NEPAL ELECTRICITY AUTHORITY

(An Undertaking of Government of Nepal) Project Management Directorate



Hetauda-Parwanipur-Pokhariya 132 kV Transmission Line Project

A Component of PTDSSP (Power Transmission and Distribution System Strengthening Project)

BIDDING DOCUMENT FOR

Supply, Installation, Testing and Commissioning of Parwanipur-Pokhariya 132 kV Transmission Line

(Procurement of Plant)

Single Stage, Two - Envelope Bidding Procedure (OCB)

Issued on: Invitation for Bids No.: OCB No.: Employer: Country: 25 March 2025 PMD/PTDSSP/HPP/2080/81-01 PMD/PTDSSP/HPP/2080/81-01 Nepal Electricity Authority Nepal

VOLUME: - II OF III (Employer's Requirements)

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Preface

This Bidding Document for Procurement of Plant – Design, Supply, and Installation has been prepared by Nepal Electricity Authority and is based on the Standard Bidding Document for Procurement of Plant – Design, Supply, and Installation (SBD Plant) issued by the Asian Development Bank dated June 2018.

ADB's SBD Plant has the structure and the provisions of the Master Procurement Document entitled "Procurement of Plant – Design, Supply, and Installation", prepared by multilateral development banks and other public international financial institutions except where ADB-specific considerations have required a change.



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CHAPTER - 1

Project Specific Requirement (PSR)

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CHAPTER 1

PROJECT SPECIFIC REQUIREMENT

1. General Information and Scope

Hetauda-Parwanipur-Pokhariya 132 kV Transmission Line Project consists of the construction of 132 kV Multi (**Four circuit tower**) circuit transmission line from Parwanipur to Pokhariya. Volume II-A of bidding documents covers the technical requirement for construction of approximately 22km long, 132 kV transmission line starting from Parwanipur substation at Jeetpur-Simara Sub-metropolitan ward number 23 of Bara District and ending at New 132/33/11kV Substation at Pokhariya Municipality ward no 1 of Parsa district. The proposed 132 kV transmission line traverses through plain landscape. The variations of altitudes of the proposed 132 kV transmission line range from approximately 112.13 m to 108.7 m above MSL.

Design, engineering, drawing and construction of works shall satisfy the general technical requirements specified in the Specification or **implied as per relevant IEC/IEEE/ IS/ASTM/British** standard codes (B S Codes)/ equivalent International Standards.

1.1 Scope

1.1.1 The following 132 kV transmission line associated with Project Management Directorate in a **turnkey basis** for Execution of **132 kV Multi (4) circuit Parwanipur to Pokhariya Transmission Line** are included in the scope of the contractor for this package: -

Line Length (approx.)

Parwanipur to Pokhariya 132 kV Transmission Line - 22 km

- 1.1.2 This Specification covers the following scope of works:
 - (i) Check survey; tower spotting, optimization of tower locations, soil resistivity measurement, geo-technical investigation.
 - Fabrication and supply of all type 132 kV transmission line towers, including River crossing towers (wherever applicable) as per Employer design/drawings including fasteners, step bolts, hangers, D-shackles etc.
 - (iii) All types of tower accessories like phase plate, circuit plate (wherever applicable), number plate, danger plate, anti-climbing device, Bird guard (wherever applicable).
 - (iv) Supply of Conductor, Insulator, OPGW, Hardware Fittings and Conductor & OPGW Accessories.
 - (v) Classification of foundation for different type of tower, design drawings of foundation casting of foundation (including special foundation locations, viz. pile/well foundation locations) for tower footings as per approved foundations drawing
 - (vi) Erection of towers, tack welding of bolts and nuts including supply and application of zinc rich primer & two coats of enamel paint, tower earthing, fixing of insulator strings, stringing of conductors (4 circuits) and earth wires along with all necessary line accessories.
 - (vii) Painting of towers & supply and erection of span markers, obstruction lights (wherever applicable) for aviation requirements (as required).
 - (viii) Testing and commissioning of the erected transmission lines.



- (ix) Other items not specifically mentioned in this Specification and / or BPS but are required for the successful commissioning of the transmission line, unless specifically excluded in the Specification.
- 1.1.2.1 The employer shall provide structural drawings, shop drawings (if required) & Bill of Materials of QA &QD type towers which are designed as per IS 802-199. Employer consultant revised the Designs of QA, QD with existing general arrangement of tower geometry as per IS 802-P1-S1 2015 and P1 S2 -2016 and QB QC type towers are newly designed for this project. Design SLD of QA, QB, QC, QD towers and its extensions will be furnished to the contractor. Contractor shall be required to check the design and develop structural drawing (Auto Cad format), BOM and shop drawings (Auto Cad format) for all above towers and its extensions and submit the same for approval of employer irrespective of the actual requirement at site conditions. Charges for the same are deemed to be included in the quoted prices. During execution if other type of towers/Structures Viz. River crossing towers/special towers, Gantry, tower of Higher extensions, towers of different configuration for which design is not in the scope of Contractor, fabrication and installation of these items shall be carried out by the contractor. Payments for these items shall be made based on per MT rate derived from the rates contained in the contract for respective item of work as the case may be.

Note: Though the type testing of updated QA & QD towers is not in the scope of the work, proto assembly inspection shall be arranged for QA & QD towers before commencing the supplies.

- 1.1.2.2 Design of foundations for all towers with extensions shall be developed by the Contractor based on the standard/investigated soil properties and shall be submitted for approval of Employer, irrespective of the actual site requirement. Charges for the same deemed to be included in the quoted prices. The indicative shape of foundation is enclosed in this specification. In case of normal foundation, minimum clearance between chimney concrete level and ground level shall be 225 mm. Based on specific site condition to avoid rusting of stubs, foundation with 500 mm clearance between concrete level and ground level may be used on case-to-case basis as may be decided by Site Incharge.
- 1.1.2.3 (a) The provisional quantities of fabricated & galvanized steel parts as per specifications required for towers and other items are given in an appropriate Schedule of Bid Price Schedule (BPS). However, the work shall be executed as per approved construction drawings.
 - (b) The various items of work are described very briefly in the appropriate Bid Price Schedule (BPS). The various items of the BPS shall be read in conjunction with the corresponding sections in the Technical Specifications including amendments and, additions, if any. The Bidder's quoted rates shall be based on the description of activities in the BPS as well as other necessary operations required to complete the works detailed in these Technical Specifications.
 - (c) The Unit rates quoted shall include minor details which are obviously and fairly intended, and which may not have been included in these documents but are essential for the satisfactory completion of the various works.
 - (d) The unit rate quoted shall be inclusive of all plant equipment, men, material skilled and unskilled labor etc. essential for satisfactory completion of various works.
 - (e) All measurements for payment shall be in S.I. units, lengths shall be measured in meters corrected to two decimal places. Areas shall be computed in square meters & volume in cubic meters rounded off to two decimals.
- 1.1.2.4 The Bidder shall submit his offer taking into consideration that the tower designs/drawings shall be developed/ provided by Employer, but and foundation design and drawing shall be developed by the bidder themselves and design rights will be strictly reserved with Employer. Bidder shall quote the unit rates for various items of towers and foundations as per units mentioned in appropriate schedule of BPS. However, payment of these items identified in the schedule of prices shall be made as follows:

A)	TOWER	
i)	Supply items	On supply of respective complete tower
ii)	Erection items	On erection of respective complete tower

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B)	Foundation items:	On	completion	of	respective	foundation	in
		airr	especi				

The payment to be made for towers/foundations shall be worked out based on the unit rates and approved Bill of Materials (BOM) for towers and quantities/volumes as per approved tower foundation drawings.

- 1.1.3 This specification also includes the supply of Conductor, Insulators, OPGW, hardware fittings and all type of accessories for conductor and OPGW as detailed in the specification. Bidders shall clearly indicate in their offer the sources from where they propose to procure these materials in appropriate Schedule of BPS. The technical description of these items is given in relevant section of this Volume of the bidding documents.
- 1.1.4 All the raw materials such as steel, zinc for galvanizing, reinforcement steel, cement, coarse and fine aggregates for tower foundation, coke and salt for tower earthing etc. are included in the Contractor's scope of supply.
- 1.1.5 Bidder shall also indicate in the offer the sources from where they propose to procure the fasteners, anti-theft fasteners, step bolts, hangers, D-shackles etc., tower accessories, aviation signal (if required) etc.

