(vi) SDR/Fissured Rock/Week Rock/Hard Rock/Weathered Rock: Effective Unit Weight, Unconfined Compressive

Strength, Shear Strength, Initial modulus of Rock mass, porosity and density test, Point load index, Core recovery, RQD index as per relevant IS/IRC standards, etc.

(vii) Details of water table, if any
(viii) Geotechnical investigation scheme
(ix) Bore-logs indicating soil and rock stratification with IS classification, sampling details and SPT 'N' values
(x) Soil cross-sections along various bore holes in two orthogonal directions indicating soil stratification based on field and laboratory tests
(xi) Settlement characteristics of the foundation
(xii) Grain size distribution curves
(xiii) IS classification of soils
(xiv) Shear tests (UU) to be done on saturated soil samples (Internal fraction, cohesion)
(xv) Presence of carbonates, sulphates, nitrates, organic matter and any other chemicals harmful to the concrete foundation obtained from chemical test on soil sample
(xvi) Bearing capacity of soil at different levels
(xvii) Highest Flood Level (H.F.L.); Maximum discharge, velocity etc. (from authenticated source such as CWC or appropriate State authorities)
(xviii) Recommendations regarding type of foundation to be adopted at the location.

9.1.3.1 **Specific requirement for river crossing poles:**

(a) For River Crossing Poles following additional information must be included in the report:

(i) Discharge by Irrigation & CAD department
(ii) Maximum River Level
(iii) Catchment Area
(iv) Scouring depth
(v) River Cross Section at specified pole location
(vi) Recommended Silt Factor or shall be considered as per 703.2.2.1 of IRC 78 as suitably based on geotechnical Investigation report data.

(b) Contractor is required to mobilize a suitable arrangement (floating pontoon, plant, equipment etc.) to carry out geotechnical investigation work in creek/river locations identified by the Purchaser.

(c) Contractor shall fully satisfy himself about the conditions of creek/river (depth of water, wave currents, wind conditions, etc.) prevailing in the area of proposed investigation and plan the necessary tools and plant to be deployed before quoting. Any

claim resulting from lack of data collection in this respect shall not be entertained.

(d) Contractor shall make his own arrangements for locating the coordinates and position of boreholes in creek/river with respect to two grid-lines indicated by Purchaser.

(e) Boring in creek or river shall be payable only below the bed level and no payment shall be made for lowering the casing in water.

(f) Contractor shall arrange for necessary transportation on water (e.g. motor boat) to facilitate the supervision of work by officials of Purchaser at its own cost.

(g) Full details of the construction plant, proposed working method for boring and sampling in water shall be submitted along with the Tender.

9.1.4 Codes and Standards for Geotechnical investigations

(a) All work shall be carried out in accordance with the Indian Standards and codes (latest revisions) and as amended from time to time.

(b) All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of conflict between the present specifications and those referred to herein, the former shall prevail. Internationally accepted standards which ensure equal or higher performance than those specified shall also be accepted.

9.2 Foundation

(a) The foundation shall generally be either open cast raft type or pier type/Drilled Concrete Caisson/Steel Caisson/Embedded type or pile/micro piles or screw/Helical pile type/well type etc., based upon the ground water table and type of soil & rock, depending on economy and feasibility of construction at site and shall be in conformity with the present day practices followed in the country or abroad and the specifications laid herein. Plain Cement Concrete/Reinforced Cement Concrete footing shall be used for all types of normal poles.

(b) The scope of work for foundation shall include design, supply of materials such as cement, sand, aggregates, reinforcement steel as well as all items of work related to supply and installation of foundations such as form work, excavation, anchor bolt setting, concreting, placement of reinforcement, shoring, shuttering,

dewatering, stock piling, dressing, curing, backfilling with excavated/borrowed earth (irrespective of leads), consolidation of earth, carriage of surplus earth to the suitable points of disposals required by the Purchaser or any other activity related to completion of foundation work.

(c) The proposal for these types of foundations shall be submitted by the Contractor based on the detailed soil investigation and approval for the same shall be obtained from the Purchaser.

(d) The bidder has to furnish along with the bid one sample calculation for each type of foundation offer for verification of correctness of design procedure adopted by the bidder.

(e) The bidder is required to quote in the relevant schedules of Bid, the composite rate of foundation per pole for the foundations listed in the Bill of quantities. The composite rate quoted shall deem to include the complete scope of work as indicated above.

(f) The bidder is also required to furnish estimated foundation volumes and unit rates for excavation, concreting and reinforcement in the relevant schedules of Bid. The unit rates of excavation, concreting & reinforcement when multiplied with the corresponding estimated volumes shall match with the composite rate quoted for the foundations for the complete scope of work.

(g) However, if foundations of types/classifications other than those listed in Bill of Quantities, are required to be designed and installed at certain locations due to different soil conditions, the payment for such foundations shall be made based on the unit rates for excavation, concreting and reinforcement, which shall be deemed to include the complete scope of work as indicated above.

9.3 Loads on Foundations

9.3.1 The foundation shall be designed for the pole base reactions obtained from structural analysis due to specific loads or load combinations on the superstructure with the relevant load factors in accordance with relevant IS and IRC standards.

9.3.2 The reactions on the foundation/pedestal for Pole structure shall be calculated considering following types of the loads:

a) Tension (uplift)/Compression (Downward thrust) force
b) Horizontal Shear forces
c) Longitudinal & Transverse direction base moments

9.3.3 The additional weight of concrete over the earth weight in the foundation below ground level and the full weight of' concrete above the ground level in the foundation will also be taken into account adding to the down thrust.

9.4 Stability Analysis

In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of loss of contact with soil/rock, failure by over-turning, uprooting, sliding and tilting of the foundation. The maximum bearing pressure on soil should not exceed bearing capacity of soil. The foundation should remain stable under all the possible combinations of loading, to which it is likely to be subjected under the most stringent conditions. The stability of foundations should be checked for the following aspects:

9.4.1 The following primary type of soil resistance shall be assumed to act in resisting the loads imposed on the footing in earth:

a) Resistance against uplift

The uplift loads will be assumed to be resisted by the weight of earth volume contained in an inverted frustum of a cone on the footing pad whose sides make an angle equal to the angle of repose of the earth with the vertical, in average soil. The weight of concrete embedded in earth and that above the ground will also be considered for resisting the uplift.

b) Resistance against down-thrust

The following load combinations shall be resisted by the bearing strength of soil:

i) The down thrust loads combined with the additional weight of concrete above earth are assumed to be acting on the total area of the bottom of the footing.
ii) The moment due to side thrust forces at the bottom of the footing.
iii) Additional moments due to eccentricity of the loads.

The structural design of base slab shall be developed for the above load combination. In case of toe pressure calculation due to above load combination, allowable bearing pressure can be increased by 25%.

c) Resistance against Over Turning Moment

The lateral load capacity of a chimney foundation shall be based on the chimney acting as cantilever aided by the passive earth resistance developed 500 mm below the ground level. The chimney shaft shall be designed as per limit state method for the combined action of axial forces, tension and compression and the associated maximum bending moment. In these calculations, the tensile strength of the concrete shall be ignored.

9.4.2 In case the tension develops at the base of the foundation, the base area should be reduced to a size where no tension occurs and base pressure is recalculated. The recalculated maximum pressure on such reduced area should not exceed allowable bearing pressure. Such reduced area shall not be less than 80% of the total base area of the footing/raft under worst load combinations.

9.5 Properties of Concrete & Reinforcement

9.5.1 The cement concrete used for the foundations shall be of minimum grade M20 corresponding to 1:1.5:3 nominal mix ratios with 20 mm coarse aggregate. If required higher grade concrete may be used for casting of pole foundations as per site conditions. The concrete of grade M25 or above shall be design mix concrete as per IS: 456. All the properties of concrete regarding its strength under compression, tension, shear, punching and bend etc. as well as workmanship shall conform to IS: 456.

9.5.2 Ready Mix Concrete (RMC) from batching plant can also be used. The ready mix concrete shall conform to IS: 4926. The selection and use of Materials for the ready mix concrete shall be in accordance with IS: 456. The minimum cement content shall not be less than 330kg/m^3. The transport of concrete and transportation time shall be as per IS: 4926.

9.5.3 For foundation in creek or aggressive soil areas, concrete of grade M30 Design Mix conforming to IS: 456 and epoxy coated reinforcement as per IS: 13620 shall be used. In addition, 02 (two) coats of bituminous painting of minimum 1.6 kg/m^2 per coat shall be applied on all the exposed faces of the foundation (i.e. pedestal & base slab).

9.5.4 The weight of concrete to be considered for design of foundations shall be as given in Table-15 below:

Table-15

Type of Concrete	Weight of Concrete	
	Weight of dry region KN/m^3 (Kg/m^3)	Weight in presence of sub-soil water KN/m^3 (Kg/m^3)
Plain Concrete	21.96 (2240)	12.16 (1240)
Reinforced	23.54 (2400)	13.73 (1400)

9.5.5 a) The Ordinary Portland Cement (OPC) used in the concrete shall conform to:

(i) IS: 269 - for 33 grade OPC
(ii) IS: 8112 - for 43 grade OPC
(iii) IS: 12269 - for 53 grade OPC.

b) The Pozzolana cement, if used in concrete, shall conform to IS: 1489.

9.5.6 Concrete aggregates shall conform to IS: 383.

9.5.7 Reinforcement shall conform to IS: 432 (Part-1) for Mild Steel & Medium Tensile Steel bars and IS:1786 for High Strength Deformed Steel Bars. All reinforcement shall be clean and free from loose mill scales, dust, loose rust, and coats of paint, oil or other coatings, which may destroy or reduce bond. Contractor shall supply, fabricate and place reinforcement to shapes and dimensions as indicated or as required to carry out the intent of drawings and specifications. Only one type of steel shall be used for the design.

9.5.8 IS: 2502 - "Code of practice for bending and fixing of bars for concrete reinforcement" shall be complied for reinforcement and IS: 5525 & SP: 34 to be read in conjunction with IS: 456, shall be followed for reinforcement detailing.

9.6 Design of Foundations

9.6.1 Structural design of the foundations shall be done by Limit State Method as per IS: 456.

9.6.2 The physical properties of soil under various conditions furnished in table-16 to be considered for the design of foundations. However, it may be noted that these properties are tentative in nature. These soil properties shall be measured by the Contractor at the various locations in conformity with the standard method of testing. After soil investigations, if it is found that the design of foundations

based on above soil properties cannot be used at that location, new foundation design shall be developed based on properties furnished in soil report.

Table-16

1.	**Properties of soil**	**Ultimate bearing capacity KN/m² (Kg/m²)**	**Angle of Repose Degree**
	(a) Normal Dry Soil (b) Sandy Dry Soil (c) Wet soil due to presence of sub-soil water/surface water (d) Wet Black cotton soil	268 (27350) 268 (27350) 134 (13675) 134 (13675)	30 20 15
2.	**Weight of Earth**	**Unit**	**Value**
	(a) Dry (b) Sandy (c) In presence of surface water (d) In presence of subsoil water	KN/m³ (Kg/m³) KN/m³ (Kg/m³) KN/m³ (Kg/m³) KN/m³ (Kg/m³)	14.12 (1440) 14.12 (1440) 14.12 (1440) 9.22 (940)
3.	**Fissured Rock**		
	(a) Ultimate bearing capacity (both for dry as well as submerged fissured rock) (b) Weight of fissured rock i) Dry ii) In presence of subsoil water c) Angle of repose i) Dry Fissured rock ii) submerged fissured rock	KN/m² (Kg/m²) KN/m² (Kg/m²) KN/m² (Kg/m²) Degree Degree	612.19 (62500) 14.12 (1440) 9.22 (940) 20 deg. 10 deg.
4.	**Hard rock**		
	a) Ultimate Bearing Capacity b) Ultimate bond between steel and concrete	KN/m² (Kg/m²) KN/m² (Kg/m²)	1225.83 (125000) 0.147 (15)

9.6.3 Particulars of the foundations, along with the estimated volumes of concrete and excavation volumes for the various types of poles shall be given in the bid.

9.6.4 The thickness of concrete in the pedestal portion of the pole foundation would be such that it provides minimum clear cover of not less than 50 mm from any part of the reinforcement to the nearest outer surface of the concrete in respect of all dry locations and not less than 75 mm, in case of all wet, partially submerged & fully submerged locations.

9.6.5 While working out the volume of soil resisting uplift in Desert areas, upper 500 mm depth of soil/sand shall not be considered.

9.6.6 The chimney top or muffing must be at least 300 mm above ground level or above Highest Flood Level (whichever is higher).

9.6.7 The centroid axis of the concrete slab shall coincide with the axis of the Pole/pedestal and pass through the center line of foundation base. The design of the foundations (base slab and its reinforcement) shall take into account the additional stresses in the foundation resulting from the eccentricity introduced due to non-compliance of this requirement.

9.6.8 At least 100 mm thick pad of size equal to the base of raft with its sides vertical shall be provided below the raft for P.C.C. type foundations and 150 mm for R.C.C. type foundation. Also, at least 75 mm thick lean concrete (1:3:6) pad shall be provided below bottom slab. The size of the lean concrete shall be 75 mm beyond base of bottom slab on all sides.

9.6.9 The thickness of base slab at centre i.e., at the point of maximum bending shall not be less than 300 mm in case of RCC type foundation.

9.6.10 The minimum distance between the lowest edge of the anchor bolt and the bottom surface of concrete footing shall not be less than 200 mm.

9.6.11 The portion of the anchor bolt/anchor plate in the pedestal/raft/ chimney (or slab) shall be designed to take full down-thrust & uplift loads by the anchor bolt/anchor plate combined with concrete. The Contractor shall furnish the calculation for uprooting of anchor bolt and design for bending of anchor plate along with the foundation design.

9.6.12 Pile foundation design shall be based on IS: 2911 and non-destructive integrating test shall be as per IS: 14893.

9.6.13 **Over Load Factor:** The overload factor for foundations shall be considered as 1.1 i.e. the reaction on foundations shall be increased by 10 per cent.

9.6.14 Pier type foundation, proposed to be adopted by bidder, shall be designed and constructed as per IS: 456, IS: 491, and applicable national/international standards/prudent utility practices so as to withstand all loads/reactions due to pole structures.

9.6.15 In case of Screw anchor type/Steel caisson foundations, design shall be as per applicable international standards and prudent utility practices. Detailed design calculations shall be submitted by the Contractor for approval of the Purchaser.

9.6.16 The construction drawings/working drawings along with design calculation of foundations shall be submitted by the Contractor for approval before execution.

9.7 Construction of pole foundations

9.7.1 Testing of Soil

The Contractor shall be required to undertake testing of soil for the pole locations in the manner specified under relevant Clauses of this Specification and shall submit his report about the subsoil water table, type of soil encountered, bearing capacity of soil, possibility of submergence and other soil properties required for the design of foundations. The Contractor shall also furnish soil resistivity values to the Purchaser along the line alignment.

9.7.2 Excavation

9.7.2.1 Excavation work must not be started until the pole schedule and profile has been approved by the Purchaser.

9.7.2.2 Except as specifically otherwise provided, all excavation for footing shall be made to the lines and grades of the foundation. The excavation wall shall be vertical and the pit dimensions shall be such as to allow a clearance of 150 mm on all sides from the foundation pad. All excavation shall be protected so as to maintain a clean sub-grade, until the footing is placed, using timbering/shuttering, shoring etc., if necessary. Any sand, mud, silt or other undesirable materials which may accumulate in the excavated pit shall be removed by the Contractor before placing concrete.

9.7.2.3 If any problem of dewatering persists at the construction site, detailed scheme of dewatering shall be prepared before starting of

excavation work and IS: 9759 shall be followed as general guidance for dewatering.

9.7.2.4 The soil to be excavated for pole foundations shall be classified as under:

(a) **Normal Dry Soil**

Soil removable either manually, by means of an ordinary pick axe, spade and shovel or mechanically by excavators etc.

(b) **Wet Soil**

During the excavation, if wet soil or the subsoil water table is encountered within the range of foundation depth and/or where pumping or bailing out of water is required due to presence of surface water will be treated as wet soil.

(c) **Dry Fissured Rock**

Limestone, laterite, hard conglomerate or other soft or fissured rock in dry condition which can be quarried or split with crowbars, wedges, pickaxes etc. However, if required, light blasting may be resorted to for loosening the material but this will not in any way entitle the material to be classified as hard rock.

(d) **Wet Fissured Rock**

Above fissured rock, when encountered with subsoil water within the range of foundation depth or land where pumping or bailing out of water is required, shall be treated as wet fissured rock.

(e) **Hard Rock**

Any rock excavation other than specified under fissured rock above for which blasting drilling, chiseling are required.

9.7.2.5 Where soil is of composite nature, classification of foundation shall be according to the type of soil predominant in the footing.

9.7.2.6 No extra charge shall be admissible for the removal of the fallen earth in the pit, when once excavated. Shoring and timbering/shuttering as approved by authorized representative of the Purchaser shall be provided by the Contractor when the soil condition is so bad that there is likelihood of accident due to the falling of earth.

9.7.2.7 Where rock is encountered, the holes for pole footings shall preferably be drilled, but where blasting is to be resorted to as an economy measure, it shall be done with the utmost care to minimize the use of concrete for filling the blasted area.

9.7.2.8 Unnecessarily large quantities of excavation/blasting resulting in placement of large volumes of concrete, payment of concrete should be avoided.

9.7.2.9 The Contractor shall supply requisite blasting materials and be responsible for the purpose of the storage and use of this material.

9.7.3 Setting of Anchor Bolts

(a) The anchor bolts shall be set correctly in accordance with approved method at the exact location and alignment shall be precisely at correct levels with the help of anchor bolt setting templates and leveling instrument. Anchor bolts shall be set in the presence of Purchaser's representative available at site and for which adequate advance intimation shall be given to the Purchaser by the Contractor.

(b) Setting of anchor bolts at each location shall be approved by the Purchaser's representative.

9.7.4 Anchor Bolt Setting Templates

Anchor bolt cage assembly templates shall be designed and arranged by the Contractor at no extra cost for all types of poles Pitch Circle Diameters (PCD). The anchor bolt assembly templates shall be galvanized in case it is forming part of foundation or shall be red oxide painted where it is removable. The Contractor shall deploy suitable number of templates to ensure timely completion of line. One set of anchor bolt cage assembly of each type shall be supplied without any extra cost to the Purchaser after completion of work.

9.7.5 Mixing, Placing and Compacting of concrete

(a) The concrete shall be mixed in a mechanical mixer. However, in case of difficult terrain, hand mixing may be permitted at the discretion of Purchaser. The water for mixing concrete shall be fresh, clean and free from oil, acids and alkalis. Salty or brackish water shall not be used.

(b) Mixing shall be continued until there is uniform distribution of material and the mix is uniform in color and consistency, but in no case the mixing be done for less than two minutes. Normally mixing shall be done close to the foundation, but in case it is not

possible the concrete may be mixed at the nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.

(c) Form boxes shall be used for casting all types of foundations. The concrete shall be laid down in 150 mm layers and consolidated well, so that the cement cream works up to the top and no honey-combing is left in the concrete. The mechanical vibrator shall be employed for compacting the concrete. However, in case of difficult terrain, manual compaction may be permitted at the discretion of the Purchaser. After concreting the chimney portion to the required height, the top surface should be finished smooth with a slight slope towards the outer edge to drain off any rain water falling on the coping.

(d) In wet locations, the site must be kept complete dewatered, both during the placing of the concrete and for 24 hours thereafter. There should be no disturbance of concrete by water during this period.

(e) After the form work has been removed if the concrete surface is found to be defective, the damage shall be repaired with rich cement and sand mortar to the satisfaction of the Purchaser's representative before the foundation pits are back filled.

9.7.6 Back Filling and Removal of Anchor bolt Template

(a) After opening of form work and removal of shoring and timbering, if any, backfilling shall be started, after repairs, if any, to the foundation concrete. Backfilling shall normally be done with the excavated soil, unless it consists of large boulders/stones, in which case the boulders shall be broken to a maximum size of 80 mm. At such locations where borrowed earth is required for backfilling, this shall be done by the Contractor at no extra cost.

(b) The backfilling materials should be clean and free from organic or other foreign materials. The earth shall be deposited in maximum 200 mm layers, leveled, wetted and tempered properly before another layer is deposited. Care shall be taken that the backfilling is started from the foundation ends of the pits towards the outer ends. After the pits have been backfilled to all depth, the anchor bolt template may be removed.