1.1.6 Stringing

- a) The entire stringing work of conductor and shield wire shall be carried out by tension stringing technique. The bidder shall indicate in their offer, the sets of tension stringing equipment he is having in his possession and the sets of stringing equipment he would deploy exclusively for each package which under no circumstance shall be less than the number and capacity requirement indicated in Qualifying Requirements for Bidder. However, the Bidder having requisite experience has freedom to use helicopter for stringing. The Bidder intending to use helicopter shall furnish detailed description of the procedure, type & number of helicopter & accessories etc., to be deployed for stringing operation.
- b) In hilly terrain and thick forest or areas with site constraints such as no access to location, where deployment of tension stringing machine is not possible, manual stringing may be adopted after getting approval of Employer's site Engineer. The contractor shall deploy appropriate tools / equipment's / machinery to ensure that the stringing operation is carried out without causing damage to conductor / earth wire and conductor / earth wire is installed at the prescribed sag-tension as per the approved stringing charts.
- 1.1.7 The casting of special pile/well foundations (if applicable) wherever required shall be in the scope of the Contractor. The design shall be developed by the contractor and submit to employer for approval. If the bidder does not have necessary experience, some other agencies meeting the qualifying requirements may be engaged by the bidder for the casting of pile/well foundations. The Unit rate shall be derived as per pro rata basis with existing items/ Foundations.

1.2 Details of Transmission Line Routes and Terrain

The check survey shall be carried out using Total stations, DGPS, 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 survey.

Bidders may however visit the line route to acquaint themselves with terrain conditions and associated details of the proposed transmission lines. For this purpose, they are requested to contact the project office.

1.3 Location Details and Terminal Points

i. 132 kV M/C Parwanipur to Pokhariya Transmission Line shall emanate from Parwanipur substation at Jeetpur-Simara Submetropolitan ward number 23 of Bara District and ending at New 132/33/11kV Substation at Pokhariya Muncipality ward no 1 of Parsa district.



1.4 Access to the Line and Right of Way

Right of way (RoW) and way leave clearance shall be arranged by the Owner in accordance with work schedules. The responsibility of the owner shall be limited to securing the RoW, compensation of land acquisition and permanent structure. All other responsibilities shall be of the Contractor as mentioned in the respective Chapters. Owner will secure way leave and Right of way along the route. However, the details of RoW i.e., plot number and area of the land required for construction of tower foundation and plot number and area of the land within 9 m on the either side of the center of the transmission line, shall be prepared and submitted by the Contractor.

2.0 Transmission towers and Line data

2.1 General Description of the Tower

- 2.1.1 The transmission towers are of self-supporting hot dip galvanized lattice steel type, designed to carry the line conductors with necessary insulators, earth wires and all fittings under all loading conditions. Outline diagram of Multi circuit towers is enclosed with the Specification.
- 2.1.2 The tower shall be fully galvanized using mild steel or/and high tensile steel sections as specified in relevant clause in section-IV. Bolts and nuts with spring washer are to be used for connections.
- 2.1.3 The towers are of the following types:

A) 132 kV Four Circuit (QA, QB, QC, QD)

2.2 Classification of Towers

2.2.1 The towers for 132 kV Lines are classified as given below:-

Type of Tower	Deviation Limit	Typical Use
QA	0 deg2 deg.	i) To be used as tangent tower.
QB	2 deg - 15 deg	i) Angle towers with tension insulator string.ii) Also, to be used for anti-cascading condition.
QC	15 deg-30 deg	i) Angle tower with tension insulator string.ii) Also, to be used for anti-cascading condition.
QD	30 deg-60 deg	 i) Angle tower with tension insulator string. ii) For river crossing anchoring with longer wind span & 0 deg. Deviation on crossing span side and 0 deg. To 30 deg. Deviation on other side.

Note: The above towers can also be used for longer span with smaller angle of deviations without infringement of ground clearance

Extensions

- 2.2.1.1 Towers were designed to be suitable for adding 3M, 6M and 9M body extensions and 1.5M, 3M, 4.5M, 6M, 7.5M and 9M leg extensions (LE if required) for maintaining adequate ground clearances without reducing the specified factor of safety in any manner.
- 2.2.1.2 The towers have been designed for providing unequal leg extensions. The details of unequal leg extensions provided in the design shall be indicated to the contractor during execution stage, so that proper optimization of benching / revetment requirement can be done accordingly by the contractor. The towers are designed for unequal leg extensions of 1.5M, 3M, 4.5M, 6M, 7.5M and 9M generally

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with 3M maximum leg differential and in specific cases with 6m maximum leg differential. In exceptional situations where difference in leg differential does not suit the standard unequal leg extension provisions on the tower mentioned above, then suitable chimney extension shall be provided.

- 2.2.1.3 All above extension provisions to towers and foundations shall be treated as part of normal towers and foundations only.
- 2.2.1.4 The leg extensions, unequal leg extensions, chimney extensions and / or a combination of these suitable for a tower location shall be selected on the basis of techno-economics.

2.3 Span and clearances

2.3.1 Normal Span

The normal ruling span of the line is 320m.

2.3.2 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.

2.3.3 Weight span

The weight span is the horizontal distance between the lowest points of the conductors on the two spans adjacent to the tower. For spotting of structures, the span limits given in Table below for 132 kV lines shall prevail.

TOWER TYPE	NORMAL CONDITION		BROKENWI	RE CONDITION
	MAX (m)	MIN (m)	MAX (m)	MIN (m)
QA	600	200	300	100
QB	900	-900	540	(-) 540
QC	900	-900	540	(-) 540
QD	900	-900	540	(-) 540

2.3.4 In case at certain locations where actual spotting spans exceed the design spans and cross- arms and certain members of towers are required to be modified/ reinforced, in that case drawings for the modified/reinforced towers will be supplied to the Contractor as per requirement.

2.4 Electrical Clearances

2.4.1 Ground Clearance

The minimum ground clearance from the bottom conductor shall not be less than 7000 mm for 132kV lines at the maximum sag conditions i.e at 80° C and still air.

- a) An allowance of 150mm shall be provided to account for errors in stringing.
- b) Conductor creep shall be compensated by over tensioning the conductor at a temperature of 26°C lower than the stringing temperature for ACSR "BEAR" conductor.

2.4.2 Line Data for 132 kV transmission line:

A. Electrical System Data:

а	Nominal Voltage	kV	132
b	Maximum system voltage	kV	145
с	BIL(Impulse)	kV (Peak)	650
d	Power frequency withstand voltage (Wet)	kV (rms)	275

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B. Details of Line Materials

A.	Conductor and shield win	re

SI. N	lo. Description	Unit	Shield Wire	Conductor
1. 2.	Name/Type Size	Mm	OPGW 48 single-mode OPGW	ACSR Bear 30/3.35 +7/3.0 steel
3.	Configuration		single to run top of the towers	Vertical on

C. Insulator Strings

SI. No.	Particulars	Tension/Suspensio String	n String
1.	Type of Insulator	Com	nposite long rod
2.	E&M Strength of the insulator string in KN Single	120	70
	Double	240	140
3.	Rated lightning impulse withstand voltage, kV	650	650
4.	Rated power frequency withstand voltage, kV a. Dry	>275	
	b. Wet	275	

Note:

- For double suspension and tension string the hardware shall have at least 2-time higher strength than the insulator.
- The above parameters are applicable for installations up to an altitude of 1000m above mean sea level. For altitude exceeding 1000m above MSL, necessary altitude correction factor shall be applicable as per IEC or part thereof. Bidders shall furnish the suitable value after taking altitude correction factor in Chapter 7: Technical Data Sheet (Guaranteed Technical Particulars) separately for each item as applicable.
- The insulation and RIV levels of the equipment's shall be as per values given in the respective chapter of the equipment's.

D. Insulator String Hardware (As may be applicable)

- a) Anchor Shackle
- b) Chain Link
- c) Ball Clevis / Socket clevis / Clevis Eye
- d) Arcing horns / Arcing horn holding plate
- e) Yoke plate
- f) Free center type/Armor grip suspension clamp for suspension strings.
- g) Compression type dead end clamp.
- h) Grading ring.
- i) Sag adjuster.

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j) Balancing weight

E. Accessories for Conductor & OPGW (As may be applicable)

- Preformed Armor rods a)
- Mid Span compression joint b)
- **Repair Sleeves** c)
- Flexible copper bonds d)
- Vibration dampers e)
- Suspension assembly for OPGW. f)
- Tension assembly for OPGW. g)

CONDITIONS OF SERVICE 2.5

All plant and equipment supplied under the contract shall be entirely suitable for the climatic conditions prevailing at site. Climate varies from moderately hot and humid tropical climate to cold climate.

Maximum ambient shade temperature	46 degree C
Minimum ambient shade temperature	5.0degree C
Maximum wind velocity	47 m/sec
Monsoon season	June-August
Relative humidity,	maximum 100 %
-	Minimum 10 %
Altitude	90m MSL (Max.) Pokhariya-92m Parwanipur
Atmospheric pollution	Light to medium

The information in this Clause is given solely for the general assistance to Bidders. No responsibility for it will be accepted, nor will any claim based on this Clause be considered. The Bidder is advised to survey the sites covered under this Bid to acquaint him with site conditions.