(c) The backfilling and grading shall be carried to an elevation of about 75 mm above the finished ground level to drain out water.

After backfilling, 50 mm high earthen embankment (band) will be made along the sides of excavation pits and sufficient water shall be poured in the backfilling earth for at least 24 hours.

9.7.7 Curing

The concrete after setting for 24 hours shall be cured by keeping the concrete wet continuously for a period of 10 days after laying. The pit may be back filled with selected earth sprinkled with necessary amount of water and well consolidated in layers not exceeding 200 mm of consolidated thickness after a minimum period of 24 hours and thereafter both the backfilled earth and exposed chimney top shall be kept wet for the remainder of the prescribed time of 10 days. The uncovered concrete chimney above the backfilled earth shall be kept wet by providing empty cement bags dipped in water fully wrapped around the concrete chimney for curing and ensuring that the bags are kept wet by the frequent pouring of water on them.

9.7.8 Benching

When the line passes through hilly/undulated terrain, for a few pole locations it may be required to level the ground for casting of pole footings on same elevation. All the activities related to make the required area of ground in same elevation for casting of foundation, shall be termed as benching work. Benching work shall include cutting of excess earth and removing the same to a suitable point of disposal as required by the Purchaser. Benching shall be resorted to only after getting specific approval from the Purchaser. Volume of the earth to be cut shall be measured before cutting and got approved from the Purchaser. This volume of earth shall be considered for the purpose of payment against the head of benching work.

9.7.9 Protection of pole footing

9.7.9.1 The work shall include all necessary stone revetments, concreting and earth filling above ground level and the clearance from stacking on the site of all surplus excavated soil, special measures for protection of foundation close to or in nallas, river bed hilly/undulated terrain etc. by providing suitable revetments or galvanized wire netting and meshing packed with boulders. The top seal cover of the stone revetments shall be done with M150 concrete (1:2:4 mix). The Contractor shall furnish recommendations for providing protection at these locations wherever required.

9.7.9.2 The quantity of excavated earth obtained from a particular location shall generally be utilized in backfilling work in protection of pole footing of same location, unless it is unsuitable for such purpose. In

the latter case, the backfilling shall be done with borrowed earth of suitable quality irrespective of lead. The consolidation of earth shall, however, be done after backfilling free of cost.

9.7.9.3 The provisional quantities for protection work to foundations, if required, are to be furnished by the Purchaser.

10.0 Pole Erection, Stringing and Installation of Line

10.1 The erection, stringing and installation of line shall be carried out as per the relevant standards and procedures.

10.2 The details of the scope of erection work shall include the cost of labour, all tools & plants and all other incidental expenses in connection with erection and stringing work.

10.3 The Contractor shall be responsible for transportation of all the materials as per the scope of work to site, proper storage and preservation at his own cost till such time the erected line is taken over by the Purchaser. The Contractor shall be responsible for transportation, proper storage, safe custody, loss or damage of all supplied items for incorporation in the lines and shall maintain & render proper account for all such materials at all times.

10.4 Contractor shall set up required number of stores along the line and the exact location of such stores shall be discussed and agreed to between the Contractor and the Purchaser.

10.5 Anchor bolt nuts can be secured to prevent loosening during service, if desired by the Purchaser. The nuts may be secured by mechanically damaging the bolt threads, using a mechanical locking system, using a jam nut (a third nut set above the top nut and tightened onto the top nut), or applying a tack weld between the anchor bolt nut and the base plate. Because of the risk of heat damage to high-strength bolt material, welds should not be applied directly to the anchor bolt.

11.0 Earthing

11.1 Suitable provision shall be made for fixing of pipe type and counter poise earthing on the pole structure. For counterpoise type earthing, the earthing will vary depending on soil resistivity. For soil resistivity less than 1500 ohms-meter, earthing shall be established by providing 4 lengths of 30 m counterpoise wire. Otherwise, for soil resistivity greater than 1500 ohms meter earthing shall be established by providing 4 length of 70 m counterpoise wire.

11.2 The footing resistance and impedance of each pole shall be measured by the Contractor in dry weather after pole erection but

before the stringing of earth-wire and record of measurement shall be submitted to the Purchaser. All the poles are to be earthed, however, in any case Pole Footing impedance shall not exceed 10 ohms. Pipe type or Counterpoise type earthing or multiple earthing or use of environmental friendly earth enhancement material shall be used for earthing of poles to achieve specified pole footing impedance. If it becomes difficult to achieve required pole footing resistance & impedance, line surge arresters, if required, shall be used on phase conductors, which will prevent back flashover. Pipe type earthing and counterpoise type earthing shall be provided in accordance with the stipulations made in IS: 3043 and IS: 5613 (Part-II/section-2). Additional earthing shall be provided on poles after every 7 to 8 km distance for direct earthing of shield wires.

11.3 The provisional quantities for pipe type earthing and counterpoise earthing shall be furnished in Bill of Quantities. The bidder shall include cost of fabrication, supply and installation of earthing material including supply of coke, salt, earth enhancement material etc.

12.0 Statuary regulation and Standards

12.1 The Contractor is required to follow local statutory provisions, stipulations of CEA Regulations & Electricity Act 2003 as amended from time to time and other local rules and regulations referred in these specifications.

12.2 The codes and/or standards referred to in specifications shall govern, in all cases wherever such references are made. In case of a conflict between such codes and/or standards and the specifications, latter shall govern. Such codes and/or standards, referred to shall mean the latest revisions and as amended from time to time.

13.0 Quality Assurance

13.1 To ensure that the supply and services under the scope of this Contract, whether manufactured or performed within the Contractor's works or at his Sub-Contractor's premises or at Site or at any other place of work, are in accordance with the specifications. The Contractor shall adopt suitable Quality Assurance Program to control such activities at all points necessary. Such program shall be outlined by the Contractor and shall be finally accepted by the Purchaser after discussions before the award of Contract. A Quality Assurance Program of the Contractor shall generally cover but not limited to the following:

(a) His organization structure for the management and implementation of the proposed quality assurance program.

(b) Documentation control system.
(c) Qualification data for bidder's key personnel;
(d) The procedure for purchases of materials, parts/components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases, store inventory ledger, etc.
(e) System for shop manufacturing including process controls and fabrication and assembly controls.
(f) Control of non-conforming items and system for corrective action.
(g) Control of calibration and testing of measuring and testing equipment.
(h) Inspection and test procedure for manufacture.
(i) System for indication and appraisal of inspection status.
(j) System for quality audits.
(k) System for authorizing release of manufactured product to the Purchaser.
(l) System for maintenance of records.
(m) System for handling storage and delivery.
(n) A Quality Plan detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of supply.

13.2 The Quality Plan shall be mutually discussed and approved by the Purchaser after incorporating necessary corrections by the Contractor as may be required.

13.3 **Quality Assurance Documents:** The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of or prior to Purchaser's inspection of material.

13.4 The Purchaser, through his duly authorized representatives, reserves the right to carry out Quality Audit and Quality Surveillance of the systems and procedures of the Contractor's/his sub-Contractor's Quality Management and Control Activities. A typical Manufacturing Quality Plan (MQP) is enclosed as **Annexure-E.**

14.0 Inspection and Tests

14.1 The prototype of pole structures with body extension shall be tested as per relevant IS and specification. However, it shall not be mandatory to test prototype of tall river crossing pole structures and other special type pole structures designed for reliability level - 3 (500 year return period).

14.2 All standard tests, including quality control tests, in accordance with appropriate Indian/International standard, shall be carried out unless otherwise specified herein.

14.3 The Contractor shall keep the Purchaser informed in advance about the time of starting and of the progress of manufacture and fabrication of various pole parts at various stages so that arrangements can be made for inspection.

14.4 The acceptance of any part of items shall in no way relieve the Contractor of any part of his responsibility for meeting all the requirements of the Specification.

14.5 The Purchaser or his representative shall have free access at all reasonable times to those parts of the Contractor's works which are concerned with the fabrication of the Purchaser's material for satisfying himself that the fabrication is being done in accordance with the provisions of the specifications.

14.6 Unless specified otherwise, inspection shall be made at the place of manufacture prior to dispatch and shall be conducted so as not to interfere unnecessarily with the operation of the work.

14.7 Structural components and 100% of all welds shall be visually inspected to determine conformance to drawings, procedures, overall workmanship, weld contour, weld size and any other pertinent items.

14.8 Visual inspection shall be performed to detect pinhole crackings and other undesirable characteristics.

14.9 Structural components shall be inspected for dimensional compliance to determine conformance with detail drawings and established tolerances.

14.10 Should any member of the structure be found not to comply with the approved design, it shall be liable for rejection. No member once rejected shall be resubmitted for inspection, except in cases where the Purchaser or his authorized representative considers that the defects can be rectified.

14.11 Defect which may appear during fabrication shall be rectified/made good according to the procedure proposed by the Contractor and approved by the Purchaser.

14.12 All gauges and templates necessary to satisfy the Purchaser shall be supplied by the Manufacturer.

14.13 The correct grade and quality of steel shall be used by the Contractor. To ascertain the quality of steel used, the inspector may at his discretion get the material tested at an approved laboratory.

14.14 The Purchaser shall have the right to re-inspect at his expenses any material though previously inspected and approved by him at the Contractor's works, before and after the same are erected at Site.

14.15 Pole Load Tests

I. Testing of Pole Structure

(a) The Pole structure designed and supplied by Contractor shall be proto type tested by Contractor at NABL accredited pole testing station in India only. The proto type pole structure after inspection by Purchaser shall be transported to the test bed by the Contractor. The Contractor shall also carryout erection of pole structure at the pole testing station and after successful completion of proto-type testing, shall dismantle and take back.

(b) Testing of Pole structure shall generally conform to IS: 802 (Part-III). The Purchaser shall depute its representative to witness the tests. The responsibility for design and successful proto type testing shall solely lie with the Contractor. At the time of proto-assembly and/or proto testing, if any modification is required to be carried out, the same shall be carried out by the Contractor. These modifications, if any, shall also be incorporated on the fabrication shop drawings and structural drawings.

(c) A galvanized pole structure of each type complete with extension or critical poles (poles with maximum angle of deviation or with maximum extension or both) as decided by the Purchaser based on quantities of supply and site requirement shall be subjected to design and non-destructive tests by applying test loads in a manner approved by the Purchaser. The pole shall withstand these tests without showing any sign of failure or permanent distortion/deformation in any part and does not exceed the specified deflection limits.

(d) The pole shall be tested for all the conditions considered for the design of pole. The Contractor shall submit to the Purchaser, for approval, the detailed program and proposal for testing the poles showing the methods of carrying out the tests and manner of applying the loads. After the Purchaser has approved the test procedures and programs, the Contractors will intimate the Purchaser about carrying out the tests at least

one week in advance of the scheduled date of tests during which the Purchaser will arrange to depute his representative to be present at the time of carrying out the tests. The Contractor shall submit one set of shop drawings along with the bill of materials at the time of prototype pole testing for checking the pole and material. Further at the time of submitting test report, the Contractor has to submit the final tracings of shop drawings, Bill of materials and structural drawings of pole for Purchaser's reference and record.

(e) **Premature Failure**

(i) In the event of failure at less than 95% of the specified design load, the failed component(s) may be replaced by other component(s). The modified structure shall be retested to resist 100% of specified design loads.

(ii) In the event of failure between 95% and less than 100% of the specified design loads, with the exception of the final load case, the support shall be modified and retested. If failure occurs in the final load case, the Purchaser may opt not to retest the modified support.

(iii) In the event of failure at 100% of the specified design loads at less than 5 min. into the holding period, the client may accept the support without modification.

Note: 1) The steel used in damaged portion/section in the earlier test shall not be used again in the Pole structure.

2) In case of failure of any particular section/components during testing, that particular section shall be replaced and tests shall be continued for remaining tests/load cases. The load case that caused the failure should then be repeated.

(f) In case of premature failure, the Purchaser may decide to carry out the tensile test, bend test etc. as per relevant IS in any NABL accredited lab for compliance of the material with the specification for root cause analysis. The Contractor shall make suitable arrangement for the same without any extra cost to the Purchaser.

(g) No part of any pole shall be allowed to be used on the line unless it has been subjected to test.

(h) The Contractor shall ensure that the specification of materials and workmanship of all poles actually supplied conform strictly to the poles which have successfully under gone the tests. In case any deviation is detected, the Contractor shall replace such defective poles free of cost to the Purchaser.

(i) Each type of pole to be tested shall be a full scale prototype/ galvanized pole and shall be erected vertically on rigid foundation on the base plate arrangement above ground level as provided in the design/drawing. The pole erected on the bed shall not be out of plumb by more than 1 in 360.

(j) All the measuring instruments shall be calibrated in systematic/ approved manner with the help of standard weight/device. Calibration shall be done before commencing the test of each pole up to the maximum anticipated loads to be applied during testing.

(k) The suspension pole is to be tested with an arrangement simulating the chosen insulators string.

(l) The tension pole is to be tested with strain plate as per approved design/drawings.

(m) The sequence of testing shall be as per relevant standard or as decided by the Purchaser at the time of approving the rigging chart/test data sheet.

(n) Prefix T shall be marked on all members of test pole in addition to the mark no. already provided.

(o) Purchaser's liability is limited to witnessing testing of poles only once for each type of pole. Due to premature failure, if the testing of pole is to be repeated more than once for any type of pole, in such circumstances the Contractor has to bear all the expenses in respect of Purchaser's representative.

(p) **The destruction test shall not be carried out.** The prototype shall be inspected after testing. Welds shall be inspected in accordance with the normal fabrication procedures. Visual inspection shall be conducted for any signs of structural damage.

(q) The pole structure subjected to test shall be allowed to be used on the transmission line locations with lower deviation angle limits (for e.g. PC type pole (15 to 30 degree deviation) structure to be spotted for PB type pole location (2 to 15 degree deviation)) or for locations having span lower than the designed span, as decided by the Purchaser.

(r) Before utilization of tested pole in the transmission line the pole shall be de-stressed and all specified tests including examination of weld joints through Ultrasonic test shall be carried out. The pole should be structurally sound and within the fabrication tolerances.

II. Method of Load Application

(a) Loads shall be applied according to the approved rigging arrangement through normal wire attachments, angles or bent plates.

(b) The various types of loads, transverse, vertical and longitudinal shall be applied in such a way that there is no impact loading on the pole due to jerks from the winches.

(c) All the loads shall be measured through a suitable arrangement of strain devices or by using weights. Positioning of the strain devices shall be such that the effect of pulley friction is eliminated. In case the pulley friction cannot be avoided, the same will be measured by means of standard weights and accounted for in the test loads.

III. Pole Testing Procedure

All the test procedures shall be approved prior to conducting the type tests as per IS: 802 part 3. The procedure for conducting the pole test shall be as follows:

(a) Bolt Slip test & Joint adjustment test

In a bolt slip & joint adjustment test the test loads shall be gradually applied up to the 50% of design loads under normal condition, kept constant for two (2) minutes at that loads and then released gradually.

For measurement of deflection the initial and final readings on the scales (in transverse & longitudinal directions) before application and after the release of loads respectively shall be taken with the help of theodolite. The difference between readings gives the values of the bolt slip & joint adjustments. The theodolite value after releasing the load to zero will be the initial/base reading for all the main loading tests to be conducted further.

(b) Normal Broken Wire Load Tests

All the loads, for a particular load-combination test, shall be applied gradually up to the full design loads in the following steps and shall also be released in the similar manner:

50 percent,
75 percent,
90 percent,

95 percent and
100 percent

(c) Observation Periods

Under normal and broken wire load tests, the monopole structure shall be kept under observation for sign of any failure for two minutes (excluding the time of adjustment of loads) for all intermediate steps of loading up to and including 95 percent of full design loads.

For normal, as well as broken wire tests, the monopole structure shall be kept under observation for five (5) minutes (excluding the time for adjustment of loads) after it is loaded up to 100 percent of full design loads for each load case.

While the loading operation are in progress, the monopole structure shall be constantly watched, and if it shows any tendency of failure anywhere, the loading shall be immediately stopped, released and then entire monopole structure shall be inspected. The reloading shall be started only after the corrective measures are taken.

Full design loads for five (5) minutes, with no visible local deformation after unloading (such as bowing, buckling etc.) and no breakage of elements or constitute parts. The structure shall be considered to be satisfactory, if it is able to support the specified loads with no structural failure of prototype members or parts and does not exceed the specified deflection limits. Unloading should be controlled to avoid possible damage or overload to the prototype.

Ovalization of holes and permanent deformation of bolts shall not be considered as failure.

(d) Recording

The deflection of the pole structure at the top cross arm level in transverse & longitudinal directions shall be recorded “before” and “off” load conditions as well as at each intermediate and final stage of normal load and broken wire load tests by means of a theodolite and graduated scale. The scale shall be of about one meter long with markings up to 5 mm accuracy. All deflections shall be referenced to common base readings taken before the first test loads are applied.

IV. Test Reports:

a) The test reports shall include the information as specified in IS 802 Part-III. Any other information as specified by the Purchaser shall also be included in the report.

b) Certified steel producer test reports and physical test reports for the material being used in prototype pole shall be furnished as specified by the Purchaser.

15.0 Packing

15.1 The steel pole structure and its parts shall be suitably packaged so as to avoid physical damages to pole and its galvanizing. Packing procedure shall be submitted by Contractor for approval of the Purchaser.

15.2 All components of any pole shall be sent in single consignment so that complete pole can be erected without waiting for next consignment.

15.3 The procedure that will prevent damage, loss or deterioration to the structure during storage and shipment shall be provided by Contractor/manufacturer.

15.4 Cleat angles, gusset plates, brackets, fillet plate, hanger and similar loose pieces shall be tested and bolted together in multiples or securely wired through holes.

15.5 Bolts, Nuts, washers and other attachments shall be packaged in double gunny bags accurately tagged in accordance with the contents.

15.6 The packings shall be properly done to avoid losses/damages during transit. Each bundle or package shall be appropriately marked.

16.0 Annexures as listed below have been provided for guidance of the utilities/developers and may be modified as per requirement:

(a) Annexure-A: Survey, Route marking, Profile Plotting and Pole Spotting
(b) Annexure-B: Assembly and Installation of Pole structures
(c) Annexure-C: Safety Guide Lines
(d) Annexure-D: Bidder's/Contractor's Guaranteed Data Sheet
(e) Annexure-E: Standard Manufacturing Quality Plan (MQP)
(f) Annexure-F: Field Quality Plan
(g) Annexure-G: Relevant Indian/International Standards

APPENDIX-I

Sample Calculation of Wind Load on Pole Type Structures

Dimensional details of the monopole

Top diameter of the pole	d1	=	420	mm
Bottom diameter of the pole	d2	=	1360	mm
Height of the segment/pole	Le	=	28.1	m
C.G of the pole	h1	=	11577	mm

Wind pressure calculations

Basic wind speed	Vb	=	47	m/s
Wind zone	Z	=	4	
Terrain category		=	2	
Reliability level		=	1	
Reference wind speed $V_R=V_B/K_0$	47 / 1.375	=	34.18	m/s
Risk coefficient	k1	=	1	
Terrain roughness coefficient	k2	=	1	

Design wind speed: Vd=Vr*k1*k2 = 34.18 x 1 x 1

Vd = 34.18 m/s

Design wind pressure: Pd=0.6*Vd^2 = 0.6 x 34.182 x 34.18

Pd = 701 N/m^2

Height for gust factor	hg	=	11.58	m
Gust response factor	Gt	=	1.956	(As per IS:802(part-1/sec-1).Table.6)
Drag coefficient	Cdt	=	1	(for 12 sided polygonal section)

(Refer Annexure-3 of the letter)

Diameter of the pole	d	=	0.89	m
Projected length of the member	Le	=	28.1	m

Case-1 θ' 90 Degrees

θ 0 Degrees

Component in transverse direction

$F_{WT, TRA}$ = $[P_d*C_{dt}*G_t*d*L_e*Sin^3\theta']*Cos\theta$

= 701 x 1 x 1.956 x 0.89 x 28.1 x sin^3(90 x Cos(0)

= 34290 N @ 11.58 m from the base level.

Component in longitudinal direction

$F_{WT, LOI}$ = $[P_d*C_{dt}*G_t*d*L_e*Sin^3\theta']*Sin\theta$

= 701 x 1 x 1.956 x 0.89 x 28.1 x sin^3(90 x Sin(0)

= 0.000 N @ 11.58 m from the base level.

Case-2 θ' 90 Degrees
θ 30 Degrees

Component in transverse direction

$F_{WT, TRAN}$ = $[P_d*C_{dt}*G_t*d*L_e*Sin^3\theta']*Cos\theta$

= 701.038 x 1 x 1.9558 x 0.89 x 28.1 x sin^3(90) x Cos(30)

= 29696 N @ 11.577 m from the base level.

Component in longitudinal direction

$F_{WT, LONG}$ = $[P_d*C_{dt}*G_t*d*L_e*Sin^3\theta']*Sin\theta$

= 701.038 x 1 x 1.9558 x 0.89 x 28.1 x sin^3(90) x Sin(30)

= 17144.8 N @ 11.577 m from the base level.

Case-3 θ' 90 Degrees
θ 45 Degrees

Component in transverse direction

$F_{WT, TRAN}$ = $[P_d*C_{dt}*G_t*d*L_e*Sin^3\theta']*Cos\theta$

= 701.038 x 1 x 1.9558 x 0.89 x 28.1 x sin^3(90) x Cos(45)

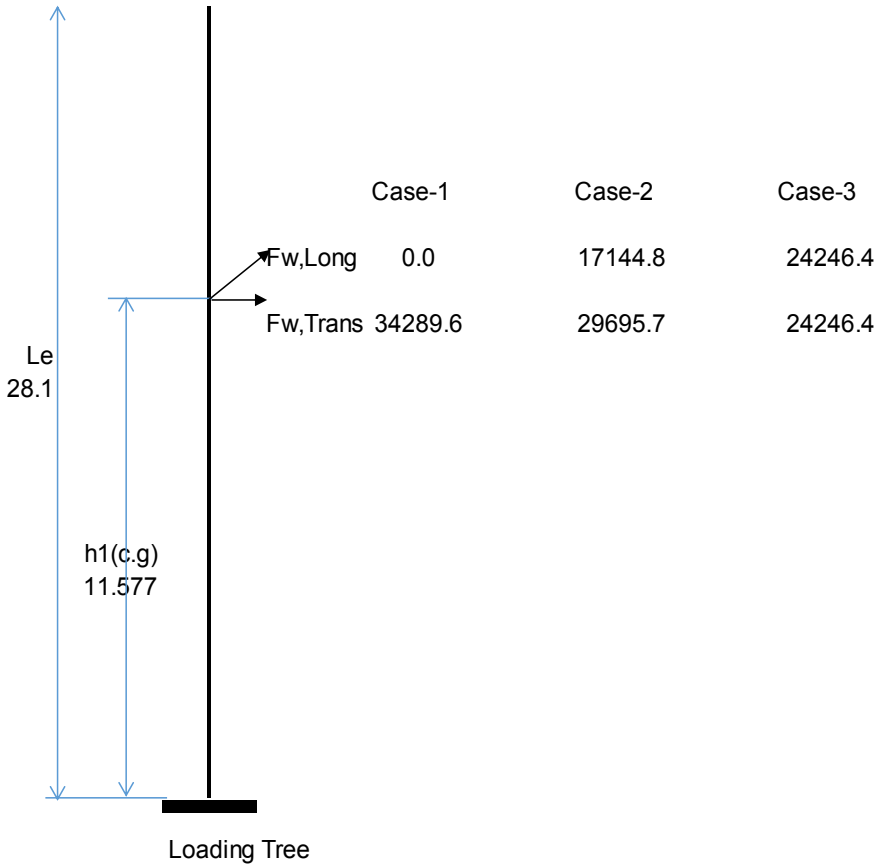
= 24246 N @ 11.577 m from the base level.

Component in longitudinal direction

$F_{WT, LONG}$ = $[P_d*C_{dt}*G_t*d*L_e*Sin^3\theta']*Sin\theta$

= 701.038 x 1 x 1.9558 x 0.89 x 28.1 x sin^3(90) x Sin(45)

= 24246.4 N @ 11.577 m from the base level.



Annexure-A

Survey, Route Marking, Profile Plotting and Pole Spotting

Annexure-A

Survey, Route marking, Profile Plotting and Pole Spotting

1.0 Route Alignment

Route Alignment shall be done using Bhuvan/ Google imagery and Survey of India topographical maps (scale 1:50,000). In case the required Survey of India maps are available in digitized form, the same shall be procured and used by the Contractor.

1.1 Requirement of Transmission Line Routing

(a) Routing of transmission lines shall be done in accordance with CEA (Technical Standards for Construction of Electrical Plants and Electric lines) Regulations and relevant IS codes.

(b) The routing and realignment, if any required, of the transmission line shall be most economical from the point of view of construction and maintenance. The Contractor shall identify & examine alternative route alignments and suggest to the Purchaser the optimal route alignment.

(c) The line routing should avoid large habitations, densely populated areas, scheduled areas, forest/national park/wildlife infringement/GIB area/Animal/Bird sanctuary, infringement of endangered species habitat, vicinity to civil and defense Airports, major river/sea crossings & coal/ mineral mining areas, oil pipe line/underground pipe line/land slide prone areas, firing range, coastal regulation zones, inflammable pipe lines etc., to the extent possible. In case it is not possible to avoid the forests or areas having large trees completely, then keeping in view of the overall economy, the route should be aligned in such a way that cutting of trees is minimum.

(d) The route should have minimum crossings of major river, railway lines, National/State highways, overhead EHV power line and communication lines.

(e) The number of angle points shall be kept to minimum.

(f) Angle points during survey should be selected such that shifting of the point within 100 m radius is possible at the time of construction of the line.

(g) The distance between the terminal points specified shall be kept shortest possible, consistent with the terrain that is encountered.

(h) Marshy and low lying areas, river beds and earth slip zones shall be avoided to minimize risk to the foundations.

(i) The areas requiring special foundations and those prone to flooding should be avoided.

(j) It would be preferable to utilize level ground for the alignment.

(k) Crossing of power lines shall be minimum. Alignment of a transmission line with respect to existing line shall be kept considering ROW and pole falling distance.

(l) Crossing of communication line shall be minimized and it shall be preferably at right angle. Proximity and parallelism with telecom lines shall be eliminated to avoid danger of induction to them.

(m) Areas subjected to flooding such as nalah shall be avoided.

(n) All alignment should be easily accessible both in dry and rainy seasons to enable maintenance throughout the year.

(o) Certain areas such as quarry sites, tea, tobacco & saffron fields, rich plantations, gardens & nurseries which may present the Purchaser problems in acquisition of right of way and way leave clearance during construction and maintenance, should be avoided.

1.2 For examination of the alternatives & identification of the most appropriate route, besides making use of information/data/details available/extracted through Bhuvan/google imagery and Survey of India Topographical maps, the Contractor shall also carryout reconnaissance/preliminary survey as may be required for verification and collection of additional information/data/details.

1.3 The Contractor shall submit his preliminary observations & suggestions along with various information/data/details collected and topographical map data marked with the alternative routes etc. The final evaluation of the alternative routes shall be conducted by the Contractor in consultation with the Purchaser's representatives and optimal route alignment shall be proposed by the Contractor. Site visit and field verification shall be conducted by the Contractor jointly with the Purchaser's representative for the proposed route alignment.

1.4 Final route alignment drawing with latest topographical and other details/features including all rivers, railway lines, canals, roads etc. up to 8 kms on both sides of selected route alignment shall be

submitted by the Contractor for Purchaser's approval along with report containing other information/details as mentioned above.

1.5 Changes in the route alignment, if any, during detail survey, shall be incorporated in the final route alignment drawings.

2.0 Detailed Survey

2.1 The detailed survey shall be carried out using Total Work stations etc. along the approved route alignment. As an alternative, the Contractor may also use ALTM (Airborne Laser Terrain Modeling) techniques of equal or better accuracy for the detailed survey.

2.2 Soil resistivity, along the route alignment shall be measured in dry weather by four electrode method keeping inter-electrode spacing of 50 m. For calculating soil resistivity, formula $2\pi ar$ (Where a=50 m and r= megger reading in ohms) shall be adopted. Measurement shall be made at every 2 to 3 km along the length of the route. In case soil characteristics changes within 2 to 3 km, values shall have to be measured at intermediate locations also. Megger reading and soil characteristics should also be indicated in the soil resistivity results.

3.0 Route Marking

3.1 The route of the transmission line shall be recorded using GPS/DGPS of positional accuracy less than 3m.

3.2 The co-ordinates of all the angle points as well as other important crossings, landmarks etc. shall be recorded using GPS for easy relocating.

3.3 At the starting point of the commencement of route survey a suitable peg/spike shall be driven firmly into the ground to indicate location of the survey instrument. The co-ordinates of the location of the survey instrument shall also be recorded. Further, the co-ordinates at prominent position at intervals of not more than 750 meter along the transmission line to be surveyed up to the next angle point shall also be recorded and wooden peg of 50mm x 50mm x 650mm size shall also be driven. Wire nails of 50mm length should be fixed on the top of these pegs to show the location of instrument. The pegs shall be driven firmly into the ground to project 100mm only above ground level. Wherever the line alignment crosses the EHV line, Railway line, P&T line or roads, the Contractor shall record co-ordinates on the points of crossing. Wherever line route alignment passes over permanent land marks such as rocks, boulders, culverts etc. suitable white paint marks with directional and utility markings shall be made and co-ordinates recorded. At angle positions stone/concrete pillars of 150 x 150 x 1000mm in size with name of

utility marked on them shall be embedded into the ground for easy identification.

4.0 Profiling

4.1 The complete profiling along the route shall be carried out using modern surveying equipment viz. total stations. Reference levels at every 20 m along the route are to be recorded. RLs at other undulations along the route as well as in the route plan and other en-route details viz. crossings, building & structures, trees & other infrastructure etc. shall also be recorded. Areas along the route, which in the view of the Contractor, are not suitable for pole spotting, shall also be marked in profile. Any undulation keeping conductor location as reference may also be indicated as dotted line in profile.

4.2 The complete profiling details shall be digitized and the data shall be prepared & stored in the format compatible to computer-aided pole spotting software.

4.3 A printed/plotted output of the digitized profiling shall be submitted by the Contractor to the Purchaser's site-in-charge for review before taking up computer-aided pole spotting.

5.0 Optimization of Pole Location/Pole Spotting

5.1 Optimization of pole locations including profiling shall be done by the Contractor using computer-aided pole spotting software – PLSCADD (or other software as specified by the Purchaser) and shall furnish sample calculations and manual pole spotting drawings for some typical sections.

5.2 Necessary data in respect of conductor, earth-wire and insulator are to be collected from the Purchaser. On the basis of these, the Contractor shall prepare the sag template drawing & pole spotting data and submit the same along with sag tension calculations for the approval of the Purchaser. Sag template prepared based on the approved sag-template curve drawing shall only be used for pole spotting on the profiles. Approved templates, prepared on rigid transparent plastic sheet, shall be provided by the Contractor to the Purchaser for the purpose of checking the pole spotting. The templates shall be on the same scale as that of the profile.

5.3 **Pole Spotting:** While profiling & spotting the poles, the following shall be kept in mind:

I Span

The number of consecutive spans between the section points shall not exceed 15 spans or 5 km in plain terrain and 10 spans

or 3 km in hilly terrain or in cyclone prone areas. A section point shall comprise of tension point with tension type poles (with deviation angle 0-15 deg./2-15 deg./0-30 deg./15-30 deg./30-60 deg.), as applicable.

II Extension

An individual span shall be as near to the normal design span as possible. In case an individual span becomes too short with normal supports on account of undulations in ground profile, one or both the supports of the span may be extended by inserting standard body extension. The provisions kept in the design of poles w.r.t. body extensions (as applicable) shall be intimated to the Contractor by the Purchaser during execution stage.

III Loading

There shall not be any upward force on suspension poles under normal working conditions and the suspension poles shall support at least the minimum weight span as provided in the designs. In case uplift is unavoidable, it shall be examined if the same can be overcome by adding standard body extensions to the poles failing which tension poles designed for the purpose shall be deployed at such positions.

IV Road Crossing

At all important road crossings, the poles shall generally be fitted with normal tension insulator strings but the ground clearance at the roads under maximum temperature and in still air shall be such that even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces shall not be less than specified minimum ground clearances. At all National/State highways, tension type poles (with deviation angle of 30-60 deg.) with tension insulator strings shall be used and crossing span will not be more than 250 meters, unless higher span is permitted by National Highways Authority.

V Railway Crossings

All the railway crossings en-route the transmission line shall be identified by the Contractor. At the time of detailed survey, the railway crossings shall be finalized based on the requirement of Regulation laid down by the Railway Authorities.

VI River Crossings

In case of major river crossing, river crossing poles shall be of suspension type along with anchor poles of tension type (with

deviation angle of 30-60 deg.) on either side of the main river crossing. Alternately on the basis of economics and/or site/execution constraints, crossing of rivers using normal extended angle poles (+18/+25/+30M extensions) may also be considered. For navigable rivers, clearance required by navigation authority shall be provided. For non-navigable river, clearance shall be reckoned with respect to Highest Flood Level (HFL).

VII Power line Crossings

(i) Where the line is to cross over another line, poles with suitable extensions may be used, depending upon the merit of the prevailing site condition.

(ii) For crossing of power line of 400 kV or above voltage class, large angle poles of deviation angle of 30-60 degree & designed for dead end condition, with required body extension, shall be used on either sides of the power line.

(iii) For crossing of power line of 110 kV, 132 kV, 220 kV and 230 kV voltage class, the tension poles with required body extension shall be used on either sides of the power line and the crossing of power lines of 66 kV class shall be done with any type of poles (suspension/tension) with required body extension.

(iv) In case of crossing with tension poles proper guying shall be provided to facilitate stringing of the power line crossing sections separately on obtaining line shutdowns.

(v) Clearance between lines crossing each other shall be kept in accordance with the CEA (Measures Relating to Safety and Electric Supply) Regulations.

VIII Telecommunication Line Crossings

The angle of crossing shall be as near to 90 degree possible. However, deviation to the extent of 30 degree may be permitted under exceptionally difficult situations.

When the angle of crossing has to be below 60 degree, the matter will be referred to the authority in charge of the Telecommunication System. On a request from the Contractor, the permission of the telecommunication authority may be obtained by the Purchaser.

Also, in the crossing span, power line support will be as near the telecommunication line as possible, to obtain increased vertical clearance between the wires.

IX Oil Pipe-Line Crossings

Wherever transmission line crosses an oil/gas pipeline, the angle of crossing shall be as near to 90 degree as possible. Further, a minimum separation of 3m should be maintained between pipe line and transmission line footings & pipe/counterpoise earthing.

X Details En-route

All topographical details, permanent features, such as trees, building etc. within 33.5m (765kV D/C), 32m (765kV S/C Delta), 42.5m (765kV S/C Horizontal), 34.5m (±800kV HVDC), 26m (400kV S/C), 23m (400KV D/C), 26m (±500kV HVDC), 17.5m (220KV), 13.5m (132 KV) on either side of the center line alignment shall be detailed on the profile plan.

XI Clearance from Ground, Building, Trees etc.

Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the CEA (Measures relating to Safety and Electric Supply) Regulations 2010 or its successor.

6.0 Details of trees, forest areas, land owners etc.

6.1 To evaluate and tabulate the trees and bushes coming within 33.5m (765kV D/C), 32m (765kV S/C Delta), 42.5m (765kV S/C Horizontal), 34.5m (± 800kV HVDC), 26m (400kV S/C), 23m (400KV D/C), 26m (±500kV HVDC), 17.5m (220KV), 13.5m (132 KV) on either side of the central line alignment, the trees will be numbered and marked with quality paint serially from angle point 1 onwards and the corresponding number will be painted on the stem of trees at a height of 1 meter from ground level. The tree outside the ROW but expected to infringe in the ROW of the line and may require lopping/trimming shall also be evaluated. The bushy and under growth encountered within this area should also be evaluated with its type, height, girth and area in square meters, clearly indicating the growth in the tree/bush statement. The trees list should contain the following:

a) Girth (circumstances) measured at a height of 1 meter from ground level.

b) Approximate height of the tree with an accuracy of +2 meters.

c) Name of the type of the species/tree.

6.2 The Contractor shall also intimate the Purchaser his assessment about the likely amount of tree & crop compensation etc. required to be paid by the Purchaser during execution stage. This assessment shall be done considering prevailing practices/guidelines, local regulations and other enquiries from local authorities.

6.3 The Contractor shall also collect data/details of ownership of land within the line corridor and pole base from the concerned revenue/local authorities and submit the same to Purchaser.

6.4 The Contractor shall also identify the forest/non forest areas involved duly authenticated by concerned authorities and shall provide following details:

(a) A statement of forest areas with survey/compartment Nos.(all type of forest RF/PF/Acquired forest/Revenue forest/Private forest/Forest as per dictionary meaning of forest etc.)

(b) A statement of non-forest areas with survey/compartment nos.

(c) Tree cutting details(Girth wise & specie wise)

(d) Marking of forest areas with category on topo sheets 1:250000 showing complete line route, boundaries of various forest divisions and their areas involved.

(e) Village forest maps of affected line and affected forest area and marking of the same.

(f) Forest division map showing line and affected forest area.

6.5 The Contractor shall finalize the forest clearance proposal on the prescribed format, as per requirements of the state/MOEF&CC, duly completed in all respects for submission by the Purchaser to the Forest Department.

7.0 Preliminary Schedule

The profile sheets showing the locations of the poles together with preliminary schedules of quantities indicating pole types, wind & weight spans, angle of deviation, crossing & other details etc. shall be submitted by the Contractor for review & approval by Purchaser's site-in-charge.

8.0 Check Survey of Pole Locations

8.1 The check survey shall be conducted to locate pole locations on ground conforming to the approved profile and pole schedule.

8.2 The co-ordinates of all the pole locations shall also be recorded using GPS/DGPS of positional accuracy less than 3m for easy relocating. The position of all pole locations shall be marked in the final digitized route alignment drawing with relative distances from any permanent bench mark area.

8.3 The Contractor shall also collect required data at each pole location in respect of soil strata, ground water level, history of water table in adjacent areas/surface water, distance from permanent bench mark (these details to be furnished in a tabulated form) and classify the suitable type of foundation at each pole location based on the data collected at each location and detailed soil investigations carried out at selected locations etc.

8.4 **Contouring at hilly/undulated locations:** The levels up or down of each pit centre with respect to centre of pole location shall be recorded at intervals of 2m using total stations/GPS/digital theodolite and digitized contour plans shall be made. Based on the digitized elevation plans, the quantities of benching & protection work shall be optimized using suitable computer-aided techniques/software or manual method.

8.5 The changes desired by the Purchaser in the preliminary pole schedule or as may be required based on detailed survey of pole locations & contouring shall be carried out by the Contractor and the final pole schedule shall be submitted for approval of Purchaser. The pole schedule shall show position of all type of poles, span length, type of foundation for each pole, benching & revetment requirement, deviation at all angles, crossings & other details etc.

9.0 Survey Methodology & Precision

9.1 All elevations shall be referenced to benchmarks established by the Survey of India. Survey operations shall begin and end at benchmarks approved by the Purchaser.

9.2 During the leveling of the profile, check surveys will be effected at intervals not exceeding 50 km with benchmarks of known elevations. The difference in elevations as surveyed by the Contractor and as declared by Survey of India for these benchmarks shall not exceed the precision required for 3rd order surveys;

$$e \leq 24k$$

where k is the distance between benchmarks in km, and
e is the difference between elevations in mm.

9.3 In the absence of suitable benchmarks, the leveling shall be done by two independent leveling parties working in opposite directions along the same line. The difference in elevations between the two surveys shall not exceed the precision required for 3rd order surveys as stated above.

9.4 All important objects and features along the transmission line centerline (railways, highways, roads, canals, rivers, transmission lines, distribution lines, telephone lines etc.) shall be surveyed and located with a positional accuracy of 1:2000 between points of known horizontal position.

10.0 Survey Report

10.1 Complete BOQ of the transmission lines as per format provided by the Purchaser shall be furnished in the survey report.