2.6 Variation in Quantities of Work

- The provisional quantities required are mentioned in the respective schedule of prices. Final a) quantities shall be determined after completion and approval of the detailed route survey and check survey.
- The final quantities of towers, line materials and foundations shall be confirmed by the NEA based b) on the requirement of quantities of various items furnished by the Contractor after completion of check survey. Hence it will the responsibility of the Contractor to intimate the exact requirements of all towers, line materials and foundations required for the line at the earliest after the survey. NEA will order the final quantities at the unit rates quoted in the bid.
- c) NEA reserves the right to increase or decrease up to **15% (fifteen percent only)** of Contract value. The quantities of individual items may vary up to any extent after the final route plans and route profiles of the lines covered in the package are finalized.
- d) The Contractor shall agree to make no claim for anticipated profits or for alleged losses because of any difference between the quantities actually furnished and installed and the estimated quantities as indicated in these Bidding Documents.
- e) In the course of check survey, tower staking; installation of special tower (other than the tower type specified in the schedule) or modification on the cross-arm may be found necessary. In such case the Contractor shall conduct design related works without any additional cost to the Employer. Payment for the special tower and the modified cross-arm will be made at the unit rate of the tower material (weight) used. Unit rate will be derived as described above on the basis of QD type tower.

2.7 Expected life cycle



Life expectancy of the following items shall be as given below: Long rod insulator: min. 20 years Optical terminal equipment: min. 10 years

The Contractor shall submit a certificate from independent laboratory for the life expectancy above material equipment or the manufacturer shall provide any other reliable document to prove the life expectancy.

2.8 Additional responsibilities of the Contractor

The Contractor shall take care of the following during execution of the works under the Contract.

2.8.1 The Contractor shall be responsible for selecting and verifying the route, mode of transportation and making all necessary arrangement with the appropriate authorities for the transportation of the equipment. The dimensions of the equipment shall be such that when packed for transportation, it will comply with the requirements of loading and clearance restrictions for the selected route. It shall be the responsibility of the Contractor to coordinate the arrangement for transportation of the Transformers for all the stages from the manufacturer's work to site.

The conditions of roads, capacity of bridges, culverts etc. on the route shall also be assessed by the bidders. The scope of any necessary modification/ extension/ improvement to existing road, bridges, culverts etc. shall be included in the scope of the bidder. The Contractor shall carry out the route survey along with the transporter and submit the detailed proposal and methodology for transportation of Tower parts for approval of Employer within three months from the date of award.

- 2.8.2 The Contractor shall also be responsible for the overall co-ordination with internal/external agencies; project management, training of Owner's manpower, loading, unloading, handling, moving to the final destination for successful erection, testing and commissioning of the Transmission Line.
- 2.8.3 Design of Transmission line and its associated electrical & mechanical auxiliaries systems includes preparation of tower spotting, foundation layout, tower protection works, and drawings and other relevant drawings & documents required for engineering of all facilities for the transmission line to be provided under this Contract, are covered under the scope of the Contractor.
- 2.8.4 Any other items not specifically mentioned in the specification, but which are required for erection, testing and commissioning and satisfactory operation of the transmission line are deemed to be included in the scope of the specification unless specifically excluded.

Employer has standardized its technical specification for various equipment's and works for different voltage levels. Items which are not applicable for the scope of this package as per schedule of quantities described in Schedules of Rates and Prices, the technical specification for such items should not be referred to.

2.9 Specific Requirement

- a. The bidders are advised to visit the site and acquaint themselves with the topography, infrastructure, route alignment, road heads, and access/approach roads etc.
- b. The bidder shall be responsible for the safety of humans and equipment during the working. It will be the responsibility of the Contractor to co-ordinate and obtain Electrical Inspector's clearance before commissioning. Any additional items, modification due to observation of such statutory authorities shall be provided by the Contractor at no extra cost to the owner.
- c. The Contractor shall arrange all T&P for erection, testing & commissioning of the system at his own cost. Further, all consumables, wastage and damages shall be to the account of Contractor.
- 2.10 Environmental Management Plan (EMP) Requirements to be Complied with Prior to Construction, During Design Phase & During Implementation: Ref. to See Annex -A of Volume- II.
 - a. The Bidders are required to include the costs related to EMP in the respective items in the price schedule



(See Price Schedule 4 F: EHS Requirements) so as to cover the works mentioned in EMP, Annex-A of Volume II.

b. All commitments mentioned in the EMP tables, which fall under the Contractor's responsibilities but are not explicitly listed in the price schedule, are deemed to be included in the Contractor's scope of work and shall be executed without any additional cost to the Employer.

2.11 Labor Camp Standards to be Complied by the Contractor During Implementation: Ref. to See Annex -B of Volume- II.

- a. The Bidders are required to include the costs related to Labor Camp with the standard as mentioned in Annex-B of Volume II in the respective items in the price schedule (See Price Schedule 4 F: EHS Requirements) so as to cover the works mentioned in Labor Camp Standards, Annex-B.
- 2.12 Drawings (for tender purpose only): Refer to see Annex-C of Volume- II.



CHAPTER - 2 GENERAL INFORMATION AND SCOPE FOR 132 kV MULTI CIRCUIT TRANSMISSION LINE



1. GENERAL INFORMATION AND SCOPE

Salient Features of the Project

Hetauda-Parwanipur-Pokhariya 132 kV Transmission Line Project consists of the construction of 132 kV Multi (Four circuit tower) circuit transmission line from Parwanipur to Pokhariya. Volume II of bidding documents covers the technical requirement for construction of approximately 22km long, 132 kV transmission line starting from Parwanipur substation at Jeetpur-Simara Sub-metropolitan ward number 23 of Bara District and ending at New 132/33/11kv Substation at Pokhariya Municipality ward no 1 of Parsa district. The proposed 132 kV Transmission line traverses through plain landscape. The variations of altitudes of the proposed 132 kV transmission line range from approximately 112.13 m to 108.7 m above MSL.

Intent of the Specification:

This part of the specification is intended to cover the design, manufacture, engineering, inspection and testing at Bidder's work(s), packaging, forwarding to site, unloading, erection, testing, commissioning, performance testing and handing over of 132 kV Multi Circuit (4-circuit) Transmission Line from Parwanipur to Pokhariya with all associated ancillaries and auxiliaries.

This specification shall be read and construed in conjunction with the drawings and annexure to determine the scope of work and terminal points. The quantities shown on drawings and annexure are indicative. Any variation arising during the detailed engineering stage will be considered by the Bidder without any extra cost and time to the Employer.

Bidder shall be responsible for providing all material, equipment, and services, specified or otherwise which are required to complete the scope and fulfill the intent of ensuring efficiency, operability, maintainability and the reliability of the complete work covered under this specification. It is not the intent to specify completely herein all aspects of design and construction of equipment. Nevertheless, the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing continuous commercial operation, in a manner acceptable to Employer, who will interpret the meaning of the specification, drawings, requirements of operation, maintenance redundancy etc. and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification and/or applicable International standards mentioned elsewhere in the specification.

Bidder is requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specifications. In the event of conflict between the requirements of any two clauses of this specification or requirements of different codes/ standards, the more stringent requirement shall govern, unless confirmed otherwise by the Employer in writing before the award of this contract, based on a written request from the bidder for such a clarification. However, if the bidder feels that, in his opinion, certain features brought out in his offer are superior to what has been specified, these may be highlighted separately.

Scope of Work

The scope of works covering design, engineering, procurement, inspection & testing at manufacturer's works, supply, insurance, receipt at site, storage and preservation at site, site transportation, construction, erection, commissioning, trial operation, handing over to Employer, guarantee all equipment, spares and material, catalogues, drawings, documents and services including consumables for the proposed 132 kV Multi Circuit Transmission Line from Parwanipur to Pokahriya inclusive of all mechanical, electrical and civil, structural works on basis of single point responsibility.