10.2 Each angle point locations shall be shown with detailed sketches showing existing close by permanent land marks such as specific tree(s), cattle shed, homes, tube wells, temples, electric pole/tower, telephone pole, canal, roads, railway lines etc. The relative distance of land marks from the angle points and their bearings shall be indicated in the sketch. These details shall be included in the survey report.

10.3 Information regarding infrastructural facilities available along the final route alignment like access to roads, railway stations, construction material sources (like quarry points for stone, sand and availability of construction water), labour, existing transport facilities, fuel availability etc. shall be furnished in the survey report.

10.4 All observations which the Contractor thinks would be useful to the construction of the transmission lines mentioned under scope of work are to be reported. The Survey report shall include identification and explanation of route constraints.

10.5 Suggestions regarding the number of convenient zones (line segments/portions) in which the entire alignment can be divided keeping in view the convenience of construction/project implementation are to be given.

10.6 Suggestions regarding location for setting up stores during line construction in consultation with Purchaser's representative shall also be provided by the Contractor.

10.7 Working months available during various seasons along the final route alignment, with period, time of sowing & harvesting of different type of crops and the importance attached to the crops particularly in the context of way leave problems and compensation payable shall be stated by the Contractor.

10.8 Some portions of the line may require clearance from various authorities. The Contractor shall indicate the portion of the line so affected, the nature of clearance required and the name of concerned organizations such as local bodies, municipalities, P&T (name of circle), Inland navigation, Irrigation Department, Electricity Boards and Zonal railways, Divisional Forest Authorities, airport Authorities etc.

10.9 All the requisite data for processing the case for statutory clearances such as PTCC, Forest and Railway shall be provided along with the report.

10.10 The Contractor shall also collect & report details pertaining to pollution levels envisaged along the transmission line.

10.11 The soft copies of survey reports shall be furnished by the Contractor to the Purchaser.

Annexure-B

Assembly and Installation of Pole Structures

Annexure-B

Assembly and Installation of Pole Structures

The installation Contractor is ultimately responsible for the proper assembly and installation of pole structures. The Contractor shall provide storage and handling instructions to minimize damage to galvanized or painted surface. Care must be taken during installation to avoid structural damage which could weaken the members and prevent them from supporting the intended loads.

1. Identification of components:

Each major component should include an identification tag. The assembly and component drawings should show:

(a) The location of each tag;
(b) The identification number on each tag;
(c) A list of all parts required for each structure or assembly.

2. Anchorage:

(a) An evaluation of local soil conditions should be made by a foundation designer. The foundation size and reinforcement must be adequate to withstand the maximum reactions which might be applied by the pole base.
(b) Concrete foundations should be installed well ahead of the installation of the poles. Standard concrete requires about 28 days to develop its full design strength.
(c) In designing and installing the foundation, consideration should be given to the possible need for underground wiring and grounding.
(d) Projection of the anchor bolts should allow for the thickness of the base plate, nuts (including the leveling nuts), and raking if required.
(e) Orientation of the anchor bolts in relation to the direction of the transmission line must be checked carefully using data from the Manufacturer's drawings and the Purchaser's plans and specifications. The anchor bolts must also be vertical. This is typically checked by leveling the top cage template.
(f) Prior to installing the anchor bolt cage, the following assembly checks should be made:
    (i) Verify the part number on the cage assembly with the part number listed on the erection drawing.
    (ii) Inspect the cage assembly for shipping or handling damage. Verify the anchor bolt cage assembly and the anchor bolt circle roundness against the assembly drawing. A four way measurement of the anchor bolt assembly across the 45 degree orientation is recommended. This check will avoid an out-of-round anchor bolt

cage not fitting the structure base plate. If the anchor bolt cage is found to be out-of-round, contact the Manufacturer.

(g) Reinforcing steel for the foundation must not be welded to the anchor bolts.

(h) Care must be taken not to disturb the position of the anchor bolts while pouring concrete.

(i) After the concrete sets, the top cage template should be removed and the nuts should be retained for installation of the structure.

(j) Leveling nuts should be adjusted before installing the pole. Typically, they should be in a horizontal plane. However, they can be used to obtain a desired rake. The bottom of the base plate should be no more than 2 times the diameter of the anchor bolt above the top of the concrete foundation.

(k) In the case of structures which utilize embedded base installation, typically the bottom (embedded) section of the pole is installed in the ground first. The specified embedment depth should be shown on the manufacturer's erection drawing.

3. Assembly:

(a) General

(i) Assembly of pole sections at site shall in general be conducted using hydraulic jacking devices and/ or suitable chain pulley blocks to achieve proper jacking force.

(ii) Where space near the foundation and lifting capabilities permit, it is preferable to assemble the complete structure on the ground and erect it as a unit. The sections of the pole should be aligned on the ground and supported, typically with wood blocks, in such a manner that they will readily fit together. Care should be taken to prevent dirt, stones, etc. from being trapped between the mating surfaces.

(iii) Proper alignment of the pole sections is facilitated by the location of the identification tags. These are positioned on the pole sections so that aligning them on the same side for the entire pole length will assure proper orientation of all conductor attachment points, arms attachments, camber, etc.

(iv) If the structure is assembled vertically, extra care may be needed to assure that all joints are properly assembled as indicated in the following paragraphs.

(v) Any work left incomplete at the end of day should be guyed/ anchored properly to avoid any damage and a warning notice be displayed.

(b) Slipover Joints

(i) To facilitate the assembly, mating surfaces may be lubricated. Care should be taken not to use a lubricant that will later leak from the joint and stain the pole. Soapy water can also be used successfully for this purpose.

(ii) Each identification tag is positioned to indicate maximum splice. The mating section should never exceed this position. In addition, this tag can be used to determine if minimum splice has been achieved.

(iii) A sound slip joint depends on the application of the necessary force to achieve a tight joint, although the method selected may depend upon the size of the pole sections, the type of pole design and the equipment available to the Contractor. It is recommended to use a hydraulic jacking device. Alternatively, two ratchet chain hoists or similar devices on opposite sides of the pole tube may be used provided adequate assembly forces can be achieved. Equal forces must be applied by the devices simultaneously. If the jacking nuts are used, forces must be applied no more than 1.5 inches from the surface of the pole and the forces must be distributed equally to all the nuts at each joint.

(iv) A tight, sound slip joint is dependent on meeting all of the following:

- The force used in assembly is at least the minimum value specified on the manufacturer's drawings.
- Any additional force applied to the joint does not result in additional movement of the joint.
- The overlap length is not less than the minimum length specified and is not more than the maximum length specified on the manufacturer's drawings.
- The joint shows no more than small gaps (which can be caused by slight mismatch in the shapes of the mating sections).

(v) Forces should be applied in a slow steady pull and the assembly be facilitated by oscillating the advancing section with the supporting crane or by striking the pole in the area of the joint with a hammer using a cushioning block of wood.

(vi) It should be ensured that galvanization on the external and internal surface of the pole does not get damaged.

(c) Bolted Joints

Any bolting instructions specifically provided on manufacturer's drawings will supersede these general guidelines.

(i) **Multiple-bolt, moment connections (e.g. arm-to-pole connections, flange connections):** Threads may need to be lubricated in the field in order to achieve bolt tension in accordance with American Institute of Steel Construction (AISC) recommendations.

(ii) **Single-bolt, pinned connections (e.g. swing brackets, cross-bracing, pinned cross arms):** The bolt head and the nut are snug against the outer plates and the locking device or nut is fully engaged. All plates do not need to be in contact.

(iii) **Anchor Bolts:** After plumbing the structure, all nuts should first be uniformly snug-tightened against the base plate. Then, some provision should be made to prevent unauthorized loosening of the nuts. The two most common methods are:

- A slight amount of additional tightening of each top nut.
- Peening of the threads.

(iv) **All connection bolts with diameters of 1.75 inches or more** should be snug-tightened until the bolt head and the nut are snug against the outer plates and the locking device or nut is fully engaged. All plates do not need to be in contact.

(v) **Cantilever Arms:** Before tightening the arm attachment bolts, the arm should be rotated toward the base of the structure to remove all play in the connection. While tightening the bolts, care should be taken to assure that the all arms remain in the same plane. Bolt tightening beyond the above recommended pretension is not required just to bring the connection plates into contact. A small gap between the arm bracket and connection vangs is acceptable.

(vi) **H-frame Structures:** Bolts in connections that are part of the frame assembly (i.e. not attachments of cantilever sections) should be left loose until all such bolts are installed. After all bolts are installed, the nuts should be tightened in the following sequence:

- Connections between main pole sections.
- Connections between cross-arms and poles.
- Connections between cross-braces and poles.
- Connections between cross-braces.

Care should be taken to maintain all alignments during this tightening operation.

(vii) Every flange joints shall be provided with copper or any suitable material bye-pass strip to facilitate continuous path for leakage/short circuit current/Lightening discharge current to ground to ensure safety both to human and animals.

4. Corrosion protection and storage:

(a) After assembly, any damage to the protective coating on the structure should be repaired.

(b) An on-going maintenance program must include periodic inspection for normal deterioration of the protective coating and for any indication of corrosion. Rehabilitation of the protective coating must be done to preserve the structural integrity of each assembly.

(c) Structures should not be stored longer than 6 months prior to use without a thoughtful storage maintenance and inspection program. The following recommendations should be considered for all stored sections:

(i) All stored structures should be kept well ventilated, which includes not allowing vegetation to grow in and around sections. Sections should be blocked off the ground and separated if sections are stacked on top of each other to provide air flow and ventilation.

(ii) Sections should be supported on wooden rafters while placing on the ground. Wooden blocks should be non-treated wood (wood treatments can be caustic to steel) and metal blocking should be coated (rusting of steel will stain the sections).

(iii) Remove all packing and shipping materials to avoid finish deterioration through holding moisture against the surface.

(iv) Provide proper inclination and orientation to allow free drainage of water, including any condensation inside the pole, so that it does not accumulate inside the pole or on outside surfaces.

(v) Rotation of the poles should be performed as necessary to equalize any finish aging and to assess the continued effectiveness of blocking and allowing good air flow ventilation inside & around the sections.

(vi) Space should be maintained between two sections to avoid white rust.

5. Erection

(a) Prior to lifting the structure, any slipover joint below the crane attachment point should be securely lashed to prevent any possibility of separation during lifting.

(b) The lifting crane must be attached:

(i) Above the center-of-gravity of the entire assembly including the weight of all equipment mounted on the structure before erection.

(ii) To the main pole member(s) or, if to the arms, the attachment(s) must be close to the pole(s).
(iii) As high as possible since higher attachment will result in more nearly vertical alignment of the assembly while suspended above the foundations.

(c) H-frame structures may require a spreader bar to achieve two points of attachment to the structure and to assure that all lifting forces are applied vertically.
(d) Care should be taken to operate the crane smoothly since movements inducing jolts will cause impact loads which could damage some portion of the assembly.
(e) At least a few anchor bolt & nuts should be installed as quickly as possible after the base plate is in place. If the pole is eccentrically loaded, such as in the case of arms on only one side of the structure, the nuts on the side opposite the direction of eccentricity should be installed first.
(f) The use of grout between the base plate and the concrete foundation is not recommended or structurally required. Galvanized structures require a method of drainage for any moisture that may enter the pole section and weathering steel structures should not have a surface that could hold moisture against the bottom of the base plate. If grouting under the base plate is used, it is critical that sufficient drainage is provided from the inside of the pole.

6. Protection from vibration:

Transmission structure components may be affected by vibrations induced aerodynamically or from other sources. Although rare, these vibrations can be severe enough to cause damage. This is believed to be more likely to happen when structures (or components such as arms) are installed without insulators and conductors which contribute damping to the system. It is considered good practice for installers to attach at least some equipment to each arm at the time of installation of the structure. The IEEE document, "Guide to the Assembly and Erection of Metal Transmission Structures", mentions the following methods:

(a) Suspending weights or insulators from the arms;
(b) Tying the arm tips together and to the structure.

Also, damping devices such as the Stockbridge type may be effective. In accordance with IS:1367/IS:12427 (latest revision) bolts and galvanized bolts shall not be reused. Touching up or re-tightening bolts that may have been loosened by the installation of adjacent bolts shall not be considered to be a reuse.

7. Installation:

Prior to installation, the fastener components shall be properly stored. For joints that are designated as snug-tightened joints, the bolts shall be installed in accordance with the section below.

Snug-tightened joints:

All bolt holes shall be aligned to permit insertion of the bolts without undue damage to the threads. Bolts shall be placed in all holes with washers positioned as required and nuts threaded to complete the assembly. Compacting the joint to the snug-tight condition shall progress systematically from the most rigid part of the joint. The snug-tightened condition is the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the nut and connection plate into firm contact.

8. Handling of material

a) Suitable capacity of Hydra Cranes or overhead cranes should be used for lifting.
b) Clean Nylon belts of appropriate capacity should be used for material handling.
c) Sections should be lifted with two nylon belts fixed at the extreme ends from the center of gravity for easy lifting.
d) Only one section should be lifted at time.
e) Welded accessories should not come under direct load.

Annexure-C

Minimum Safety Guide Lines

Annexure-C

Minimum Safety Guidelines

The provision in Central Electricity Authority (Measures Related to Safety and Power Supply) Regulations, Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Power Plants and Power Lines) Regulations and relevant Indian Standards should be followed during erection and stringing along with the following safety guidelines.

1. Use of Personal Protective Equipment (PPEs):

(a) No work at site should be without proper PPEs in place for all concerned.
(b) All workers are to wear Safety Helmets, Safety Shoes, Hand Gloves & Safety Jackets all the time while executing the work. Contractor's Supervisors will also have to wear Safety Shoes and Safety Helmets while in the field. Goggles & Masks to be used while working in dusty or highly polluted areas.

2. Working at height:

(a) Full body harness with double lanyard Safety Belts are to be used during working at heights above 1.5 m and secured with safety lifeline or any other rigid object/structure safely before starting the work. Also well-built ladders (properly secured at the base) can be used for working at height, where ladders can be used.
(b) Efforts should be made to assemble the poles & accessories on the ground only so that working on height can be avoided later.
(c) No work at height is to be carried out in case of inclement weather conditions such as rain, lightning, heavy winds, etc.
(d) Ensure use of tool belts/backpack to properly secure hand tools at all times.
(e) Ensure proper barricading of the drop zone to safeguard people at ground from any falling objects.

3. Proper demarcation & barricading:

(a) Safety barricading to be done around the working area from day one to safe guard against trespassing. "Men at work" board must be put to indicate work under progress in the vicinity. Barricading to be kept in place till the work is over, even if it takes few days to complete.
(b) No excavated pits/ loose soil areas should be kept open without barricading around the area.

(c) Also all storage area of materials near the working area has to be demarcated & barricaded properly.

4. Use of cranes & clings:

(a) Cranes with 20% factor of safety (i.e. cranes with a lifting capacity 20% higher than the weight to be lifted) are to be used.
(b) The crane should be operated by a licensed operator only.
(c) Operational fitness of the crane has to be checked before hiring the crane.
(d) The lifting hooks must have a safety lock in place to avoid slipping of the clings.
(e) The lifting capacity of the clings to be checked before starting of the work. The clings with 20% factor of safety in mechanical strength must be used for lifting.

5. Working near the existing power lines:

(a) No work to be taken up without proper shutdown while working in the existing power line or while working in the proximity of any existing power line.
(b) Work to be started only after the line (all the phases) is properly/securely earthed from both the ends and line clearance/work permit is issued by the concerned authority in writing.
(c) All the earthing points to be personally verified by Site Engineer of Contractor.
(d) No shutdown to be arranged over phone communication. Personal check is to be made for every shutdown and line clearance.
(e) The work under shutdown should be executed under direct supervision of a qualified supervisor/engineer of the Contractor only.

6. Material handling & work process:

(a) Poles and accessories to be stored in proper demarcated area and should be away from the routes/places of public use. Ensure adequate ingress & egress around the work area.
(b) While lifting or shifting the Poles/sections nobody should stay boarded on it.
(c) Proper/suggested tools & plants must be used for fixing & assembling to avoid accidents in the process. All the work must be supervised by experienced supervisor(s), who can guide the team in every activity.
(d) While lifting heavy poles with multiple sections, proper support clings (along the length of the pole) are to be provided from the

point of lifting cling to the bottom of the pole to avoid fall of sections due to malfunction of the slip joints.

(e) Any person under the influence of alcohol neither should be allowed to enter the work location nor should help in the work from outside by any means.

7. Working at night (After sun set):

(a) No work should be taken up once the day light is over.

(b) However if there is need to execute the work at night, proper/sufficient lighting to be arranged to cover the working area and the work should be executed under direct supervision of responsible/qualified supervisor only and prior intimation to the Purchaser representative in writing. The work group shouldn't be left alone to execute the work.

8. Emergency Response Plan:

(a) First aid boxes to be kept handy at sites. The Contractor's supervisor(s) must have the knowledge of first aid treatment to meet the exigency.

(b) Contact numbers for emergency help (e.g. Doctors, Hospitals, Ambulance services, Fire services, Police, etc.) available in the nearby areas to be kept displayed in the work site at all times.

(c) All incidents including the near misses to be noted down by the Contractor's supervisor(s) and reported to the concern authority. However, all major incidents/accidents causing **"**Lost Time Injuries**"** & **"**Medically Treated Injuries**"** should be intimated immediately and in no case more than half an hour of occurrence.

9. Tool Box Meeting:

(a) Tool Box Meetings to be conducted every day before starting of the work. Work Plan for the day along with hazards/risks involved in the activities and safe working practices for the same are to be discussed with the workers.

(b) Record of the Tool Box Meeting to be generated and signature of all the workers/supervisor are to be taken on the TBM sheet. This activity will gradually enhance the safety awareness and will also help in operating in a planned manner.