The scope of work shall include but not limited to the following:

- Detailed survey and check survey including route alignment and profiling, right of way identification and clearance, tower spotting, optimization of tower locations, soil resistivity measurement, geotechnical investigation and check survey.
- Complete engineering services for the project including basic & detailed engineering, design philosophy, operation philosophy, submission of technical parameters, characteristic curves, capability curves, etc. of equipment and material for Employer's approval.
- Proto assembly testing of towers at manufacturing plant of the Contractor and Proto Testing of towers at NABL accredited laboratory.
- Any study through which the capacity and rating of equipment offered shall be proved for the main & auxiliary system on analysis of site location and attitude.
- Submission of manuals, engineering & construction drawings, design basis reports, optimization study reports, design calculations, quality assurance plans, testing procedures, operation and maintenance manuals, commissioning procedures, etc.
- Obtaining of any consents, licenses and approvals from relevant statutory authorities required as per applicable law in Nepal, other than those obtained by the Employer. The scope of Bidder also covers extending necessary assistance wherever logically required to enable Employer to obtain the requisite approval.
- Quality assurance of all work related to scope of work of the Bidder.
- Submission of schedule of work from zero date to handing over for complete plant to Employer and equipment in the form of chart, 'S'-curve; write up, visual chart etc. for Employer's approval. Submission of monthly progress reports, photographs, graphs etc. for engineering, supply, construction, and commissioning for all major works with suggestions and plans for making up back log if any for review of Employer. To attend meetings, review, discussion etc. for resolving all issues.
- Submission of shipping schedule of equipment and material from country of origin up to receipt at site for offshore supply and ex-works to site for onshore supply matching with schedule of work for approval of Employer.
- Manufacture, fabrication, quality control, shop testing of equipment and material after approval of required technical data and drawings by Employer. To furnish notice to Employer for inspection.
- Packing, forwarding, shipment and transportation (including port handling and custom clearance) from the manufacturer's works to site. Comprehensive marine/ transit-cum-storage-cum-erection insurance coverage of all equipment from Nepal Border/ ex-works to project site till the equipment supplied is taken over by Employer. Preservation of all equipment starting from transportation till completion of testing and commissioning.
- Hiring of a suitable storing area which shall be approved by the Employer,
- Receipt at site, unloading, movement to proper storage, carriage to storage area/ interim/ final foundation location, security, preservation, and conservation of equipment at the site.
- Erection and construction including supply of construction material and labor complete for structural and including all temporary enabling works, cabling, testing, start-up, successful trial operation and performance guarantee testing of the plant as indicated under the specifications and bidding documents.
- Performance Guarantee of the plant.
- Supply of spares parts.



- Supply any other equipment including special tools & tackles, for operation, capital maintenance.
- Supply of all manuals covering erection and commissioning, performance testing, operation, preservation, and capital maintenance including supply of as-built drawings and services required for satisfactory completion of the project.
- Supply of all construction consumables, e.g., welding electrodes, cleaning agents, diesel oil as well as materials required for temporary supports, scaffolding, storage tanks, illumination as necessary.
- Deployment of all skilled and unskilled manpower required for erection, commissioning, testing, etc, supervision of erection, commissioning, testing etc for services to be rendered.
- Deployment of all erection tools & tackles adequate number and capacity of cranes, construction machinery, transportation vehicles, and all other implements in adequate number, capacity and size. Any other tools, tackles and resources required to complete the contract with required quality and within the schedule.
- Training of Employer's personnel as specified.
- Arrangement of construction power and construction water at site.
- Any other activity not listed above but required for safe and trouble-free operation of the works shall be deemed to have been included in the Bidder's scope.

1.1.1 Major Equipment and Works

The following list of the major plant items and systems shall be included in the Bidder's scope of work. This list is not exhaustive and is without prejudice to the more fundamental responsibility of the Bidder for completeness of 132 kV Multi Circuit Transmission Line from Parwanipur to Pokhariya.

- a) Conductors and Accessories
 - Line Conductor (ACSR BEAR) and accessories
 - Optical fibre ground wire (OPGW) and accessories
 - Optical fibre terminal equipment (OLTE) at Parwanipur Substation
 - Insulator, hardware Fittings and other accessories
 - b) Tower and Tower Accessories
 - All types of transmission line towers (total 4 types QA, QB, QC and QD including bolts, nuts and washers, hangers, D-shackles etc.
 - All types of tower accessories like phase plate, circuit plate, number plate, danger plate, anticlimbing device, bird guard, aviation signals, painting of towers etc.

Foundations

- Classification of foundations for different soil conditions for different type of towers and casting of foundation for tower footings including stub setting.
- c) Grounding of each tower.
- d) Other items not specified above but required to complete the transmission line as per technical specifications, Bid Forms & Price Schedules.

Exclusions

None



Terminal points

The Bidder's scope of work shall terminate at the points as shown on the table below. These interconnection points represent the physical boundary points of the Bidder's scope of works. They do not necessarily define the operational responsibilities between the Bidder and the third parties.

System	Terminal Points
Termination of Line conductor at Parwanipur and Pokhariya Substation	132 kV Gantry of the line bay within Parwanipur and Pokhariya Substation. Connection with the Gantry including supply of string insulators hardware and other accessories are included in the scope of work of this specification.
Termination of OPGW	Optical line terminal equipment (OLTE) shall be supplied and installed within the communication room inside control building of the Parwanipur substation. Connection of OLTE with Multiplexer (MUX) of Pokhariya substation is included in the scope of this specification.

Additional responsibilities of the contractor

The Contractor shall take care of the following during execution of the works under the contract.

1.1.2 Existing Fences

Where it is necessary to operate equipment through existing fences, the Contractor shall install suitable temporary gates. The temporary gates shall be constructed of materials and to standards equal to those of the existing fence. Before cutting the fences for the installation of temporary gates, the Contractor shall install adequate braces and additional posts, if necessary, on each side of the opening and shall fully anchor the fence so that all wires will maintain their original tension after opening is cut. Except when equipment is passing, such gates shall be kept closed. After completion of the work, the fence shall be restored as nearly as practicable to its original condition. Deviation from the above requirement will be permitted only where the Contractor furnishes advanced written approval from the landowner or landowners for a different method of operation.

Where it is necessary for the Contractor to remove or to alter portions of existing fences to permit construction, temporary fence protection shall be always provided during construction and upon completion of the construction, the fence shall be rebuilt in its original or relocated position.

The cost of all the work herein described shall be borne by the Contractor. Should the contractor refuse or neglect to perform any work required by the above provisions within twenty-four hours after notification by the Employer to do so, the Employer reserves the right to perform the work and the cost thereof will be deducted from payment due to the Contractor.

1.1.3 Transmission, Telegraph and Telephone Lines:

The Contractor shall make all necessary or required provisions concerning any interference with the operation or maintenance of traffic or service of any transmission, telegraph or telephone lines existing on the date of receiving bids, caused by the work of the Contractor under this Contract, all in a manner satisfactory to the Employers or operators and to the Employer.

The Contractor shall notify the Employers of such facilities of any damage, which is his responsibility, and shall promptly settle proper claims. Pending settlement of such claims by the Contractor, an appropriate sum as determined by the Employer may be withheld from payments due to the Contractor until the matter is settled.

The cost of providing and maintaining all necessary or required watchmen, signals, guards, and temporary



structures, of making any necessary repairs, replacements, or similar operations and all or any other costs required by this Sub-Clause shall be borne by the Contractor.

1.1.4 Operation and maintenance

The Contractor shall provide at least one operating and maintenance expert at the site for a continuous period of Six (6) months or any extension required thereof because of serious breakdown or any extensions of warranty period, from the commencement of the Defect Liability Period to train the local staff on the operation of various equipment.

1.1.5 Commissioning and pre-commissioning

The Contractor shall provide sufficient, properly qualified personnel; shall supply and make available all raw materials, utilities, lubricants, chemicals, catalysts, other materials, and facilities; and shall perform all work and services of whatsoever nature required to properly carry out Pre-commissioning, Commissioning and Guarantee Test all in accordance with the provisions of the Contract Agreement.

1.1.6 Other Responsibilities

- a) The Contractor shall be responsible for selecting and constructing appropriate communication means necessary for the execution of the project at his own expense. If required, the Employer will assist the Contractor in obtaining licenses/ permits from the concerned government agencies.
- b) Gasoline, oil and lubricants for construction equipment and vehicles are available in Nepal and the Contractor will not be permitted to import such products for use on the work.
- c) The Contractor shall be responsible for the arrangement of the water supply for drinking and construction purposes at his own cost.
- d) The Contractor shall be responsible for the arrangement of the electricity supply for construction and any other purposes at his own cost.
- e) The Employer requires to get approval of cutting trees falling in RoW of the transmission line. For this the Contractor shall be responsible for enumeration of trees i.e. marking of trees at breast height, calculation of number and types of trees and its total volume to be removed in close coordination with the concerned forest department. The cost of all such activities is deemed to be included in the bid proposal. The Employer shall however assist in all such activities and get approval from the concerned agencies.

Required Completion Schedule

The scope under Volume – II-A of the bidding document includes following component of Parwanipur - Pokhariya 132 kV transmission line project:

- a. Design, manufacturing, supply, construction, installation, testing and commissioning of 132 kV Multi circuits Transmission Line from Parwanipur to Pokhariya.
- b. All works under the scope shall be completed within 540 days from the effective date of the contract.

Supply of all material and equipment shall be done by the contractor according to the approved supply schedule and this should be the responsibility of the contractor to submit and get approval of the supply schedule from the employer.