Annexure-D

Bidder's/Contractor's Guaranteed Data Sheet

Annexure-D

BIDDER'S/CONTRACTOR'S GUARANTEED DATA SHEET

BIDDER'S/ CONTRACTOR'S GUARANTEED DATA		Unit	Data offered for poles
(I)	**General**		
(i)	Nominal voltage	kV	
(ii)	Highest system voltage for equipment	kV	
(iii)	Frequency	Hz	
(iv)	Rated lighting impulse withstand voltage	kV peak	
(v)	Rated switching impulse withstand voltage (for 400 kV and above)	kV peak	
(vi)	Rated short duration power frequency withstand voltage	kVrms	
(vii)	System neutral (effectively earthed/ unearthed)	-	
(viii)	System short-circuit level & duration	kA & sec	
(ix)	Short circuit current & duration for thermal stability check of the OPGW	kA & sec	
(x)	Minimum Specific creepage distance based on highest system phase to phase	mm/kV	
(xi)	Radio Interference Voltage	μV	
(II)	**Main Design Parameters**		
(i)	Maximum ambient air temperature	^{0}C	
(ii)	Minimum ambient air temperature	^{0}C	
(iii)	Maximum conductor operating temperature to be considered for design (for sag tension calculation)	^{0}C	
(iv)	Every day temperature	^{0}C	
(v)	Temperature with maximum wind	^{0}C	
(vi)	Wind Zone and basic Design wind speed	m/s	
(vii)	Terrain Category		
(viii)	Reliability level		
(ix)	Wind span	m	
(x)	Weight span max	m	
(III)	**Line Data**		
(i)	Number of circuits	-	
(ii)	Number of conductors per phase	-	
(iii)	Number of OPGW	-	
(iv)	Number of earthwire	-	
(v)	Conductor Details	-	

	[Type of conductor, no. of sub-conductors per phase, Overall Diameter, stranding & wire diameter for Al/Al alloy & steel, weight per km, UTS, resistance per km, modulus of Elasticity, coefficient of linear expansion]		
(vi)	Earthwire & OPGW details [Overall Diameter, stranding & wire diameter, weight per km, UTS, resistance per km, modulus of Elasticity, coefficient of linear expansion]	-	
(IV)	**Types of Poles (Specify data for all types of poles)**		
(i)	Angle of deviation		
(ii)	Type of Insulator sets		
(iii)	Wind Span	m	
(iv)	Weight span	m	
(v)	Maximum span	m	
(vi)	Total weight of pole for Basic/normal height pole and extension poles	kg	
(V)	**Corrosion protection measures**		
(i)	Average weight (gm/m^2) and thickness (microns) of Zinc coating on Pole Structure & Parts		
(a)	Plates & Section below 5mm		
(b)	Plates & Section above 5mm		
(ii)	Galvanizing of bolts, nuts & washers	µm	
(VI)	**Main Design Data**		
(i)	Minimum partial factors		
(ii)	Partial factors for actions		
(iii)	Deadweight		
(iv)	Wind for normal conditions		
(v)	Conductor tension for normal conditions		
(vi)	Conductor tension for exceptional conditions		
(vii)	Erection/maintenance loads		
(viii)	Partial material factors(M)		
(ix)	Steel poles cross section areas		
(x)	Steel poles net section areas at bolt holes		
(xi)	Support bolts		
(xii)	Reinforcing steel for concrete foundations		
(xiii)	Foundation in-situ concrete structure		
(xiv)	Soil property		
(xv)	Conductors for maximum wind load		
(xvi)	Conductors for everyday conditions		
(xvii)	Insulators for normal conditions		
(xviii)	Insulators for exceptional conditions		

(xix)	Fittings for normal conditions		
(xx)	Fittings for exceptional conditions		
(VII)	**Clearances**		
(i)	**Minimum vertical clearances** (Minimum vertical clearances from the line conductors at maximum sag ground or for various crossings)		
(a)	Normal ground	m	
(b)	Ground in populated areas	m	
(c)	Roads and streets	m	
(d)	To residential or other buildings	m	
(ii)	**Minimum Horizontal clearances**		
(a)	Roadside (sidewalk of paved roads)	m	
(b)	Roadside of unpaved roads- depending on area	m	
(c)	Railway track axis	m	
(d)	Parallel running power lines	m	
(e)	Pipelines	m	
(iii)	**Mid-span clearances**		
(a)	Mid-span phase to phase clearance for horizontal phase arrangement	m	
(b)	Mid-span phase to phase clearance for quasi-vertical phase arrangement	m	
(c)	Mid-span phase to phase clearance for quasi-vertical wire phase arrangement	m	
(iv)	**Minimum clearances between conductors/live fittings and pole steel structure**		
(a)	Between conductors under still air condition	m	
(b)	Clearance between live parts and earthed Pole parts in still air	m	
(c)	Clearance under swung insulator string due to maximum wind on conductor	m	
(v)	**Clearance condition for earthwire / OPGW**		
(a)	EW/OPGW sag, compared to the conductor sag at every day temperature for the nominal span	-	
(b)	Shielding angle		
(VIII)	**Foundations**		
	Soil Data (for Bidding only) The foundations will be designed on the basis of the soil investigations performed by the Contractor. As soil investigations is not complete, the bid shall be based on the soil		

	characteristics given below		
(a)	**Class 1 - Hard rock**		
	Density	kN/m^3	
	Soil pressure	kN/m^3	
	Shear friction resistance	kN/m^3	
(b)	**Class 2 - Soft rock**		
	Density	kN/m^3	
	Soil pressure	kN/m^3	
	Angle of frustum		
(c)	**Class 3 - Good Soil**		
	Density	kN/m^3	
	Soil pressure	kN/m^3	
	Angle of frustum		
(d)	**Class 4 - Poor Soil, no Water**		
	Density	kN/m^3	
	Soil pressure	kN/m^3	
	Angle of frustum		
(e)	**Class 5 - Poor Soil, with Water (submerged)**		
	Density without groundwater	kN/m^3	
	Density with groundwater	kN/m^3	
	Soil pressure	kN/m^3	
	Angle of frustum		
(f)	**Class 6 - Very Poor Soil, with Water (submerged)**		
	Density	kN/m^3	
	Soil pressure	kN/m^3	
	Angle of frustum		
(g)	**Backfill (good soil)**		
	Density (compacted)	kN/m^3	
	Angle of frustum		
(IX)	**Poles General information and data**		
(a)	Material used for all Pole parts		
(b)	Bolts and nuts standard for poles		
(c)	Bolts and nuts qualities for poles		
(d)	Step bolt diameter (min.)	mm	
(e)	Permissible stresses of structural members, bolts and nuts correspond with	-	
(f)	Bolt connections secured with washers and spring washers		
(g)	All Pole steel parts hot dip galvanized	Yes/No	
(h)	Zinc coat for steel sections for bolts and nuts	µm	
(X)	**Quality and tests correspond with**		

	Welding qualification	-	
	Welding quality	-	
(XI)	**Min. diameter and number of bolts**		
	Bolt diameter	mm	
(XII)	**Tolerances for poles**	**-**	

Annexure-E

Standard Manufacturing Quality Plan

Sl No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling rate	Reference document/ Standard	Acceptance norms	Category of Responsibility			Remarks
						Sub-Vendor	Manufacturer	Purchaser	
1	**RAW MATERIAL**								
1.1	**STRUCTURAL STEEL (ANGLE SECTIONS, RODS, CHANNELS, FLATS, PLATES)**								
1.1.1	**Mechanical Properties**								
1.1.1.1	Yield Stress	Mechanical	2 Samples for per cast/heat size up to 100 MT 3 Samples for per cast /heat size between 100-200 MT 4 Samples for per cast/heat size over 200 MT	IS: 2062/Relevant Standard as mentioned in technical specification	IS: 2062/Relevant Standard as mentioned in technical specification	-	P	V	
1.1.1.2	Ultimate Tensile Strength	Mechanical				-	P	V	
1.1.1.3	Percentage Elongation at 5.65√Area	Mechanical				-	P	V	
1.1.1.4	Bend Test	Mechanical				-	P	V	
1.1.1.5	Impact Test (if applicable)	Mechanical	1 sample per section per lot for each source	IS: 2062/Relevant Standard as mentioned in technical specification	IS: 2062/Relevant Standard as mentioned in technical specification	-	P	V	
1.1.2	**Chemical properties**								
1.1.2.1	Chemical Analysis	Chemical	100% on each coil and plate (1 No. for each coil if material is manufactured in coil form and 1No. for each Plate, if material is manufactured in Sheet Form)	IS: 2062/Relevant Standard as mentioned in Technical specification	IS: 2062/Relevant Standard as mentioned in technical specification	-	P	V	
1.1.3	**Visual Inspection**								
1.1.3.1	Visual	Visual	One sample for 50 MT / Section or Part Thereof	IS: 2062/Relevant Standard as mentioned in Technical specification	Material to be free from surface defects like laminations, rough/jagged and imperfect edges, cracks, rounded apex, deep roll marks, pipy and any harmful defects	-	P	V	

Sl No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling rate	Reference document/ Standard	Acceptance norms	Category of Responsibility			Remarks
						Sub-Vendor	Manufacturer	Purchaser	
1.1.4	**Dimensional Inspection**								
1.1.4.1	**Plates**								
1.1.4.1.1	Weight Tolerances	Unit Weight Test	One sample for 50 MT / Section or Part Thereof	IS 1852 / IS 1730	+5%, -2.5% over weights specified in IS 1730	-	P	V	
1.1.4.1.2	Thickness Tolerance	Measurement		IS 2062 IS 1730 / IS 1852	(i) For < 8 mm thick: -- + 12.5 %, - 5 % (ii) 8 mm to 12 mm:-- + 7.5 %, - 5 % (iii) over 12 mm :-- ± 5 %	-	P	V	
1.2	**Zinc**								
1.2.1	Chemical Composition	Chemical	Every Consignment	IS 209/IS 13229	IS 209/IS 13229	P	V	-	
			One sample for 100MT or Part thereof	IS 209/IS 13229	IS 209/IS 13229	P	V	-	
			One sample of molten zinc taken from bath per quarter	IS 209/IS 13229	Min Zinc purity 98.5%	P	V	-	
1.3	**Zinc Wire for Metallization (Make: Metallizing Equipment Company)**								
1.3.1	Chemical Composition	Chemical	One Sample per Batch		Min. Zinc Purity 99.9%	P	V	-	
2	**IN-PROCESS INSPECTION**								
2.1	**Fabrication of Monopole: Pole segments, as far as possible shall be fabricated in single piece. In case of restriction due to the size of Hot Dip Galvanizing bath, segments in two or more parts may be fabricated in line with the relavant clause of Technical Specification**								
2.1.1	Cut to Length	Dimensional	1st piece and every 50th piece	IS 802 Part II/ IS 7215/ Utility approved Drawings., Shop Sketches	As per cutting plan/ ± 5 mm on either sides./Utility approved Drwg., Shop Sketches	-	P	V	
2.1.2	Shearing	Dimensional			As per cutting plan/ ± 2 mm on either sides./ Utility approved Drwg., Shop Sketches	-	P	V	
2.1.3	Profile cutting	Dimensional			As per cutting plan/ ± 2 mm on either sides./ Utility approved Drwg., Shop Sketches	-	P	V	
2.1.4	Stamping	Visual	100%		As per Drawing; Shall be clear and visible stamping	-	P	V	

Sl No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling rate	Reference document/ Standard	Acceptance norms	Category of Responsibility			Remarks
						Sub-Vendor	Manufacturer	Purchaser	
2.1.5	Punching/Drilling/Hole cutting	Dimensional	5%		Hanging Holes +/- 3 mm; Other Holes : +/- 1.5 mm / As per Utility approved Drwg., Shop Sketches	-	P	V	
2.1.6	Bending	Dimensional	1st piece and every 50th piece		+/- 3 Degree/ Utility approved Drwg., Shop Sketches	-	P	V	
2.1.7	**Welding**								
2.1.7.1	(a) WPS Approval (Welding procedure specification) (b) PQR/WQR Approval (Procedure /Welder qualification record)			As per Technical specn./approved Drawing/Utility approved Welding procedure & Welder`s qualification		-	P	V	WPS and Welder's qualification Approval by Utility
2.1.7.2	Check for Blow Holes	Visual	100%	Utility approved Drwg. / AWS D1.1	Utility approved Drwg. / AWS D1.1	-	P	V	
2.1.7.3	Check for Undercut	Visual	100%	Utility approved Drwg. / AWS D1.2	Utility approved Drwg. / AWS D1.2	-	P	V	
2.1.7.4	Check for Discontinuity	Visual	100%	Utility approved Drwg. / AWS D1.3	Utility approved Drwg. / AWS D1.3	-	P	V	
2.1.7.5	Bead thickness	Measurement	100%	Utility approved Drwg. / AWS D1.4	Utility approved Drwg. / AWS D1.4	-	P	V	
2.1.7.6	Dye-Penetration Test / Ultrasonic Test	Visual	100%	As per ASME SEC V & SEC VIII / AWS D1.1	As per ASME SEC V & SEC VIII / AWS D1.1	-	P	V	Ultrasonic Test will be performed in black/un-galvanized condition. (10mm and above thickness)
2.1.7.7	Magnetic Particle Test (MPI)	Visual	25%	Utility approved Drwg. / AWS D1.1	Utility approved Drwg. / AWS D1.1	-	P	V	
2.1.8	Straightening	Dimensional	100%	Utility approved Drawing	Height/600 ie. FOR 10 MTR Section ie, 16MM	-	P	V	
2.1.9	Dimensions of Sections and Accessories	Dimensional	100%	Utility approved Drawing	Utility approved Drawing	-	P	V	

Sl No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling rate	Reference document/ Standard	Acceptance norms	Category of Responsibility			Remarks
						Sub-Vendor	Manufacturer	Purchaser	
2.1.10	Final Inspection of Fabricated Parts		100%	All parameters from 2.1.1 to 2.1.9 above are checked and record maintained before releasing the material for galvanizing.	Utility approved Drwg. / AWS D1.4	-	P	V	
2.2	**Galvanizing**								
2.2.1	Degreasing	Chemical	One sample daily	IS 2629	Manufacturer's plant standard/Relevant IS	-	P	V	
2.2.2	Pickling	Chemical	One sample daily	IS 2629	Manufacturer's plant standard/Relevant IS Iron contents 100 to 120 gram/litre. Max	-	P	V	
2.2.3	Rinsing	Chemical	One sample daily	IS 2629	Manufacturer's plant standard/IS	-	P	V	
2.2.4	Pre Fluxing	Chemical	One sample daily	IS 2629	IS 2629	-	P	V	
2.2.5	Pre-heating	Measurement	One Check per day	IS 2629	IS 2629	-	P	V	
2.2.6	Dipping After drying is over the material is dipped in molten zinc. Following parameters are controlled					-	P	V	
2.2.6.1	Zinc bath temperature Recording is done by graphical manner or sensors with digital display		Hourly Check	IS 2629	450+/-10° C	-	P	V	
2.2.6.2	Immersion & Withdrawal time. Degree of immersion and withdrawal time is decided based on thickness and length of material		Hourly Check	IS 2629	IS 2629	-	P	V	

Sl No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling rate	Reference document/ Standard	Acceptance norms	Category of Responsibility			Remarks
						Sub-Vendor	Manufacturer	Purchaser	
2.2.7	Quenching in Running Water: After dipping the material is quenched in running water			IS 2629	IS 2629	-	P	V	
2.2.8	Dichromating : After quenching, material is dipped in sodium dichromatic solution to avoid the white rust.(Proprietary Chemicals.)		One Sample daily	IS 2629	IS 2629	-	P	V	
2.3	**Galvanizing Check**								
2.3.1	Visual Checking	Visual	100%	IS 2629	Surface to be free from defects like bare / black spots, (except when small and suitable for patching) heavy ash & flux inclusions, lumps, pimples, runs etc	-	P	V	*For monopole to be installed in Coastal area, Coating Thickness shall be ≥5mm=127 micron, <5mm & plate=87 micron *For marine, ≥5mm=900gm/ m², <5mm & plate=610 gm/ m²
2.3.2	Thickness of Zinc coating	Measurement	100%	IS 4759 (BSEN ISO 1461)	The minimum average zinc coating for all section shall be 87 microns for thickness ≥ 5 mm & 65 microns for thickness < 5mm and for plates	-	P	V	
2.3.3	Weight of Zinc Coating*	Measurement	25% samples / shift	IS 4759 / IS 6745	(a) For thickness below 5mm, but not less then 2 mm and for plates- Average Mass of Coating -460gm/m² (b) For thickness 5mm & above – Average Mass of Coating - 610 gm/m²	-	P	V	
2.3.4	Uniformity of Zinc coating*	Measurement	25% samples / shift	IS 2633	Material to withstand 4 dips of one minute each without showing signs of copper deposits	-	P	V	
2.3.5	Adhesion Tests of Zinc coating*	Pivoted Hammer Test	25% samples / shift	IS 2629	No removal or lifting of coating in areas between hammer impressions	-	P	V	
	***Testing to be done on Coupon Samples associated with structures except for Thickness of Zn coating (checked by Elcometer) which shall be checked on sections**								

Sl No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling rate	Reference document/ Standard	Acceptance norms	Category of Responsibility			Remarks
						Sub-Vendor	Manufacturer	Purchaser	
2.4	**Metallization**								Pole segments, as far as possible shall be fabricated in single piece. In case of restriction due to the size of Hot Dip Galvanizing bath, segments in two or more parts may be fabricated/metallization be carried out in line with the clause of Technical Specification. Base Plate and shaft will be Galvanized separately and after welding. Metallization will be performed on welded area of Base Plate, Shaft and Gussets.
2.4.1	Surface Preparation	Visual	100%		Sweep blasting Surface	-	P	V	
2.4.2	Application of Hot Zinc Spray though Zinc Wire		100%		Manufacturer's Plant Standard/ Metallizing Equipment Catalogue	-	P	V	
2.5	**Metallization Inspection**								
2.5.1	Thickness of Zinc coating by Elcometer	Measurement	100%	IS 4759	For thickness 5mm & above – Avg. Thickness of zinc Coating - 87 Microns	-	P	V	*For Coastal area, ≥5mm=127 micron, <5mm & plate=87 micron
3	**FINAL INSPECTION AND TESTING (Inspection Engineer to ensure/check compliance of Notes/general requirements mentioned in the MQP)**								
3.1	Visual and Dimensional Inspection: For Fabrication (as per approved Drawing) & Galvanizing	Visual & Measurement	One sample for Every 50 MT/ section/Lot or part thereof	Please refer Sr. No 2.1.1 to 2.1.9 /Utility's approved drawing	Please refer Sr. No 2.1.1 to 2.1.9 /Utility's approved drawing	-	P	W	

Sl No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling rate	Reference document/ Standard	Acceptance norms	Category of Responsibility			Remarks
						Sub-Vendor	Manufacturer	Purchaser	
3.2	Mechanical Properties (Coupon test samples to be taken during cutting for structure)								
3.2.1	Yield Stress Test	Mechanical	One sample for Every 50 MT/ section/Lot or part thereof	Please Refer (for test values) Sr. No. 1.1.1.1 to 1.1.1.5	Please Refer (for test values) Sr. No. 1.1.1.1 to 1.1.1.5	-	P	V/W	**Coupon Test sample during cutting of plates,rods, channels,flats for welded items only)**
3.2.2	Ultimate Tensile Strength	Mechanical							
3.2.3	Percentage Elongation at 5.65√Area	Mechanical							
3.2.4	Bend Test	Mechanical							
3.2.5	Impact Test (if applicable)	Mechanical							
3.3	Chemical Properties	Chemical	One sample per section	IS: 2062/Grade as mentioned in Technical Specification	IS: 2062/Grade as mentioned in Technical Specification	-	P	V/W	**(For Chemical Properties, agency shall not cut the hole 100% during cutting of lifting holes. Sample for chemical composition shall be taken by Purchaser representative before / after galvanizing by cutting the hole completely)**
3.4	Galvanizing Tests*								
3.4.1	Thickness of Zinc Coating (Galvanizing coating check by Elcometer)	Chemical	One sample for Every 50 MT/ section and part thereof	IS 2629/IS 4759/IS 6745/IS 2633/ (BSEN ISO 1461)	Please refer Sl. No. 2.3	-	P	W	
3.4.2	Weight of Zinc Coating	Chemical							
3.4.3	Uniformity of Zinc Coating	Chemical							
3.4.4	Adhesion Test of Zinc Coating	Chemical							
3.5	Packing, Storing, Bundling and Handling		100%		IS802/Technical specn./Packing list to be submitted along with dispatch documents				

Sl No.	Components/Operations & Description of Test	Type of check	Quantum of check/ Sampling rate	Reference document/ Standard	Acceptance norms	Category of Responsibility			Remarks
						Sub-Vendor	Manufacturer	Purchaser	
*Testing to be done on Coupon Samples associated with structures except for Thickness of Zn coating (checked by Elcometer) which shall be checked on sections.									