CHAPTER - 3 PRELIMINARY WORKS



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CHAPTER 3: PRELIMINARY WORKS

3 PRELIMINARY WORKS

3.1 Check Survey and Staking

Qualified surveyor not less than 15 days prior to commencement of work, the Contractor shall submit qualification of surveyors, work program and list of surveying equipment for the entire section of the proposed transmission Line and obtain approval of the Employer. Latest portable hand GPS shall also be used for determination/ verification of coordinates. The GPS used during detail/ check survey shall be the property of NEA after completion of said works. The Employer has studied several alternatives for the route alignment of the said transmission line and selected a route alignment. The Contractor shall be responsible for undertaking check survey of that selected route alignment.

The proposed 132 kV Transmission Multi circuit line with ACSR BEAR Conductor is passing through plain landscape of Bara and Parsa districts of Nepal. The variations of altitudes of the proposed 132 kV transmission line ranges from approximately 112.13 m to 108.7 m above MSL. It is envisaged to adopt towers suitable for systems with 750 kV peak BIL for the proposed 132 kV Transmission line.

The Contractor along with the Employer shall examine the angle points and fix them within 60 days from Contract signing date. Immediately after that the Contractor shall carry out a check survey and prepare Strip plans and longitudinal profile sections of that section at scales horizontal 1:2,000 and a vertical scale of 1:200 as appropriate.

The Contractor shall study the plan and profile and locate the intermediate tower location. The contractor shall fix the type of towers for the complete alignment. For the proposed 132 kV Transmission line, the contractor shall submit the following drawings:

- (i) Three (3) copies of profile drawings.
- (ii) Two (2) sets of sag templates showing the sag in still air at maximum temperature of the conductor along with sag calculations, the ground clearance line and the line showing the sag for the entire length of the transmission line.
- (iii) Two (2) sets of sag templates showing the sag in still air, 0°C temperature of the conductor along with sag calculations, ground clearance line and the line showing the sag for transmission line.
- (iv) Tower schedule indicating tower coordinates (X, Y,Z) tower number, tower type, insulator type, line angle, span length, elevation of tower spot, leg extensions, dampers, etc.

Construction of transmission line should be completed within the set milestone date.

The quantities given in the Price Schedule are provisional only and the Contractor shall finalize the quantities after the tower and foundation selection. Any delay in tower selection works will not be held as a valid reason for lack of progress in manufacture and construction and the Contractor will be expected to commence manufacture and construct the line even though the final quantities are not known until a later stage.

The Contractor shall perform all necessary survey work which consists of determination, checking and lay out the accurate center of line and elevation of all the reference points, based on the key map and plan and profile drawings. Furthermore, the Contractor shall check the minimum clearance of conductor crossing the existing highways, major waterways, power, and telecommunication lines, etc.

The tower to be erected shall comprise of Basic body and leg extensions as provided, if for some reason the leg extensions are not sufficient or require some modification in the body extension part, the Contractor shall make necessary changes with the prior approval of the Employer. The Contractor shall not be entitled to claim for any materials furnished or work performed in this respect.



During the check survey, the Contractor shall assess, and design works required to be undertaken for the protection of the foundations.

The check survey work shall be performed by qualified and experienced personnel and supervised by a Project team.

Following points shall also be considered during tower staking and preparation of tower schedule.

a) Road Crossing

At all important road crossings, the tower shall be fitted with double suspension or tension insulator strings depending on the type of tower but the ground clearance at the roads under maximum conductor design 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 will not be less than the values specified at Schedule A- 3, Chapter-11 for 132 kV lines. At all national highways crossing span will not be more than as basic span specified in schedule A.4 (Support Types and Design Spans) item no. 2 in Chapter –11.

b) River Crossings

In the case of Major River crossings which are more than 500 meters, towers shall be of suspension type and the anchor towers on either side of the main river crossing shall be DD type tower. Clearance required by the navigation authority shall be provided. For non-navigable rivers, clearance shall be reckoned with respect to highest flood level (HFL). In the case of river crossing with a span up to 500-meter normal tower spotting procedure shall be followed to achieve minimum clearance as given in schedule A-3, Chapter-11 (Minimum Clearance).

c) Power Line Crossings

Where this line is to cross over another line of the same voltage or lower voltage, the tower with suitable extensions (if necessary) shall be used. Provisions to prevent the possibility of its coming into contact with other overhead lines shall be made in accordance with the directions of the Employer. All the works related to the above proposal shall be deemed to be included in the scope of the Contractor except if modifications are required to line below, in which case, the conditions to be agreed upon. The minimum clearance while crossing the lines up to 132 kV shall be 3500 mm as given in schedule A-3, Chapter-11 (Minimum Clearance).

For power line crossings of voltage level of 132 kV and above, angle towers shall be provided on either side of DA type tower which can be temporary dead end condition with proper guying.

d) Telecommunication Line Crossings

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

When the angle of crossing has to be below 60 degrees, 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 Employer.

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.

Payment:

Payment for the contract item, **Check Survey and Staking**, will be made at the unit price bid (per km) based on horizontal distance measurement. Therefore, in the schedule the unit bid price shall include full compensation for all costs incurred in furnishing all materials, equipment and labor and other operations related to the scope of work of survey as specified before.

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3.2 Detail Survey works.

The Employer has studied several alternatives for the route alignment of the said transmission line and selected a route alignment. For some practical reason such as change in topography due to construction of some new object in the line route, to avoid heavy afforestation or to avoid abolishment of houses under the line in some section of the line route minor modifications may require. Therefore, the Contractor along with the Employer shall examine the angle points and fix them within 60 days from the Contract signing date. As route selection was confirmed few years ago, there is probability of new constructions performed on the route. Moreover, some portions of previously selected route may subject to rerouting demanded by both technical and site-based reasons. The heading **Detail Survey works** deems to meet this requirement for few portions of the route. The Contractor shall be responsible for undertaking a detailed survey of few portions of rerouting work.

The contractor shall carry out a detailed survey of some part of the transmission line route, where relocation of angle towers may be required. The provision of a detailed survey has been made and payment shall be made in accordance with BoQ.

The Contractor shall perform all necessary survey work which consists of determination, checking and laying out the accurate center of line and elevation of all the reference points, based on the key map and plan and profile drawings. Furthermore, the Contractor shall check the minimum clearance of conductor crossing the existing highways, major waterways, power, and telecommunication lines, etc.

Payment:

Payment for the contract item, **Detail Survey works**, will be made at the unit price bid (per km) based on horizontal distance measurement. Therefore, in the schedule the unit bid price shall include full compensation for all costs incurred in furnishing all materials, equipment and labor and other operations related to the scope of work of survey as specified before.

3.3 Preparation of Land parcel data for Tower and RoW lands

The work "Preparation of Land parcel data for Tower and RoW lands" consists of;

a) Land Schedule preparation work

The land schedule of the given line route will be prepared by the Contractor. The land parcel preparation work shall be done in close coordination with district "Survey office" and district "Land Revenue office" as Land Parcel data will be approved by employer only after verification from these district level offices and work will be considered mature for payment. The Employer shall assist the Contractor to the extent possible. The Contractor will identify the exact land parcel number and area of the land required for the tower foundations and protection works to be acquired for land acquisition purpose.

b) Routes, Right-of-Way, and Access data preparation work

The land schedule of the given *line route* will be prepared by the Contractor. The Employer shall assist the Contractor to the extent possible. The Contractor will identify the exact land parcel number and area of the land required for the RoW for compensation purpose. The Contractor shall identify the exact land parcel number and area of such land falling within RoW (9 m X 9 m) for compensation purposes and rectify all the errors if arise to the satisfaction of the concerned landowners and the Employer.



Later, the necessary right of way for the lines to enable the Contractor to carry out stringing and erection will be obtained by the Employer. But the Contractor will not be reimbursed for the waiting time caused by the delay in obtaining right of way unless he has established on site as per instruction of the Employer in advance of obtaining right of way. Where partial right of way only is granted, the Contractor shall program his work accordingly.

The Contractor shall make all necessary arrangements for the access roads with the landowners before going onto private land, but if any difficulty should arise, the Contractor shall promptly inform the Employer. Such arrangements should be at least one month in advance of the desired access date to allow time to clear up any difficulties. The Employer shall be kept informed of all negotiations and successful arrangements.

At any early stage of the Contract the Contractor shall arrange all proposed points of access and after the approval of the Employer shall prepare maps for submission to the Employer for the settlement of way leave arrangements. No other access shall be used without the prior consent of the Employer.

It shall be clearly understood by the Contractor that the cost of construction of access roads and delivery of construction material to erection points shall be deemed to be included in the bid price and the Contractor shall have no claim whatsoever to extra payment for construction and maintenance of access as may be required.

Further the contractor should understand clearly that the following are his responsibilities:

I. Clearing

The Contractor shall be responsible for clearance of the foundation site. Clearing shall include removal and disposal of all trees, bushes, down timber, tree roots, debris, indicated structures and other obstructions from the areas to be occupied by permanent works of the contract, and as indicated on the drawings, specified herein and as directed by the Employer at tower foundation site and the access. The Contractor shall be responsible for the removal of creeping vines and all vegetation on all existing towers from the base to the top. The Contractor shall also be responsible for trees enumeration and removal of trees during foundation excavation, erection, and stringing works at its own cost. However, compensation of such trees shall be borne by the Employer. The Employer shall be responsible for the clearance of the right of way for the transmission line as regards houses.

II. Protection

The Contractor shall be responsible for prevention of damage to structures and other objects which are not included in the clearing work. No objects of any kind outside the indicated limits of the work shall be removed or damaged. Existing utilities which are not specifically included in the work shall be protected by the Contractor. The Contractor shall be responsible for the employment of safe methods of demolition and clearing.

III. Notices

Before construction commences, the Contractor shall give the Employer not less than seven days' notice that support positions have been pegged and are available for inspection.

Before the Contractor commences work, he shall obtain from the Employer a way leave schedule giving details of any special requirements of the occupiers or Employer concerned.

When the Contractor is about to carry out erection of the conductors along or across power, telegraph or telephone lines, or public roads he shall give the requisite notice to the appropriate authorities of the date and time which he proposes to perform the work and shall send a duplicate copy of each notice to the Employer. The Contractor shall construct trestles for such line or road crossings. No separate payment shall be made for such works.



The Contractor shall always during the execution of the Works ensure compliance with all such reasonable requirements of the occupier or Employer as are brought to the Contractor's notice by the Employer.

IV. Damage

The Contractor shall take all reasonable precautions to avoid damage to land, property, roads, crops, fences, walls, gates, etc., and shall ensure that the work is adequately supervised so that unavoidable damage is reduced to the minimum. The Contractor will be liable for all damage arising by or in consequence of the works except unavoidable damage to crops and shall pay compensation or make good at the option of the Employer. The Contractor shall remove all soil and surplus material after erection.

The Contractor will be responsible for the payment necessary for agreed passage over private roads, where arrangements have been made by the Contractor.

The Contractor will be responsible for notifying the Employer of all instances of damage to crops which in the opinion of the Contractor are unavoidable. In the event of such notification not being received by the Employer, Employer may at his discretion refuse to consider any claim by the Contractor for compensation resulting from.

V. Crossing of obstacles

The Contractor shall make all necessary arrangements and take all necessary precautions where the route crosses buildings, power lines, orchards, gardens or other obstacles or ground over which erection cannot be carried out in the normal manner.

Where the local authorities or other public undertaking affected deem it necessary to make provision for the protection of their employees or property or of the public, or for the assistance of traffic, the cost of such provision shall be borne by the Contractor.

The provision of special scaffolding for purposes of effecting crossings of the route over roads, railways, rivers, telegraph and telephone lines or other similar obstructions as the Employer and/ or the Contractor may consider necessary shall be the Contractor's responsibility and all cost of such special crossings shall be borne by the Contractor.

Adequate provision shall be made by the Contractor to prevent the straying or damage to livestock during the execution of the Contract Works and until permanent reinstatement of fences, walls, hedges, gates and the like is completed, the Contractor shall be held responsible for any loss or damage due to failure to comply with the above requirements.

Payment:

Payment of identification of land parcel number and their areas shall be done as per quoted bid price but no separate payment shall be made for clearing, cutting and special scaffolding arrangements and access road. Therefore, the Contractor shall include all the cost in the unit bid for construction of foundation, stringing or tower erection.

50 % of the quoted sum shall be paid after submission and rectification of land parcel number and area of land required for tower foundations and protection (acquisition purpose) and remaining 50 % of the sum shall be paid after submission and rectification of land parcel number and areas falling under RoW for (compensation purpose).



3.4 Soil Test

3.4.1 Scope

This specification covers all the work required for geotechnical investigation and preparation of a detailed report. The work shall include mobilization of necessary equipment, providing necessary engineering supervisors and technical personnel skilled and unskilled labor and other as required, to carry out field investigations and test, laboratory tests and analysis and interpretation of data and results, preparation of a detailed soil report including recommendations and providing technical services as and when called for by the Employer. The investigation method shall be as described herein, or any other methods approved by the Employer giving the same information as needed to ensure that soil parameters are sufficient for reliable foundation design. The location for the geotechnical investigation shall be approved by the employer.

3.4.2 Codes and standards

All work shall be carried out strictly in accordance with the Technical Specifications unless otherwise approved by the Employer in writing. Where not specified, the latest edition of one or more of the following codes of practice or any other applicable code shall be followed.

SP 32(Part-2)	: Compendium of Indian Standards on soil engineering Laboratory (Field Testing of soils for Civil Engineering Purpose.
BS 1377	: Methods of Test for Soils for Civil Engineering Purposes BS
1924	: Methods of Test for Stabilized Soils
BS 5930	: Code of Practice for Site Investigations BS
6031	: Code of Practice for Earthworks
CP 2004	: Code of Practice for Foundations CBIP
Manual on Transmission Line	

Codes equivalent to these in American/ DIN Standards can also be used.

3.4.3 Purpose

The purpose, in brief, of the proposed geotechnical investigation, is to ascertain the type of sub-strata such as soil, rock etc., their characteristics and their suitability for the structures proposed to be built and to decide on the choice of the type of foundation to be adopted for the type and magnitude of envisaged loading. All the tests that are considered necessary in the opinion of the Employer for this purpose shall be conducted. Any additional tests/ works, change in the number and type of specified tests revision in the diameter, depth of bore holes, samples to be collected etc. shall be carried out as directed by the Employer.

3.4.4 Calibration of equipment

The Contractor shall ensure that all the equipment/ instruments are properly calibrated, at the start of the work, to reflect actual values. If so, demanded by the Employer, the Contractor shall have the instruments tested at an approved laboratory at his cost and the test reports shall be submitted to the Employer. If the Employer desires to witness such tests, the Contractor shall arrange for the same at his own cost.

3.4.5 Field work

a) General

It is essential that personnel on this work of geotechnical investigation and laboratory testing should have the



appropriate experience. The entire investigation shall be supervised by a suitably qualified and experienced engineer or engineering geologist. All field and laboratory work shall be executed by experienced technicians.

The Contractor shall have on site all required survey instruments as determined by the Employer to carry out the work accurately according to Specification and Drawings. All the specified locations for boreholes and field tests shall be set out at site by the Contractor. At each location of borehole, and other field tests, the Contractor shall establish the ground level prior to commencing of the boring operation. The ground level shall be related to an established benchmark.

b) Method of boring

Boring in soil

In soil strata, boring may be carried out by auger or percussion tools or by method approved by the Employer or Employer's representative. Bentonite slurry or mud circulation process can also be used if permitted. However, for those boreholes, where water samples are to be collected for chemical analysis, bentonite slurry or mud circulation method shall not be used or shall be restricted as directed by the Employer or Employer's representative. The diameter of the boreholes, unless stated otherwise, shall be such as to permit collection of undisturbed samples of 90mm diameter.

Where necessary boreholes shall be cased and whenever a borehole is cased, the bottom of the casing shall always be maintained within 150mm of the bottom of the borehole. The casing shall never be in advance of the bottom of borehole during undisturbed sampling or standard penetration tests.

Borehole depth

All the boreholes shall be sunk to a depth of 6m in the field.

c) Sampling

Sequence of sampling

The general sequence of sampling adopted shall be such as to obtain alternatively undisturbed samples at every 1.5-meter interval and at every significant change of stratum. Undisturbed samples, wherever possible, shall be collected at every 3.0 meters interval and at every identifiable change of soil formation. Likewise disturbed samples, as obtained in the standard split spoon, shall be collected by conducting the standard penetration test at every 3.0 meters interval and at the significant change of soil stratum.

Undisturbed sampling in boreholes

Samplers used for collecting undisturbed samples in soils shall meet IS/ BS and American Standards requirements and shall be appropriate to the type of soil to be sampled. Undisturbed soil samples collected shall be 90mm in diameter and 450mm in length to enable laboratory testing.

The area ratio of samplers shall be within the permissible limit and shall not exceed 25 percent for samples of 90mm diameter. The cutting edge of the cutting shoe of the sample shall be tapered at an angle not exceeding 20 degrees and inside clearance ratio shall generally be limited to 0.5 to 1.5 percent. Samples with lower clearance ratio shall be used in soft strata and these with higher clearance ratio shall be used in stiff strata. The cutting edge or shoe of sampler shall be free from rust, pitting, burring or any other defect. The sampler shall be fitted with ball check valve at the upper end.

For clays other than very soft clays open drive samplers are permissible whereas in very soft clays and in sandy soils piston samplers with core catcher device or other approved samplers shall only be used. The use of oil inside the samplers in operation shall be limited to minimum practicable.