Notes:

P: PERFORM V: Verify W: Witness

1	The MQP should be read in conjunction with Technical specification and shall deem to include additional tests, if any required as per contract between Purchaser & Manufacturer.
2	In case of any contradiction between MQP and Utility'sTechnical specification/Approved Drawing, the Technical specifications/Approved Drawing of respective project shall have precedence over this MQP.
3	All bought out components /fasteners to be procured from Purchaser approved vendors as per their standard/respective manufacturing quality plan approved by Purchaser/relevant IS.
4	Valid calibration certificates of various testing and measuring instrument / equipments from NABL accredited Labs.
5	In case of any test being carried out at the third party lab, the same should be NABL acredited.
6	The manufacturer shall maintain the proper co-relation of test certificates from raw material stage to finished product stage and the records should be available during inspection by Purchaser. In absence of proper correlation of test certificates of Raw Material, actual testing to be done during Final Inspection.
7	The manufacturer should progressively align their Quality system and sub-vendors Quality system to the requirements of ISO 9000 series Quality standards and in due course of time should get their quality system certified to ISO 9001.
8	Grades of steel used as well as the relevant standards it is conforming to, shall be as per the approved Drawings/ BOM for the specific contract and the same shall be indicated in the offer list at the time of inspection.
9	Pieces of light sections to be wire bundled and those of heavy sections to be supplied loose. Stacking to have proper ventilation and kept inclined. Damage to galvanization coating to be avoided while handling. The manufacturer to ensure sequential supplies and other details as per Purchaser Technical Specification
10	In case monopole part is to be used at sub zero temperature, Impact testing at -20° C shall be carried out during final inspection in line with IS/ Technical Specification.
11	Welding procedure and Welder's performance qualification approval by Purchaser is required in case welding is involved at any stage of fabrication/erection.
12	All Welding procedures, qualification of welders, operators and procedures, electrodes, preheat, notch toughness and minimum yield of the electrodes needs to be ensured in conformance with the requirements of the latest revision of American Welding Society Structural Welding Code (ANSI/AWS D1.1) or other equivalent National/International standards. Preheating shall be done according to the ANSI/AWS code or the steel producers' recommendations or both.
13	All relevant standards shall be read along with the latest amendments.
14	Purchaser may review the effective implementation of the process during the product inspection/process inspection. In case of any violation in process or process parameters are observed, the reason along with corrective & preventive measure shall be conveyed to Purchaser

Annexure-F

Field Quality Plan

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
1.	Preliminary /Detailed Survey	a) Route alignment	Optimization of route length	a. Preliminary survey. b. Topographical /Digitized maps. c. Pole structure spotting data given by Utility	Contractor	100% at Field	100% based on record documents
		b) Route profiling & tower spotting.	1. Ground clearance. 2. Cold wt. Span 3. Hot wt. Span 4. Sum of Adj. Span (wind span) 5. Angle of Deviation. 6. Suitability of Pole structure spotting in hilly area	a. PLS CADD/Sag template b. Pole structure Spotting data c. Route alignment	Contractor -do- -do- -do- -do- -do-	100% at Field -do- -do- -do- -do- -do-	100% based on ref. documents -do- -do- -do- -do- Verification of 100% at Field
2.	Check Survey	Pole structure Location & Final Length	1. Route Alignment 2. Final Length. (Span/Section) 3. Angel of deviation & pit marking	a. Route alignment b. Pole structure Schedule c. Profile	Contractor -do-	100% at Field -do-	i) All angle Poles in plains and 50% in hilly terrains. ii) Final length to be checked on 100% basis based on records/documents. iii) 20 % test check at site for physical verification.
3.	Geotechnical Studies (Detailed Soil	a) Bore log	1. Depth of bore log 2. SPT Test	As per technical Specification	Contractor (Soil testing agency	100% at Field	To witness 20% at Field by Purchaser/Utility

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
	Investigation)		3. Collection of samples		approved by Utility/ Purchaser)		representative
		b) Tests on samples	As per tech. Specs.	As per Technical Specification	Contractor (Testing in Laboratory of soil testing agency approved by Utility/Purchaser)	1. 100% by testing lab (Reports to be signed by Testing agency person.) (Reports to be signed by Testing person.) 2. Recommendation part of soil testing report to be signed by contractor. 3. Jointly signed field data should be attached with the report.	Review of soil testing report by Utility/Purchaser
		c) Special foundations	As per tech. Specs	As per Technical Specification	Contractor (Testing in Laboratory of soil testing agency approved by Utility/Purchaser)	100% by testing lab (Reports to be signed by Testing person & Checking person)	Review of soil testing report by Utility/Purchaser
4	Revetment	RR Masonry	1. Size of Stone	CPWD Specification.	Contractor	100% physical verification	Physical verification on random basis
			2. Cement : Sand ratio in mortar	As per Technical Specification	Contractor	100%	Physical verification in random

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
5	Benching	Checking of Reduced Level	1. Reduced Level 2. Contour map with detailed Calculation	As per approved drawings	Contractor	100%	100% by Site Engineer and 20% by Line In-charge
6.	**Monopole Foundation**	**I) Materials** a). Cement	1. Brand approval	Cement of Purchaser/ Utility approved brands may be procured and validity of BIS license to be ensured.	Contractor	100%	Any new brand cement proposed by Contractor shall be assessed by Purchaser/ Utility .
			2. Physical tests	As per document at Annexure-I of this FQP	Contractor (Samples to be taken jointly with Purchaser/ Utility and tested at Purchaser/ Utility approved lab	Review of 100% Material Test Certificates (MTC) and one sample for every week number of manufacturer.	100% review of lab test results and MTC.
			3. Chemical Tests Chemical composition of Cement	-do-	Contractor to submit MTC	Review of all MTC's	100% review of MTC test results
		b). Reinforcement Steel	1. Source approval	May be procured either from producers directly or through the authorized dealers who can produce MTC from producers with traceability. Refer Purchaser/ Utility approved list of producers of reinforcement steel and validity of BIS license to be ensured.	Contractor	As proposed by contractor.	Material shall be supplied from Producers / authorized dealers.

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
				Also refer approved list of Cut & Bend suppliers			
			2. Physical and Chemical analysis test	As per Annexure-2 of this FQP	Contractor to submit MTC	100% MTC's One sample* / 300MT / Manufacturer shall be jointly sealed by Purchaser/Utility and tested at Purchaser/Utility Approved Lab. * **Note: All sizes of 10mm and above shall be taken for testing in every 300MT.**	100% review of MTC. 1) Review of Lab test results. 2) Unit weight of three samples to be witnessed.# #
		# # Three samples of each size of Reinforcement steel (all sizes of 10mm & above) out of 100MT steel Lot need to be physically weight at site in presence of Purchaser/ Utility representative to ascertain their acceptance as per technical specification. The weighted samples at site may be kept under custody for three months for further examination by any auditing authority (if required).					
		c). Coarse Aggregates	1. Source approval	Source with materials meeting Technical Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the test results of Joint samples tested at Purchaser/ Utility approved Lab.	To review the proposal based on the documents
			2. Physical tests	As per document at Annexure-3 of this FQP	Samples to be taken jointly and tested in Purchaser/ Utility approved lab	One sample per **1000** cum or part thereof per source for 765KV & above TL and One sample per **500** cum or part thereof per source for 500KV & below TL ,	100% review of lab test results.

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
						Samples to be tested by Contractor in Purchaser/ Utility approved lab.	
		d). Fine aggregate	1. Source approval	Source with materials meeting Technical Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the results of Joint samples tested in Purchaser/Utility approved lab.	To review the proposal based on the documents.
			2. Physical test	As per Annexure-4 of this FQP	Samples to be taken jointly and tested in Purchaser/Utility approved lab	One sample per **1000** cum or part thereof per source for 765KV & above TL and One sample per **500** cum or part thereof per source for 500KV & below TL , Samples to be tested by Contractor in Purchaser/ Utility approved lab	100% review of lab test results.
		e). Water	1. Cleanliness (Water shall be fresh and clean)	Technical Specification	Contractor	100% visual check at Field	Verification at random
			2. Ph Value	- do -	Contractor At site with calibrated Ph meter or any other approved method	One sample per source	100% review of the field test results Ph not less than 6

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
		II) Foundation Classification	1. Visual observation of soil strata 2. Ground water level 3. History of water table in adj. Area/surface water 4. Soil Investigation wherever required	Technical Specification	Contractor	100% at Field	100% at Field
	III) Concrete Works **A)Before concreting**						
		a). Bottom of excavated pit	Pit dimensions	Construction Drgs.	Contractor	100% at Field	100% check by Purchaser/ Utility
		b).P.C.C Grade , thickness & Size	Completeness	IS 456 and Purchaser/ Utility approved construction drawings & specification.	Joint Inspection by Purchaser/ Utility and CONTRACTOR	For all locations	For all locations
		c). Stub setting	1) Centre Line	Construction Drgs	-do-	-do-	-do-
			2) Diagonals and back to back	-do-	-do-	-do-	-do-
			3) Level of stubs	-do-	-do-	-do-	-do-
		d). Frustum box quality and measurements	Dimensions Placement	-do-	-do-	-do-	-do-
		e) Reinforcement steel		Bar bending schedule.	Contractor	100%	Checking of record 100% and physical verification in Random
		f). Rod Type Earthing	Dia. and length of the rod.	Technical specification and approved construction			

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
				drawings. Photograph of GPS enabled camera			(At least 5% locations shall be cross verified at random with respect to stub setting and reinforcement steel placement.)
		g). Concrete mix proportion (Applicable for Design Mix)	Ratio of mix proportion	Approval of Design Mix submitted by contractor based on inputs furnished by Purchaser/ Utility as per Annexure- 6 of this FQP.	Contractor	100%	100%
	B) During concreting	a). Workability	Slump test as per IS 1199	Range 25 mm to 75 mm refer document at Annexure-5 of this FQP	Contractor	Minimum Two per day per location, preferably one at the start of concreting	check at random
		b). Concrete Strength	Cubes Comp Strength	As per Technical Specifications & as per Annexure-5 of this FQP	Contractor Casting of cubes at site. Cubes to be tested for 28 days strength at / Purchaser/ Utility Lab/At site (if testing machine installed by contractor is duly calibrated by NABL Lab.)/ Purchaser/ Utility approved Lab. Cubes at 100% location are to be taken in presence of Purchaser/Utility officials.	**<u>Nominal Mix</u>** One sample of 3 cubes in each tower locations if all the legs are cast continuously without interruption. If otherwise, additional 3 cubes to be taken for every subsequent continuous casting case. It is to be ensured that in every case 3 cubes shall be selected in such a way that one each from start, middle and end of the casting process.	Normally testing shall be carried out at the Purchaser /Utility in-house cube testing facility. Alternatively, samples shall be tested at cube testing facility installed by contractor at Purchaser/ Utility premises, in the witness of Purchaser/utility representative.

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
					Cubes molds should be of ISI marked.		Lastly at Purchaser/ Utility approved Labs **NOTE: The efforts shall be made to carry out 100% cube testing in the in-house cube testing facility.**
				IS 456		**<u>Design Mix</u>** One sample of 3 cubes in each tower locations if all the legs are cast continuously. If otherwise, additional 3 cubes to be taken for every subsequent continuous casting case. However, In case of concrete supplied by RMC, one set of 3 nos. of cubes for every 50 cum or part thereof for each day of concreting and 28 days compressive strength shall be tested. *NOTE: Apart from cube testing, the CORE testing on casted foundations shall be carried out on 5% of total*	Utility/Purchaser to witness testing on 20% samples and also to review 100& test results.

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
						locations. For one location, any one leg shall be tested on sampling basis. The sampling should be planned in such a way that the locations are tested within 45 days after casting .Utility/Purchaser to decide the sample locations to be tested.	
		c). Anti-Corrosive paint on foundation	Portion of Pole foundation to be painted	Technical Specification	Contractor	100% at Field	20% on random basis
	C) After Concreting	a) Curing, Back filling & leveling of filled up soil	Compliance & Completeness	As per Technical Specification	Contractor	100%	100%
		b) Back to back, level and diagonals to be checked by Total Station and recorded in JMC	Dimension Check	As per Technical Specifications & approved drawings	Contractor	100% at Field	Random check & 100% verification of records
		c) Application of Bituminous paint on foundation	Visual check and quantity	As per Technical Specifications & approved drawings	Contractor	100% at Field	Random check & 100% verification of records
		NDT/Core Tests	UPV and Rebound Hammer /Core	As per Purchaser/Utility's Standard procedure for Testing/Assessment of compressive strength of casted Concrete			
7.	**Monopole Erection**	a). Materials for Monopole	Visual checking for 1. Stacking	Approved Drawings./BOM	Contractor	100% at stores	100% verification of records

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
		Sections bolts & nuts/washers/accessories	2. Cleanliness 3. Galvanizing 4. Damages				
		b). Erection of Monopole	1. Assembling of Monopole	As per Appd. Drgs./Purchaser/Utility specification	Contractor	100% at field	Random
			2. Sequence of erection	As per Appd. Drgs./ Purchaser/Utility specification	Contractor	100% at field	Random
			3. Check for completeness (Missing, hanging, bend etc)	As per Appd. Drgs./ Purchaser/Utility specification	Contractor	100% at field	25% by Site Engineer and Random by Site Incharge
			4.Erection of structures	As per Appd. Drgs./ Purchaser/Utility specification	Contractor Only winches will be allowed to secure the safety and construction ropes when erecting the structures. The erection will be performed with the help of cranes with telescopic boom	100% at field	Site Engineer
			5. Tightening, missing nuts and bolts	As per Appd. Drgs./ Purchaser/Utility specification	Contractor	100% at field	25% by Site Engr and random by Site In charge.
			6. Check for verticality	-do-	-do-	-do-	-do-

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
8.	**Earthing**	Installation of Earthing	Earthing Footing Resistance Test.	1.As per Purchaser/ Utility approved drawing and Technical Specification (TS)	Contractor 1. The earthing of the pole shall be in line with TS. . 2. The underground earthing for the Pole structures shall only be finalized once the footing resistance have been carried out. 3. The terminal structures will be bonded to the substation's main earth grid. 4. At all electrified railway crossing and metal pipelines, the line's earth conductor will be isolated from the structure for ±800m on both sides of the crossing	100% at Field 100% at Field	20% locations to be verified 100% verification of records
		Pipe Type	Salt & charcoal	As per approved drawings	Contractor	As above	Checking of record 100% and physical verification in Random
9	**Stringing**	**I. Materials**					

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
		a) **Insulators**	1. Visual check for cleanliness/glazing/cracks/and white spots.	As per Purchaser/Utility Specification, approved drawings	Contractor	100% at Field	100% verification of records and to carry Physical verification random checks on 10%
			2. IR Value Only for Disc Insulators	Minimum acceptable value 2000 Mega ohm	-do-	Test shall be carried on 100% insulators using 5/10 kV (DC) Megger	100 % by Contractor and record review by Purchaser/Utility and joint witnessing by Purchaser/ Utility on 05% insulator
			3. Traceability (Make/batch No./Locations where installed)	Packing list	Contractor	100% at field	100% Review of records
		b) Conductors	On receipt, 1. Visual check of drum.	Packing list	Contractor	100% at stores	100% Review of records
			2. Check for seals	-do-	-do-	-do-	-do-
			3.Check depth from top of flange to the top of the outer most layer 4. Greasing/Lay Ratio Tests 5. Packing	As per Purchaser/Utility specification, approved drawing	Contractor The line conductor shall be supplied on returnable steel drums or non-returnable wooden drums. Drums shall be marked with the length of the conductor on the drum and also with an arrow to show the correct	Checking of Test Certificates and Inspection Repots	100% Review of records

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
					direction of rolling		
		c) Earth wire/OPGW	Check for seals at both ends	Packing list	Contractor	100% at stores In case of OPGW, OTDR test shall be carried on 100% OPGW before stringing	20% check 20% joint witnessing by Purchaser/ Utility
		c) Hardware Fittings	Visual Check for surface finish and cracks	As per Purchaser/Utility specification and appd. drawings	Contractor All materials shall be free from folds, cracks and other exterior and interior defects which can affect its strength, ductility , durability of ability to function	100% at stores	100% Review of records
			Galvanizing	As per Purchaser/Utility specification	Contractor All parts other than steel wires shall consist of a suitable thickness of zinc coating as per TS	Record Review	100% Review of records
			Vibration Dampers	As per Purchaser/Utility specification	Contractor The damper shall be designed for a working life of at least 30 years and the design shall take full account of environmental factors	Record Review	100% Review of records

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
					including conductor temperature variations between -10°C and 80°C, ultraviolet radiation, ozone and atmospheric pollutants.		
			Stay Wire	As per Purchaser/Utility specification	Contractor Stay Wire shall be galvanized steel strand as per appd. Drawings and TS	Record Review	100% Review of records
			Armour Rod	As per Purchaser/Utility specification	Contractor Armour rods shall be used to protect ACSR conductor at all clamping points on the suspension stand-off insulators. The size of the armour rods shall be as per appd. Drawings and TS.	Record Review	100% Review of records
		d) OPGW & Hardware	Optical Ground Wire (OPGW)	As per Purchaser/Utility specification and appd. drawings	Contractor	100% inspection before despatch	100% Review of records
			Fibre Optics	As per Purchaser/Utility specification and appd. drawings	Contractor	100% inspection before despatch	100% Review of records
			Mounting and	As per Purchaser/Utility	Contractor	100% inspection before	100% Review of

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
			Suspension Hardware	specification and appd. drawing		despatch	records
			Termination and Joints	As per Purchaser/Utility specification and appd. Drawings	Contractor	100% inspection before despatch	100% Review of records
	Stringing	Field Work	Tests/Check to be done				
			Conductor	.As per Purchaser/Utility specification and appd. Drawings.	Contractor	The conductors and earth wires shall be pulled up and tensioned according to "Code of Practice for Overhead Power Lines	100% Review of records
		During Stringing	Conductor/ Earthwire	As per Purchaser/Utility specification	Contractor	The joints in the conductor with Mid Span joints and Repair Sleeve should be as per the approved drawings and TS	100% Review of records & Field check 20%
			1.Scratch/cut check (visual)	-do-			
			2.Reepair Sleeve	-do-			
			3.Mid span/Dead end joints	-do-			

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
			4.Guying	Appd. Guying arrangement/ Purchaser/Utility spec.			
		After Stringing	1.Sag/Tension	Stringing Chart/ Pole structure spotting data	Contractor	To be checked and verified 100% at site as per the approved Sag & Tension Calculation	100% Review of records & Field check 20%
			2. Electrical Clearances	As per Technical specification and appd drawings	Contractor	To be checked and verified as per approved check survey profile	100% Review of records & Field check 20%
			i)..Ground Clearance	As per Technical specification and appd drawings	Contractor	To be checked and verified as per approved check survey	100% Review of records & Field check 20%
			ii) Live Metal Clearance	As per Technical specification and appd drawings	Contractor	100% at Field	100% Review of records & Field check 20%
			3.Jumpering	As per Technical specification and appd drawings	Contractor	100% at Field	100% Review of records & Field check 20%
			4.Copper/Aluminium bond				100% Review of records & Field check 20%
			5a. Placement of Vibration Damper	As per Technical specification	Contractor	100% at Field	100% Review of records & Field check 20%

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
			5b. Tightening of hardware B&N and fixing of split pins as per manufacturer's recommendation.	As per Technical specification	Contractor	100% with fixed torque wrench	100% Review of records & Field check 20%
10.	**Commissioning**	Handing over of Site	Readiness of entire line	1.Corridor Clearance	Contractor	As per Purchaser/utility specification	100% at Field
				2.Electrical Clearance		As per Purchaser/utility specification	
				3.Statutory Compliances		As per Purchaser/utility specification	
11.	Final Testing a) Pre-commissioning of lines	a) Readiness of lines for pre-commissioning	1. Completeness of line. 2. Meggar test of line	As per pre-commissioning procedure adopted by Purchaser/Utility	Joint inspection by Purchaser/ Utility and Contractor	100%	100%
	b)Commissioning of line	Readiness of lines for commissioning	1. Geo tagged photograph of each tower after completion of stringing, to ascertain the completeness of tower.	a) As per pre-commissioning procedure adopted by Purchaser/Utility b) Pre-commissioning Report c) CEA clearance	Joint inspection by Purchaser/ Utility and Contractor	100%	100%

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Reference documents	Check/Testing		Counter Check/Test by Utility
					Agency	Extent	
12.	Storage of materials	1)Storage of Tower parts, Conductor drums, Insulators, Hardware fittings, Bolts/Nuts, 2) Cement Storage	Visual & Physical check	Purchaser/ utility specifications	Contractor	100%	Random check

NOTES:

1. This Field Quality Plan is typical & indicative only for the reference of Purchaser/Utility to develop their Field Quality Plan as per their requirement & practices.
2. For special type of foundations, such as Pile, Field Quality Plan, as approved by Purchaser/ Utility shall be adopted.
3. The Accepting Authority for various tests/checks indicated in the FQP to be decided by Purchaser/Utility as per their practice.
4. The latest edition of relevant Indian Standard codes shall be referred, wherever required.