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Before sampling operation, the Contractor shall clean the bottom of borehole very carefully and every care shall be taken to avoid disturbance of material to be sampled. For sampling the sampler shall be lowered to the bottom of borehole without impact and pressed into the soil in a single continuous movement at a sufficiently slow rate to permit the check valve to pass the water in the tube with creating excess back pressure. In firm material, and whenever approved by the Employer the sampler may be driven into the soil; but the sampler shall never be pushed or driven to its full length. After penetration to the required depth, the sampler shall be free from the soil by being rotated by one full turn and then shall be withdrawn.

The sample shall not be removed from the tube but shall be trimmed back from the ends of the tube and the space filled with molten microcrystalline wax, the tube capped with metal or plastic cap and sealed with adhesive tape.

> Undisturbed soil samples from trial pits and other sources

The Contractor may be required to collect undisturbed soil samples from trial pits excavations or other sources. These samples may be core samples or block samples and may be obtained with a special orientation as indicated by the Employer core samples shall generally be obtained by jacking a thin-walled open drive sampler of around 100mm diameter into the stratum. The sample tubes shall be delivered if approved by the Employer or Employer's representative. The sample tubes shall be held steady during jacking/ driving and a suitable frame shall be used for guiding inclined samplers.

> Disturbed soil samples

The material from the cutting shoe of the thin-walled sampler and from the split spoon sampler of the standard penetration test can be treated as disturbed sample but will not be paid for separately. All disturbed samples collected shall be placed without delay in an air-tight jar of not less than 0.4kg nominal size and each sample shall fill the jar as far as possible.

Larger disturbed samples may be required to be collected from trial pits or excavations. Each of such samples should be at least 10 kg. Such samples shall be sealed into heavy duty polythene bags immediately on collection.

Water samples

The contractor shall take water samples from boreholes, whenever directed by the Employer, before addition of water to the hole. If this is not possible prior to collection the water level in the borehole shall be lowered by about 0.5m, water allowed to rise by seepage through walls of bore hole and then water sample collected.

No water sample shall be taken when bentonite slurry or mud has been circulated in the borehole. The method of sampling shall be such as to ensure that the sample is not contaminated by rainwater, surface water etc. The quantity of samples to be collected is about 1 liter and shall be stored only in an approved airtight, clean container. Water samples should be tested as soon as possible after collection.

Numbering of samples

The Contractor shall assign a reference number to each soil and water sample taken from the borehole. this number shall be unique for that borehole and shall be in order of depth below ground level.

Labeling of samples

All samples shall be clearly labeled indicating job number, borehole number sample number, date of sampling, brief description of samples, type of sample, elevation of sample etc. and in case of undisturbed samples, the top and bottom of samples shall also be clearly labeled. Each such label shall be pasted on the container and shall also be included in the container.

Transporting and storing of samples

The Contractor shall store properly all the samples at the site till they are transported to his laboratory for testing. All rock cores and samplers with undisturbed soil samples shall be placed in order of their occurrence in strong wooden boxes suitably partitioned and provided with hinged wooden covers, so that the samples are not damaged during transit by impact or improper handling. To minimize disturbance during shipment samplers containing undisturbed soil



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samples shall be packed with wood dust or similar other resilient material and as directed by the Employer or Employer's representative.

The Contractor shall transport all samples to his testing laboratory as quickly as possible and test the samples. Samples shall be transported by air, if the stipulated completion period so warrants. All unused and excess samples after testing should be retained and safely stored by the Contractor till three months after the end of submission of the report.

d) Specific observations during boring

The observation to be made by the Contractor during boring shall include but not be limited to the following:

> Sequence and thickness of different strata Visual

description of each stratum shall be provided.

Ground water table

The depth at which ground water is struck during boring shall be carefully noted and the depth of water table shall be ascertained subsequently in the complete borehole by daily observing the depth for the next six to seven days. Depth of ground water shall also be observed in wells if wells exist in the vicinity.

> "Loss" or "Make" of drilling fluid

The "Loss" or "Make" of drilling fluid if observed during the boring shall be noted and brought to the attention of the Employer or Employer's representative. Attempts shall be made to detect joints, fissures, artisan conditions etc. Presence of lime, mica. etc.

The soil and rock samples shall be examined for the presence of lime, mica etc. and shall be recorded, if any. The Contractors rate for boring shall be deemed to include these and all other relevant observations.

e) Submission of field logs

The Contractor shall submit or mail to the Employer as directed two copies of the preliminary log of each borehole as soon as the borehole is completed.

f) Field tests

Standard penetration test (SPT)

Unless directed otherwise by the Employer or Employer's representative, the Contractor shall carry out standard penetration test at 1.0-meter intervals and at every noticeable change of soil formation and as per the procedure in IS/ BS or ANSI. The finest test shall generally begin at 1.0 m depth unless an undisturbed sample is collected at that depth, and further test at 2.0 m, 3.0 m, 4.0 m, 5.0 m, and 6.0 m depths shall be done.

For conducting the test, the bottom of borehole shall be cleaned properly, and the spoon shall be properly and centrally seated in position in the borehole. The derive weight assembly shall consist of a driving head of 65 kg weight with 75 cm free fall. It shall be ensured that the energy of falling weight is not reduced by friction between the drive weight and guides or between rope and winch drum. Standard connecting rods shall be used.



The test shall be stopped (When the test is not conducted in weathered/ Soft rock) when the total blow count including seating drive reaches 120. The corresponding penetration shall be noted. If the total penetration is more than the seating penetration of 15 cm, a breakup of blow count for 15 cm seating penetration and for the remaining portion of penetration shall also be given.

g) Excavation of trial pits

The Contractor shall excavate trial pits to the depth of 3.0 meters. Relevant tests specified in these pits shall also be carried out. Whether specified or not, in every trial pit, including those excavated for loading tests, tests by "Pocket Penetrometer" and by "Picket" shall be generously carried out at different depths in different strata. Picket test shall be conducted in non-cohesive strata. In this test a wooden picket of dimensions 5cm x 5cm in cross section, with a sharp point and about 70 cm long shall be pushed perpendicular to the surface of soil by a force of about 70 kg and the penetration of the picket shall be recorded. The test by pocket penetrometer shall be done in soils with cohesive touch and in weathered rock.

h) Backfilling of boreholes and pits

The Contractor shall back-fill the boreholes and pits. The borehole shall be back filled by bentonite/ mudcement grout. The cement and bentonite/ mud for the grout shall be in the ratio 1 to cement and bentonite for the grout shall be in the ratio 1 to 1 by weight and shall be made into a slurry with no more water than is necessary for placing the slurry in the borehole. If there is standing water in the borehole, grout shall be placed by Tremie. The pit shall be backfilled with proper ramming using the excavated material.

3.4.6 Laboratory tests

a) General

All the laboratory testing shall be performed by qualified and experienced personnel, familiar with and having access to equipment and facilities for the accurate determination of data necessary for requirements under this specification.

b) Independent laboratory

The Employer reserves the right to have the samples tested in an independent laboratory. If the Contractor is directed to get the samples tested in an independent laboratory, he shall be paid only the actual cost of such tests.

c) Program for testing

The Employer or Employer's representative will direct the Contractor on samples to be tested and on type of test to be conducted. The Employer or Employer's representative is not bound to furnish this information at the beginning of the investigation itself but shall instruct the Contractor at appropriate time during the investigation. In the case of clayed soil tri-axial compression test on undisturbed soil samples shall be carried out.

d) Standards for testing

The Contractor shall test the samples as per the relevant BS, ANSI or directed by the Employer.

e) Access to the laboratory

The Employer shall have the right of access to the Contractor's Laboratory or other Laboratory where tests have been arranged to be carried out during the progress of this investigation.

f) Submission test data and results

The Contractor shall submit when demanded by the Employer a preliminary copy of the data and the computed results tests he has conducted. However, the final report shall contain all the experimental data and the results as stated below in Article 3.2.7.



3.4.7 Formal report

a) General

The Contractor shall submit his report in two separate volumes. Volume I shall be the main body of the report containing geological history of the Site summarized test data, observations, conclusions, and recommendations. Volume II shall be in the form of an appendix and shall contain actual field and laboratory observations, calculations of test results, supporting calculations for the recommendations made etc. Initially, the Contractor shall submit these volumes to the Employer in a draft form.

b) Route plan

A route plan showing the location of all boreholes, trail pits, etc. shall be presented in the report.

c) Bore logs

A true cross-section of all boreholes, trial pits showing thickness, position and classification of each soil stratum found between top surface and bottom of the hole shall be submitted. The various tests conducted and recovered from every soil and rock stratum shall be clearly against that stratum.

A record in full of every trial pit or incomplete boring with appropriate explanations shall be reported in the same manner as the completed pits or boreholes.

d) Ground water

All available data on groundwater conditions shall be presented separately and shall be identified by borehole number and sampling dates and timing of observations, showing clearly the number of observation made in a particular safe.

e) Test results

The recommendations shall be based on observations and test results and shall encompass theoretical as well practical considerations for foundations for the types of structures envisaged. The Contractor shall acquaint himself with the type of structures proposed.