FQP Annexure-1

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR CEMENT

ORDINARY PORTLAND CEMENT					
S. No.	**Name of the test**	**Ordinary Portland Cement 33 grade as per IS 269: 2015**	**Ordinary Portland Cement 43 grade as per IS 8112:2013**	**Ordinary Portland Cement 53 grade as per IS 12269:2013**	**Remarks**
a)	**Physical tests**				To be conducted in Purchaser/ Utility approved Lab
(i)	Fineness	Specific surface area shall not be less than 225 sq.m. per Kg. or 2250 cm2 per gm.	Specific surface area shall not be less than 225 sq.m. per Kg or 2250 cm2 per gm.	Specific surface area shall not be less than 225 sq.m. per Kg or 2250 cm2 per gm.	Blaine's air permeability method as per IS 4031 (Part-2):1999, Reaffirmed 2013
(ii)	Compressive strength	72 ± 1 hour : Not less than 16 Mpa (16 N/mm2) 168 ± 2 hour : Not less than 22 Mpa (22 N/mm2) 672 ± 4 hour : Not less than 33 Mpa (33 N/mm2), Not more than 48Mpa (48N/mm2)	72 ± 1 hour : Not less than 23 Mpa (23 N/mm^2) 168 ± 2 hour : Not less than 33Mpa (33 N/mm^2) 672 ± 4 hour : Not less than 43 Mpa (43 N/mm^2), Not more than 58Mpa (58N/mm2)	72 ± 1 hour : Not less than 27Mpa (27 N/mm^2) 168 ± 1 hour : Not less than 37Mpa (37 N/mm^2) 672 ± 1 hour : Not less than 53 Mpa (53 N/mm^2)	As per IS 4031 (Part-6): 1988, Reaffirmed 2014
(iii)	Initial & Final setting time	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes	As per IS 4031 (Part-5): 1988, Reaffirmed 2014. -do-
(iv)	Soundness	Unaerated cement shall not have an expansion of more than 10mm when tested by Le Chatlier and 0.8% by Autoclave test.	Unaerated cement shall not have an expansion of more than 10mm when tested by Le Chatlier and 0.8% by Autoclave test	Unaerated cement shall not have an expansion of more than 10mm when tested by Le Chatlier and 0.8% by Autoclave test.	Le Chatlier and Autoclave test as per IS 4031 (Part-3): 1988, Reaffirmed 2014.

FQP Annexure-1

S. No.	Name of the test	Ordinary Portland Cement 33 grade *as per IS 269: 2015*	Ordinary Portland Cement 43 grade *as per IS 269: 2015*	Ordinary Portland Cement 53 grade *as per IS 269: 2015*	Remarks
b)	**Chemical composition tests**				Review of MTC only
		a) Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.66 to 1.02%	a) Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.66 to 1.02%	a) Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.80 to 1.02%	
		b) Ratio of percentage of alumina to that of iron oxide Minimum 0.66%	a) Ratio of percentage of alumina to that of iron oxide Minimum 0.66%	a) Ratio of percentage of alumina to that of iron oxide Minimum 0.66%	
		c) Insoluble residue, percentage by mass Max. 5.00%	c) Insoluble residue, percentage by mass Max. 5.00%	c) Insoluble residue, percentage by mass Max. 5.00%	
		d) Magnesia percentage by mass Max. 6%	d) Magnesia percentage by mass Max. 6%	d) Magnesia percentage by mass Max. 6%	
		e) Total sulphur content calculated as sulphuric anhydride (SO_3), percentage by mass not more than 3.5%.	e) Total sulphur content calculated as sulpuric anhydride (SO_3), percentage by mass not more than 3.5%.	e) Total sulphur content calculated as sulpuric anhydride (SO_3), percentage by mass not more than 3.5%.	
		f) Total loss on ignition shall not be more than 5 percent	f) Total loss on ignition shall not be more than 5 percent	f) Total loss on ignition shall not be more than 4 percent check	
		g) Chloride content, percent by mass, max 0.1%	g) Chloride content, percent by mass, max 0.1%	g) Chloride content, percent by mass, max 0.1%	

FQP Annexure-1

S. No.	Name of the test			Remarks
2.	**PORTLAND POZZOLANA CEMENT AS PER IS 1489 (Part 1):2015**			
a)	**Physical tests**	i) Fineness	Specific surface area shall not be less than 300 sq.m. per Kg. or 3000 Cm^2 per gm.	To be conducted in Purchaser/ Utility approved Lab
		ii) Compressive strength	a) 72 ± 1 hour : Not less than 16 Mpa (16 N/mm^2) b) 168 ± 2 hour : Not less than 22 Mpa (22 N/mm^2) c) 672 ± 4 hour : Not less than 33 Mpa (33 N/mm^2)	
		iii) Initial & Final setting time	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes	
		iv) Soundness	Un aerated cement shall not have an expansion of more than 10mm Le chatlier test and 0.8% by Autoclave test as per IS 4031 (Part-3)	
b)	**Chemical composition tests**			
		a) Magnesia percentage by mass Max. 6%		Review of MTC only
		b) Insoluble residue, percent by mass, (a) Maximum {x + 4 (100-x)/100} (b) Minimum 0.6x, where x is the declared % of fly ash in the given Portland pozzolana cement.		-do-
		c) Total sulphur content calculated as sulpuric anhydride (SO_3), percentage by mass not more than 3.5		-do-
		d) Total loss on ignition shall not be more than 5 percent		-do-
		e) Chloride content, percent by mass, max 0.1%		-do-

FQP Annexure-2

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR REINFORCEMENT STEEL AS PER IS 1786-2008 (Reaffirmed 2013), Amendment No.- 1

S. No.	Name of the test	Fe 415	Fe 500	Fe 500D
i)	**Chemical analysis test**			
	Carbon	0.30 Percent Maximum	0.30 Percent Maximum	0.25 Percent Maximum
	Sulphur	0.060 Percent Maximum	0.055 Percent Maximum	0.040 Percent Maximum
	Phosphorus	0.060 Percent Maximum	0.055 Percent Maximum	0.040 Percent Maximum
	Sulphur & Phosphorus	0.11 Percent Maximum	0.105 Percent Maximum	0.075 Percent Maximum
	Carbon Equivalent	0.42 percent Maximum	0.42 percent Maximum	0.42 percent Maximum
ii)	**Physical tests**			
	a) Tensile Strength/Yield stress ratio,	≥1.10, but tensile strength not less than 485.0 N/mm²	≥1.08, but tensile strength not less than 545.0 N/mm²	≥1.10, but tensile strength not less than 565.0 N/mm²
	b) 0.2% of proof stress/Yield stress Minimum, N/mm ²	415	500	500
	c) Elongation percent , Minimum	14.5	12	16
	d) Total elongation at maximum force, percent, Minimum	--	--	5
	e) Unit weight, Kg/m on sample sent for third party lab	As per IS 1786	As per IS 1786	As per IS 1786
iii)	**Bend & Rebend tests**	Pass	Pass	Pass

FQP Annexure-3

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR COARSE AGGREGATES AS PER IS 383:2016

3.	**Coarse Aggregates**										
i)	Physical Tests										
	a) Determination of particles size	a. IS Sieve Designation	**Percentage passing for Single-Sized Aggregate of nominal size**					**Percentage Passing for graded Aggregate of nominal size**			
			40 mm	**20 mm**	**16 mm**	**12.5 mm**	**10 mm**	**40 mm**	**20 mm**	**16 mm**	**12.5 mm**
		63 mm	100	-	-	-	-	-	-	-	-
		40 mm	85 to 100	100	-	-	-	90 to 100	100	-	-
		20 mm	0 to 20	85 to 100	100	-	-	30 to 70	90 to 100	100	100
		16 mm	-	-	85 to 100	100	-	-	-	90-100	-
		12.5 mm	-	-	-	85 to 100	100	-	-	-	90 to 100
		10 mm	0 to 5	0 to 20	0 to 30	0 to 45	85 to 100	10 to 35	25 to 55	30 to 70	40 to 85
		4.75 mm	-	0 to 5	0 to 5	0 to 10	0 to 20	0 to 5	0 to 10	0 to 10	0 to 10
		2.36 mm	-	-	-	-	0 to 5	-	-	-	-
	b. Combined Flakiness and Elongation index		Not to exceed 40%								
	c. Crushing Value		Not to exceed 30%								
	d. Presence of deleterious material		Total presence of deleterious materials not to exceed 5% for uncrushed, 2% for crushed and manufactured coarse aggregates as per Annexure- 3A.								

	e. Hardness	Abrasion value not more than 50%, Impact value not more than 45%
	f. Soundness test (for concrete work subject to frost action)	Not to exceed 12% when tested with sodium sulphate and 18% when tested with magnesium sulphate

FQP Annexure-3A

Deleterious Substance	Percentage by Mass, Max		
	Uncrushed	Crushed	Manufactured
a) Coal and lignite	1.0	1.0	1.0
b) Clay lumps	1.0	1.0	1.0
c) Materials finer than 75 micron	1.0	1.0	1.0
d) Soft fragments	3.0	--	3.0
e) Shale	--	--	--
f) Total of percentages of all deleterious materials (except mica) including S. No. a) to e) for uncrushed and crushed aggregates	5.0	2.0	2.0

FQP Annexure-4

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR FINE AGGREGATES AS PER IS 383

4.	**Fine aggregates**				
i)	Physical Tests	**IS Sieve Designation**	**Percentage passing for**		
	a) Determination of particle size		**F.A. Zone I**	**F.A. Zone II**	**F.A. Zone III**
		10 mm	100	100	100
		4.75 mm	90-100	90-100	90-100
		2.36 mm	60-95	75-100	85-100
		1.18 mm	30-70	55-90	75-100
		600 microns	15-34	35-59	60-79
		300 microns	5 to 20	8 to 30	12 to 40
		150 microns*	0-10	0-10	0-10
	b) Presence of deleterious material	Total presence of deleterious materials not to exceed 5% for uncrushed & 2% for crushed/Mixed and manufactured fine aggregates as per Annexure- 4A.			
	c) Soundness Applicable to concrete work subject to frost action	10% when tested with sodium sulphate and 15% when tested with magnesium sulphate			

***For crushed stone sand the permissible limit on 150 microns IS Sieve is increased to 20 %.**

FQP Annexure-4A

Deleterious Substance	**Percentage by Mass, Max**		
	Uncrushed	Crushed/Mixed	Manufactured
a) Coal and lignite	1.0	1.0	1.0
b) Clay lumps	1.0	1.0	1.0
c) Materials finer than 75 micron	3.0	15.0 (for crushed sand) 12.0 (for mixed sand)	10.0
d) Soft fragments	--	--	--
e) Shale	1.0	--	1.0
f) Total of percentages of all deleterious materials (except mica) including S. No. a) to e) for uncrushed aggregates and a) & b) for crushed/mixed and manufactured aggregates	5.0	2.0	2.0

FQP Annexure-5

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR CONCRETE WORK

1)	**Concrete**	a) Workability	Slump shall be recorded by slump cone method and it shall between 25-75 mm depending upon workability requirement as per IS 456: 2000.
		b) Compressive strength	For nominal (volumetric) concrete mixes compressive strength for 1:1.5:3 (Cement : Fine aggregates : Coarse aggregates) concrete 28 days strength shall be min 265Kg/cm^2 (26 N/mm2) and for 1:2:4 (Cement: Fine Aggregate: Coarse Aggregate) nominal mix concrete 28 days strength shall be min 210Kg/cm^2 (20.60 N/mm2)

Notes:

1) ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTHS FOR NOMINAL MIX CONCRETE: As per clause 5.4.10.4 of CPWD Specifications, Volume 1

(a) The average of the strength of three specimen be accepted as the compressive strength of the concrete provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.

(b) If the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 130% only for computation of strength.

(c) If the actual average strength of accepted sample is equal to or higher than specified strength up to 30% then strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.

(d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted after reconfirmation by NDT/Core test on the location portion represented by the cube samples in line with approved Standard testing procedure of Purchaser/ Utility

(e) If the actual average strength of accepted sample is less than 70% of specified strength, the Engineer-in-Charge shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of contractor. If, however the Engineer-in-Charge so desires, he may order additional tests to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the contractor.

2) 53 Grade cement shall be used after obtaining specific approval of the Engineer in charge.

3) Portland slag cement conforming to IS 455: 2015 may be used as per Technical Specification.

4) All Design Mix concrete shall be as per IS 456: 2000, reaffirmed 2016

5) ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTHS FOR DESIGN MIX CONCRETE: As per Table-11, Amendment No. 4 of IS 456: 2000 as given below:

Specified Grade	**Case No.**	**Sampling**	**Acceptance Criteria for Mix Design as per Is 456:2000**	**Remarks**
M15 and above	A 1.	Mean of Group of 4 non-overlapping consecutive test results.	Shall greater than or equal to fck+0.825 x established standard deviation (rounded off to nearest 0.5 N/sq. mm)* Or fck + 3 N/sq. mm, whichever is greater	
	A 2.	Individual test result out of A 1.	Greater than or equal (fck-3) N/ sq.mm	Out of four non-overlapping consecutive test results, one individual test result only.
	B 1.	Group of non-overlapping consecutive if test results are less than 4	fck + 4, N/sq.mm, minimum	
	B 2.	Individual test result out of B 1.	fck - 2, N/sq.mm, minimum	Out of less than four non-overlapping consecutive test results, one individual test result only.
	C 1	When number of sample is only one.	fck + 4, N/sq.mm, minimum	

* Established value of standard deviation shall be determined based on Note of Table-11 of IS 456

6.) The test results of the cube samples shall be the average of the strength of the three specimens. The individual variation shall not be more than ± 15% of the average.

FQP Annexure-6

CONCRETE MIX PROPORTIONING-MIX DESIGN (to be furnished by site while sending samples for design mix)

S. No.	Design Stipulations	Specified Criteria for Mix Proportion
A 1.	CONCRETE DETAILS: Grade of Concrete (M 20 to M 60- 28 days compressive Strength of 150mm cubes)	M20 ☐ M25 ☐ M30 ☐ M35 ☐ M40 ☐
2.	Type of Concrete- Structural Classification	PCC ☐ RCC ☐ PSC ☐ Others ☐
3.	Placing Conditions of Concrete (Structural Elements)	Building ☐ TL Pile ☐ S/S Pile ☐ S/S Structure ☐ Road ☐
B 4.	MIX DESIGN LIMITS:* Max. Water-Cement Ratio (W/C)- Optional	0.30 ☐ 0.35 ☐ 0.40 ☐ 0.45 ☐ 0.50 ☐ Others ☐
5.	Min Cement Content- Optional- Kg/m3*	300 ☐ 320 ☐ 340 ☐ 360 ☐ 380 ☐ Others ☐
C 6.	EXPOSURE CONDITIONS:@ Type of Environmental Exposure	Mild ☐ Mod. ☐ Severe ☐ V. Severe ☐ Extreme ☐
7.	Whether Exposed to Sulphate attack from Soil, Water & Containment.	Yes ☐ No ☐ Not Known ☐
8.	Whether Exposed to Chloride attack from Soil, Water & Containment.	Yes ☐ No ☐ Not Known ☐
D 9.	CONCRETE INGREDIENTS: Source of Water for Construction	Ground ☐ River ☐ Pond ☐ Others ☐
10.	Type of Cement & Strength Grade.	OPC Gr.33 ☐ OPC Gr.43 ☐ OPC Gr.53 ☐ PPC BFS ☐ PPC FAB ☐ PSC ☐ ☐
11.	Brand, Batch No./Week/Year of Cement(Test Certificate to be sent to	☐ ☐

	Lab)	
12.	Cementitious Materials Proposed for Improvement of Density & Permeability.	Microsilica/ Silica Fume ☐ Slag ☐ Fly Ash ☐ Other Pozzolona ☐
13.	FRESH CONCRETE Properties: Desired Slump of Concrete (mm)#	25-55 ☐ 25-75 ☐ 100-150 ☐ Others ☐
14.	QUALITY CONTROL AT SITE: Degree of Quality Control at Project Site (For Standard Deviation)	V.Good ☐ Good ☐ Fair ☐ Std.Lab. ☐
15.	Max. Size of Coarse Aggregate (MSA)- mm	63 ☐ 40 ☐ 20 ☐ 12.5 ☐ 4.75 ☐ Other ☐
16.	Source of Coarse Aggregate	Name of Quarry Location
17.	Type of Fine Aggregate	River Sand ☐ Crushed Sand ☐ Others Specify ☐
18.	Source of Fine Aggregate (Sand)	Name of Quarry Location
19.	Admixture proposed to be Used (Batch MTC to be Submitted to Lab)	Brand Name: Batch No.:
20.	Type of Compaction Equipment	Plate Vibrator ☐ Needle Vibrator ☐ Vibro Hyd. Pressure ☐ Piling Concrete ☐
21.	Type of Concrete Placement Facility at Project	Manual Lift ☐ Hudraulic ☐ Bucket ☐ Concrete ☐ Pump ☐
22	Maximum/Minimum temp. envisaged during placing of concrete	

* Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal Maximum Size- Reinforced Concrete

	Minimum cement content Kg/m3	Maximum free water cement ration	Minimum grade of concrete
	300	0.55	M20
	300	0.5	M25
	320	0.45	M30
	340	0.45	M35
	360	0.4	M40

Slump Value as per FQP;

i. For Switchyard civil works – 25 to 75mm
ii. For Switchyard pile foundations- 150-180mm
iii. For Transmission line open cast foundations- 25 to 75mm
iv. For Transmission line pile foundations- 150-180mm

ENVIRONMENT	**EXPOSURE CONDITIONS**
MILD	• Concrete surfaces protected against weather or aggressive
MODERATE	• Concrete exposed to condensation and rain • Concrete continuously under water • Concrete surfaces sheltered from rain or freezing whilst wet • Concrete in contact or buried under non-aggressive soil/ground water
SEVERE	• Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation • Concrete completely immersed in sea water • Concrete exposed to coastal environment
VERY SEVERE	• Concrete surfaces exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet. • Concrete in contact with or buried under aggressive subsoil/ ground water
EXTREME	• Surface of members in tidal zone, Members in direct contact with liquid/solid aggressive chemicals

Note:- The design mix shall be tested for 7 and 28 days

General Notes:

1) This standard Field Quality Plan is not to limit the supervisory checks which are otherwise required to be carried out during execution of work as per drawings/Technical specifications etc.

2) Contractor shall be responsible for implementing/documenting the FQP. Documents shall be handed over by the contractor to Purchaser/utility after the completion of the work.

3) Acceptance criteria and permissible limits for tests are indicated in the Annexures. However for further details/tests Technical specification and latest relevant Indian standards shall be referred.

4) Tests as mentioned in this FQP shall generally be followed. However Purchaser/Utility reserves the right to order additional tests wherever required necessary at the cost of the agency.

5) The authorized dealer of reinforcement steel means the dealer whose names are listed in the steel producer's web site or certified by the producers.

6) READYMIX CONCRETE (RMC) IS ACCEPTABLE FOR USE. HOWEVER, SITE INCHARGE SHALL APPROVE THE SOURCE OF MATERIALS TO BE USED FOR RMC .The documentation to be maintained shall be as per IS 4926:2003, Reaffirmed 2012 i.e.

   i) Information to be supplied by the purchaser (clause 7)

   ii) Information to be supplied by the producer (clause 8)

   iii) Sampling for concrete strength should be one set of 3 nos. of cubes for every 50 cum or part thereof for each day of concreting and 28 days compressive strength shall be tested in line with IS 456:2000, Reaffirmed 2016.

7) The preference shall be given to batching/RMC plants approved by Quality Council of India.

8) Epoxy coating on reinforcement steel wherever required shall be done as per IS 13620:1993, Reaffirmed 2015.

9) Cement is to be used in the order, it is delivered (i.e. First in First Out). In case the cement remains in storage for more than 3 months, the cement shall be retested before use and shall be rejected, if it fails to conform to any of the requirements given in the relevant Indian Standard. Cement shall be packed in bags and stored in accordance with the provisions in IS 4082:1996, Reaffirmed 2003.

10) Standard marking of ISI mark along with license number (Seven digit no., represented as CM/L-----) should be verified for construction materials and test certificate submitted for review

11) The mix design shall be approved in line with standard format for mix design concrete and final approval of mix design shall be done in consultation with Purchaser/utility's engineering department. After approval, during first use, design mix shall be verified by testing cube samples for 7 days and 28 days.

12) Tolerance of cement weight shall be governed by clause no. 10.1.1 of IS 269:2015 for OPC and by clause no. 10.1.1 of IS 1489 (Part 1):2015 for PPC.
13) Digital Photographs during concreting, erection and stringing for each location shall be taken and kept in record for future reference by high resolution GPS enabled camera.
14) All the charges in connection with NDT/ Core tests shall be borne by the contractor.
15) Bituminous paint should be applied wherever required check

Annexure-G

Relevant Indian/ International Standards

Annexure-G

RELEVANT INDIAN/ INTERNATIONAL STANDARDS

S. No.	Indian Standard	Title
1.	IS 209	Specification For Zinc
2.	IS 269	Ordinary Portland Cement, 33 Grade — Specification
3.	IS 278	Galvanized Steel Barbed Wire For Fencing - Specification
4.	IS 363	Hasps and Staples – Specification
5.	IS 383	Coarse and Fine Aggregate for Concrete– Specification
6.	IS 398 (all parts)	Aluminum Conductors For Overhead Transmission Purposes
7.	IS 432	Specification For Mild Steel and Medium Tensile Steel Bars and Hard-Drawn Steel wire For Concrete Reinforcement
8.	IS 731	Porcelain Insulators For Overhead Power Lines With A Nominal Voltage Greater Than 1000 V
9.	IS 800	Code of Practice For General Building Construction In Steel
10.	IS 802 (Part 1) Sec 1 Sec 2	Use of Structural Steel In Overhead Transmission Line Tower- Materials, Loads and Permissible Stress Section- 1: Materials and Loads Section-2 : Permissible Stresses.
11.	IS 802(Part 2)	Code of Practice For Use of Structural Steel In Over Head Transmission Line : Fabrication, Galvanizing, Inspection & Packing
12.	IS 802 (Part 3	Code of Practice For Use of structural Steel In Overload Transmission Line: Te sting
13.	ASCE 48-19	Design of Steel Transmission Pole Structure
14.	IEC 60826	Design Criteria of Overhead Transmission Lines
15.	IS 808	Dimensions For Hot Rolled Steel Beam, Column, Channel and Angle Sections.
16.	IS 875	Code of Practice For Design Loads (Other Than Earthquakes) For Buildings and Structures
17.	IS 1079	Hot Rolled Carbon Steel Sheet and Strip Specification

18.	IS 1080	Codes of Practice For Design and Construction of Shallow Foundations On Soils (Other Than Raft, Ring & Shell)
19.	IS 1340	Code of Practice For Chromate Conversion Coating On Zinc and Cadmium Coated Articles and Zinc Base Alloys
20.	IS 1363	Hexagon Head Bolts, Screws and Nuts (Size Range M5 To M36)
21.	IS 1367	Technical Supply Conditions For Threaded Steel Fasteners
22.	IS 1477	Code of Practice For Painting of Ferrous etals In Buildings: Part-I: Pre-Treatment Part-II: Painting
23.	IS 1489	Portland - Pozzolana Cement Specification
24.	IS 1498	Classification and Identification of Soils For General Engineering Purposes
25.	IS 1521	Method of Tensile Testing of Steel Wire
26.	IS 1573	Electro-Plated Coatings of Zinc On Iron and Steel
27.	IS 1586	Metallic Materials - Rockwell Hardness Test: Part 2 Verification and Calibration of Testing Machines and Indenters
28.	IS 1892	Codes For Practice For Subsurface Investigation For Foundation
29.	IS 1904	Codes For Practice For Design and Construction of Foundation In Soil: General Requirements
30.	IS 2131	Method of Standard Penetration Test For Soils
31.	IS 2220	Codes For Practice For Thin Walled Tube Sampling of Soils
32.	IS 2720 (Part-1-39)	Method of Test For Soils (Relevant Parts)
33.	IS 2809	Glossary of Terms and Symbols Relating To Soil Engineering
34.	IS 2911- Part I-VI	Code of Practice For Design and Construction of Pile Foundations (Relevant Parts)
35.	IS 1778	Reels and Drums For Bare Conductors
36.	IS 1786	High Strength Deformed Steel Bars and Wires For Concrete reinforcement— Specification
37.	IS 1852	Rolling and Cutting Tolerances of Hot Rolled Steel Products
38.	IS 1893	Criteria For Earthquake Resistant Design of Structures
39.	IS 2016	Specification For Plain Washers

40.	IS 2062	Hot Rolled Medium and High Tensile Structural Steel
41.	IS 2071	High Voltage Test Techniques
42.	IS 2074	Ready Mixed Paint, Air Drying, Oxide. Zinc Chrome , Priming Specification
43.	IS 2121	Conductor and Earthwire Accessories
44.	IS 2486	Specification For Insulator Fittings For Overhead Power Lines With A Nominal Voltage Greater Than 1000 V
45.	IS 2502	Bending and Fixing of Bars For Construction Work
46.	IS 2551	Danger Notice Plates
47.	IS 2629	Recommended Practice For Hot Dip Galvanizing of Iron and Steel.
48.	IS 2633	Method of Testing Uniformity of Coating of Zinc Coated Articles
49.	ASTM A123	Standard Specification For Zinc (Hot-Dip Galvanized) Coatings On Iron and Steel Products
50.	IS 3025	Methods of Sampling and Testing (Physical and Chemical) For Water Used In Industry
51.	IS 3043	Code of Practice For Earthing
52.	IS 3063	Fastener- Single Coil Rectangular Section Spring Lock Washers For Bolts, Nuts Screws
53.	IS 3188	Characteristics of String Insulator Units
54.	IS 3757	High Strength Structural Bolts
55.	IS) 3834-2	Quality Requirements For Fusion Welding of Metallic Materials — Part 2: Comprehensive Quality Requirements
56.	IS 4078	Code of Practice For Indexing and Storage of Drill Cores
57.	IS 4091	Code of Practice For Design and Construction of Foundations For Transmission Line Poles and Poles
58.	IS 4434	Code of Practice For In-Situ Vane Shear Test For Soils
59.	IS 4453	Code of Practice For Sub-Surface Exploration By Pits, Trenches, Drifts and Shafts
60.	IS 4464	Code of Practice For Presentation of Drilling Information and Core Description In Foundation Investigation
61.	IS 4759	Hot Dip Zinc Coatings On Structural Steel and Other Allied Products
62.	IS 4826	Galvanized Coating On Round Steel Wires
63.	IS 4926	Ready-Mixed Concrete — Code of Practice
64.	IS 4968 (Part-II)	Method For Subsurface Sounding For Soils, Dynamic Method Using Cone and Bentonite Slurry

65.	IS 5313	Guide For Core Drilling Observations
66.	IS 5369	General Requirements For Plain Washers and Lock Washers
67.	IS 5525	Recommendations For Detailing of Reinforcement in Reinforced Concrete Works
68.	IS 5613 Part-1	Code of Practice For Design Installation and Maintenance of Overhead Power Lines: Lines Upto and Including 11kv Section-1: Design Section-2: Installation and Maintenance
69.	IS 5613 Part-2	Code of Practice For Design Installation and Maintenance of Overhead Power Lines: Lines Above11kv and Upto & Including 220kv Section-1: Design Section 2: Installation and Maintenance
70.	IS 5613 Part-2	Code of Practice For Design Installation and Maintenance of Overhead Power Lines: 400kv Lines Section-1: Design Section 2: Installation and Maintenance
71.	IS 5624	Foundation Bolts - Specification
72.	IS 6610	Heavy Washers For Steel Structures
73.	IS 6623	High Strength Structural Nuts
74.	IS 6639	Hexagon Bolts For Steel Structure
75.	AWS 19.0-72	Welding of Zinc Coated Steel
76.	IS 6403	Code of Practice For Determination of Allowable Bearing Pressure on Shallow Foundation
77.	IS 6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles
78.	IS 6926	Code of Practice For Diamond Core Drilling For Site Investigation For River Valley Projects
79.	IS 6935	Method of Determination of Water Level In A Bore Hole
80.	IS 7422	Symbols and Abbreviations For Use In Geological Maps, Sections and Subsurface Exploratory Logs (Relevant Parts)
81.	IS 8009 (Part-I)	Code of Practice For Calculation of Settlements of Foundations (Shallow Foundations Subjected To Symmetrical Vertical Loads)
82.	IS 8500	Specification For Weldable Structural Steel (Medium & High Strength Qualities)
83.	IS 8764	Method For Determination of Point Load Strength Index of Rocks
84.	IS 9143	Method For Determination of Unconfined Compressive Strength of Rock Materials

85.	IS 9179	Method of Preparation of Rock Specimen For Laboratory Testing
86.	IS 9259	Specification For Liquid Limit Apparatus
87.	IS 9640	Specification For Split Spoon Sampler
88.	IS 9759	Guidelines For Dewatering During Construction
89.	IS 10050	Method of Determination of Slake Durability Index of Rocks
90.	IS 11315 (Part-II)	Description of Discontinuities In Rock Mass- Core Recovery and Rock Quality
91.	IS/IEC 60815	Selection and Dimensioning of High-Voltage Insulators Intended For Use In Polluted Conditions
92.	IS 8112	Ordinary Portland Cement, 43 Grade — Specification
93.	IS 8263	Method of Radio Interference Tests On High Voltage Insulators
94.	IS 8269	Methods For Switching Impulse Test On HV Insulators
95.	IS 10162	Specification For Spacers Dampers For Twin Horizontal Bundle Conductors
96.	IS 10238	Fasteners- Threaded Steel Fasteners - Step Bolts For Steel Structures
97.	IS 12269	Ordinary Portland Cement, 53 Grade — Specification
98.	IS 13229	Zinc Galvanization - Specification
99.	IS 13620	Fusion Bonded Epoxy Coated Reinforcing Bars- Specification
100.	IS 14893	Non-Destructive Integrity Testing of Piles (NDT) — Guidelines
101.	SP 34	Handbook On Reinforcement and Detailing

भारत सरकार

Government of India

विद्युत मंत्रालय

Ministry of Power

केन्द्रीय विद्युत प्राधिकरण

Central Electricity Authority

विद्युत प्रणाली अभियांत्रिकी एवं प्रौद्योगिकी विकास प्रभाग

Power System Engineering & Technology Development Division

3rd Floor, Sewa Bhawan, R.K. Puram

New Delhi – 66,

विषय: Constitution of Committee for preparation of Standard Technical Specification for steel Pole Type Structure

The transmission of power on overhead line will continue to dominate over other mode of power transmission due to techno-economic reasons. Presently self-supported lattice type towers/ compact narrow based towers are primarily used for transmission of power on overhead transmission lines. The steel tubular poles as an alternative to lattice structure have gained acceptance by the utilities in India and use of such structure is increasing in some areas due to less foot print & Right of Way (RoW), better aesthetic and more reliable under extreme weather condition (smaller bending moment at the base under heavy load condition).

1. At present, there is no national standard covering erection and design of steel Pole type transmission towers. The Pole type towers are designed based on the demand of the utilities on case to case basis. Hence, there is need for preparation of standard specification of steel pole type structure for transmission of power on overhead transmission lines. The standardisation will help the utilities/Transmission Service Providers and manufacturer to get products of similar quality & reliability, the delivery will be faster and would establish uniform practices across the country.

2. In view of above, a Technical Committee is constituted under the Chairmanship of Chief Engineer (PSE&TD), CEA with following composition for preparation of standard specification of steel Pole type structure for transmission of power on overhead lines.

1.	Chief Engineer (PSE&TD), CEA	Chairman

2.	Chief Engineer (TCD), CEA	Member
3.	A representative from CPRI	Member
4.	A representative from SERC	Member
5.	A representative from PGCIL	Member
6.	Representatives from Power Utilities • RRVPNL (Rajasthan) • KPTCL (Karnataka) • GETCO (Gujarat) • TANTRANSCO (Tamil Nadu) • UPPTCL (Uttar Pradesh) • TSTRANSCO (Telangana) • MSETCL (Maharashtra)	Members
7.	Representatives from Pole manufacturers • Valmont • Bajaj Electricals Ltd.	Members
8.	A representative from EPTA	Member
9.	Director (PSE&TD), CEA	Convener

Proposed Terms of Reference of the Committee are as under:

(a) To prepare technical specification of Pole type structure including type of material, constructional features, Structural & Foundation Design and testing.

(b) To standardize manufacturing Quality Plan for manufacturing, testing, and any other issue as decided by the committee.

The committee will submit the standard specification within three (3) months from the first meeting of the committee. The committee may co-opt any other member, as deemed fit.

This issues with approval of Chairperson, CEA

मोहित मुदगल / Mohit Mudgal
उप-निदेशक / Deputy Director

To:

1.	Chief Engineer (PSE&TD), CEA
2.	Chief Engineer (TCD), CEA
3.	Director (PSE&TD), CEA
4.	SA to Chairperson, CEA
5.	SA to Member (PS), CEA
Following organizations are requested to nominate a suitable officer to the Committee.	
6.	Director General, Central Power Research Institute, P B No.8066, Sadashivnagar PO, Prof. Sir C V Raman Road, Bangalore - 560 080
7.	Director, Structural Engineering Research Centre, CSIR Campus, Taramani, Post Box No.8287, Chennai–600 113.
8.	Chairman & Managing Director, POWERGRID, Saudamini, Plot No.2, Sector 29, Near IFFCO Chowk, Gurgaon (Haryana) - 122001
9.	Chairman & Managing Director, RRVPNL, Corporate office, Vidyut Bhawan, Jyoti Nagar, Janpath, Jaipur-302005
10.	Chairman & Managing Director, KPTCL, 1st floor, Kaveri Bhawan, KG Road,Bangalore-560009
11.	Chairman, GETCO, Sardar Patel Vidyut Bhavan, Corporate Office Race Course, Vadodara-390007
12.	Chairman & Managing Director, TANTRANSCO, 10th Floor/NPKR Ramasamy Malikai, No. 144, Anna Salai, Chennai-600002
13.	Chairman & Managing Director, Uttar Pradesh Power Transmission Corporation Ltd., Shakti Bhawan, 14-A, Ashok Marg, Lucknow-226001
14.	Chairman & Managing Director, Transmission Corporation of Telangana Ltd., Vidyut Soudha, Khairatabad, Hyderabad - 500082
15.	Chairman & Managing Director, Maharashtra State Electricity Transmission Company Ltd., C-19, E-Block, Prakashganga, Bandra-Kurla Complex Bandra (E), Mumbai 400 051
16.	Chairman, Valmont Structures Pvt. Ltd., Unit 203, 2nd Floor, Pentagon IV, Magarappata City, Hadapsar, Pune – 411028, Maharashtra, India. Phone: +91 20 6666 4141
17.	Business Head, EPC Power Transmission, Bajaj Electricals Ltd.,

	Rustomjee Aspire, 6th Floor, Bhanu Shankar Yagnik Marg, Sion East, Mumbai- 400022
18.	Mr. Vijay Chhibber, Director General, Electric Power Transmission association, Core 6-A, Ground Floor India Habitat Centre, Lodi Road, New Delhi – 110003.

Chairman of the Committee **Shri Ashok Kumar Thakur** Chief Engineer (PSE&TD Division) Central Electricity Authority		
List of Contributors and Participants		
1.	Shri Ravinder Gupta	CEA
2.	Shri Ramesh Kumar	CEA
3.	Shri Y.K. Swarnkar	CEA
4.	Shri Baleshwar Thakur	CEA
5.	Shri Bhanwar Singh Meena	CEA
6.	Shri Deepak Raghuvanshi	CEA
7.	Shri Mohit Mudgal	CEA
8.	Shri Akshay Dubey	CEA
9.	Shri Karan Sareen	CEA
10..	Shri Nishant Chohla	CEA
11.	Shri M. L. Sachdeva	Ex-CEA
12.	Shri S.K. Ray Mohapatra	Ex-CEA
13.	Shri J R Boro	Ex-CEA
14.	Shri Apoorv Goyal	Ex-CEA
15.	Shri Surendra Kumar	POWERGRID
16.	Shri Nitesh Kumar Sinha	POWERGRID
17.	Shri Rajiv Gandhi	POWERGRID
18.	Shri Karan	POWERGRID
19.	Shri Loveleen Singh	DTL
20.	Shri Ashok Kumar	DTL
21.	Shri Akhilesh Srivastava	UPPTCL
22.	Shri Ajay Shrivastava	MPPTCL
23.	Smt. Mamta Mehta	RVPNL
24.	Shri Sandeep Kalantri	MSETCL
25.	Shri Kishor Guard	MSETCL
26.	Shri Hardeep Singh	PSTCL
27.	Shri Arun Garg	PSTCL
28.	Ms. Deepika Joshi	HPPCL
29.	Shri Rakesh Negi	HPPCL
30.	Shri Bala Chander Rao	TSTRANSCO
31.	Shri T. Sharat Babu	TSTRANSCO
32.	Shri G Laxman Raju	TSTRANSCO

33.	Shri Krishna Mohan Singh	TSTRANSCO
34.	Shri Ajith Kumar Vamadevan	KSEB
35.	Shri Sudhakar Garapati	KPTCL
36.	Shri Syed Manzoor Hussain	KPTCL
37.	Shri. Govida Raju	APTRANSCO
38.	Er. M. Shafiulla	TANTRANSCO
39.	Shri S. Marimuthu	TANTRANSCO
40.	Mr. A. A. Joshi	GETCO
41.	Ms. M. B. Sharma	GETCO
42.	Ms. Dhara Bhatt	GETCO
43.	Shri C G Thakkar	GETCO
44.	Ms. Monica Sharma	GETCO
45.	Shri Rajesh Kumar	HVPNL
46.	Shri Sushant	BSPTCL
47.	Shri Kisan Jana	OPTCL
48.	Shri Hillol Biswas	WAPCOS Ltd.
49.	Dr. M. Selvaraj	CPRI
50.	Shri K. Vijayakumar	CPRI
51.	Dr. G. S. Palani	SERC
52.	Dr. N. Prasada Rao	SERC
53.	Shri Sanket A Barapatre	Adani Transmission Ltd.
54.	Shri Deepak Jha	Adani Transmission Ltd.
55.	Shri Paresh Mestri	Tata Power Ltd.
56.	Shri Sandeep Deshmukh	Tata Power Ltd.
57.	Shri Pramod Tupe	Tata Power Ltd.
58.	Shri Sambrit Chakraborty	Tata Power Ltd.
59.	Shri Railkar Parag	Tata Power Ltd.
60.	Shri Bipin B Shah	Ex-Torrent Power
61.	Shri Milind Nene	Kalpataru Power
62.	Shri Kaushal Thakkar	Kalpataru Power
63.	Shri Chandan Raina	Sterlite Power
64.	Dr. Deepak Lakhapati	Sterlite Power
65.	Shri Naveen Singh	Sterlite Power
66.	Shri Gopal Ji	Sterlite Power
67.	Shri C.Suresh Babu Reddy	L&T Power
68.	Shri Rajender Kumar Thakur	Sekura Energy Ltd.
69.	Shri R R Patel	KEC Ltd.
70.	Shri Ramnik Arora	KEC Ltd.
71.	Shri Bigyan Parija	Indigrid

72.	Shri Sudhir K Nayak	Indigrid
73.	Shri Saurabh Singh	Indigrid
74.	Shri Pradeep M V	Bajaj Electricals Ltd.
75.	Shri Dhiraj Chaddha	Bajaj Electricals Ltd.
76.	Shri Monal Wagh	Bajaj Electricals Ltd.
77.	Shri Kailash Deshmukh	Bajaj Electricals Ltd.
78.	Shri Sujal Shah	Skipper
79.	Shri Ramen Mukherjee	Skipper
80.	Shri Abhishek Goel	Skipper
81.	Shri Dayanand Swamy Kuna	Salasar Techno
82.	Shri Asis Panda	Valmont
83.	Shri Sreedhar Reddy	Valmont
84.	Shri Abhijeet Sapkal	Valmont
85.	Shri Priyotosh Bhattacharyya	Special Invitee

CENTRAL ELECTRICITY AUTHORITY

Central Electricity Authority Central Electricity Authority (CEA) is a statutory organization, originally constituted under Section 3(1) of the replaced Electricity (Supply) Act, 1948, since substituted by section 70 of the Electricity Act, 2003. It was established as a part-time body in 1951 and made a full-time body in 1975. The functions and duties of CEA are delineated under Section 73 of the Electricity Act, 2003. The 'Office of CEA' is an Attached Office of the Ministry of Power.

CEA is an apex technical body facilitating overall development of the power sector in the country with the vision to provide quality Power for all at an affordable price. CEA advises Central Government on the matters related to National Electricity Policy, formulates short-term and perspective plans for development of electricity systems, specify various technical standards for construction of the electric plans & electric lines, grid connectivity, safety requirement for construction and O&M of electrical plants & electric lines, installation & operation of electricity meters, promotes & assists in timely completion of schemes & projects, promotes measure for upgrading skills of human resource in the power sector, collects & utilization of industry, promotes research in matters affecting power sector, and advise the Central Government, State Governments, Electricity Regulatory Commissions & licensees on all such matter of Power Sector on which its advise is sought.

CENTRAL ELECTRICITY AUTHORITY

MINISTRY OF POWER, GOVERNMENT OF INDIA

POWER SYSTEM ENGINEERING & TECHNOLOGY DEVELOPMENT DIVISION

SEWA BHAWAN, R. K. PURAM, NEW DELHI-110066