Recommendations shall include but not be limited to the following:

- A brief geological description including that of faults, folds, etc. if any based on published literature.
- Seismic history including a brief description of previous earthquakes, giving time, period, magnitude, ground acceleration, epicenter, damage done etc.
- Recommended type of foundations and safe/ allowable Cardinalin capacities.
- Possibility and extent of scouring riverbeds.
- Recommendation for class of concrete to be used for foundations vis-a-vis deleterious effect of ground water/soil chemicals concrete and steel.
- Earth pressure coefficients that may be adopted.
- Any other relevant information and data.
- Technical services as and when called by the employer.

Payment

Payment for the contract item, Soil Test, will be made at the unit price bid. Therefore, in the schedule the unit bid price shall include full compensation for all costs incurred in furnishing all materials, equipment, technical services, labor and other operations related to the scope of work of soil test as specified before.

3.5 Measurement of Ground Resistance

The Contractor is required to perform ground resistance test at every support/ tower location. Method of

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measurement, tools and instruments shall be submitted to the Employer for approval.

The measurement of ground resistance shall be performed at every meter depth from ground surface to the specified depth or to maximum depth of sub-soil tests except where ground resistance value of 10 ohms or less is obtained at any adjacent levels, no further measurement is required.

The Contractor may use drilling rod(s) of sub-soil test equipment during performing the sub-soil test as earth electrodes for measuring the ground resistance.

The Contractor shall recommend the type of earth electrodes in accordance with the results of ground resistance obtained. Selection of earth electrode type shall be suitable for each structure and its site conditions. The data obtained shall be prepared in an approved form and submitted to the Employer.

Payment

Payment for the contract item measurement of ground resistance will be made at the unit price bid. Therefore, in the schedule the unit bid price shall include full compensation for all costs incurred in furnishing all equipment and labor related to "Measurement of Ground Resistance".

3.6 Ground Handling for crossing of 132 kV lines

This is a provisional item. The designated 132 kV transmission line has no high voltage line crossing of 132 kV till to date. Incase during stringing, any crossings of 132 kV transmission lines or dedicated feeder is demanded in field, this work should be performed.

The need of use of ERS or any other suitable alternatives shall be proposed by the contractor to the satisfaction of the employer for approval to avoid prolonged shut down of 132 kV transmission lines or dedicated feeder lines during stringing works under the scope of the contract. The work should be carried out only after approval of a plan proposed by the contractor.

Payment: Ground handling cost during shutdown shall be decided upon submission of the detailed methodology and procedures to be adopted by the contractor and payment shall be made to the contractor upon completion of approved work as per approved procedure. *The price quoted for ground handling in the price bid is only provisional*. The contractor shall provide full details of the cost to be incurred to the satisfaction of the employer. The employer shall decide the amount to be paid in this regard and shall be final and binding to the contractor but in no case the quoted price shall be exceeded.



CHAPTER - 4 TRANSMISSION LINE TOWER



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4 TRANSMISSION LINE TOWER

4.1 General

The scope of work comprises of Design, prototype testing, Supply and erection of steel lattice Four-circuit towers (QA, QB, QC and QD type). The towers shall be self-supporting, hot dip galvanized, latticed steel type & designed to carry the line conductors with necessary insulators, shield wires and all fittings under all loading conditions. Outline diagrams of Four-circuit towers are enclosed with the Specification. Please refer to drawing No DWG011.

4.2 Design Spans

The design shall provide for basic, wind and weight spans given in Schedule A.4. of Chapter 11.

The term basic span shall mean the horizontal distance between centers of the adjacent towers on ground level.

The term wind span shall mean half the sum of adjacent horizontal spans lengths supported on any one support.

The term weight span shall mean the equivalent length of the weight of conductor supported at any one support at maximum temperature in still air.

4.3 Conductor and OPGW Clearances

For all supports the clearances from conductors, arc horns, jumper loops and all live metal to the structure or grounded steel work shall not be less than those specified in the table below.

Sr. No	Type of insulator string	Swing in deg.	Min. Live metal Clearance in mm
1	Single suspension	Nil	1722
	insulator string	15	1722
		30	1204
		40	1204
		60	-
2	Jumper (without Pilot	Nil	1722
	String)	10	1722
		20	1204
		30	1204


The length of angle structure cross-arm shall be such as to ensure that the distances between conductors from straight-line structures are maintained in plain normal conductors.

The minimum clearances between the live conductors and other objects at maximum sag condition of the conductor shall not be less than those specified in schedule A.3 of Chapter -11.

Where uplift conditions occur at tension tower positions, details should be provided to show that the above requirements are not infringed.

For 132 kV towers carrying deviation angles up to 30° cross arms shall generally be so proportioned that proper live metal clearances are maintained under all conditions without the use of pilot suspension insulators. Pilot suspension insulator strings must be used on tension structures with deviation angle of 30° or more. However, for tension structures with deviation angle below 30°, suspension insulator strings should be used on locations where sufficient clearance of the jumpers is not available with the structure without any additional cost to the Employer.

The minimum ground clearances from the bottom conductor at maximum sag condition shall not be less than the clearances specified in Schedule A.3 of Chapter 11.

However, to achieve the above clearance during operation the height of tower shall be increased in the following manner:

- a) An allowance of 500 mm shall be provided to account for errors in stringing.
- b) Long term conductor creep shall be compensated by over tensioning the conductor at temperature of 21°C lower than the stringing temperature for ACSR BEAR.

The phase distance:

The minimum distance between testing points at insulators shall be set as per standard practice at IEC or any other standards. Allowance shall be made for increasing or decreasing the length and varying the arrangement of all terminal tower cross arms to enable span connections to be made in any desired phase sequence.

Where obstructions of other types are met requiring special clearance, the clearance shall be approved by the Employer. If any factors likely to cause infringement of clearance become apparent the Contractor shall inform the Employer immediately.

Clearance between phases:

The distance between conductors belonging to different circuits shall be 1.20 times the distance belonging to the same circuit. However, the distance shall not be less than 3.0 m.

Clearances with OPGW:

The sag of the OPGW for the basic span at the severest condition shall not be more than 80% of the phase conductors.

4.4 Extensions

The Multi Circuit towers for ACSR BEAR Conductor shall be designed to be suitable for adding - 3M, -1.5M, -/+0M, +1.5M, +3M, +4.5M, +6M, +7.5M and +9M extensions for maintaining adequate ground clearances without reducing the factor of safety (actual stress/ allowable stress) available for the members of tested extensions in any manner. Reference drawings for leg extension arrangement are enclosed in the Bid Document.



All above basic body/ extension provisions to towers shall be treated as part of basic tower only.

4.5 Tower Design

4.5.1 Design Requirement

Towers shall be self-supporting types of vertical configuration and are designated as suspension towers, tension towers. The proposed Multi circuit suspension towers shall be provided with single suspension string single conductor and jumper pilot string and double suspension string of EMS rating wherever as specified in relevant chapter of this document.

The details of Insulators, ACSR BEAR Conductor and OPGW Earth wire are as specified in Chapter 11 Schedules A.9, Schedule A.10 & Schedule A.11. The minimum ground clearance and height of bottom conductor, wind spans & weight span are as indicated in Chapter 11 Schedule A.3 & Schedule A.4.

In the case of certain locations where actual spotting spans exceed the design spans, cross arms and certain members of towers are required to be modified/ reinforced, the bidder shall submit the proposal to Employer for approval for reinforcement.

4.5.2 Base Width of the Towers (Not Applicable)

In view of the difficult hilly/ ridges terrain conditions, forest reaches, restricted ROW of 18 m, narrow based towers are conceived for this Transmission Line to minimize the benching, rock cutting/ revetment works. The base width of narrow based basic towers shall be fixed on techno-economic considerations as well to expedite the execution of project.

4.5.3 Sag Tension

The sag tension and loads calculation for conductor and earth wire shall be made in accordance with the relevant provision of IS 802-part1 -sec1 2015 of the following load conditions. Appropriate drag co-efficient and gust response factors (Corresponding to Terrain Cat-II) shall be considered for accounting the wind pressure.

Refer IS 802- P1-S1(2015)					
Condition I	Condition	Temperature	Wind	Ice Load	
(Every day Temperature +			Load		
100% Wind load)	0	32°	100%	Nil	
			(full)		
Condition II	Condition	Temperature	Wind	Ice Load	
(Minimum Temperature +			Load		
36% Wind load)	0	0°	36%	Nil	
			(full)		

In addition, all the standard conditions for Sag Tension calculation as per IS 802 -part 1 sec1(2015) and Design as per Part 1 Sec 2 (2016) and CBIP Manual shall be considered as per good Industries practice.

4.5.4 Preliminary design

The preliminary Checking design of the towers including suspension and tension tower design shall be prepared at the start of the project which shall be sound in engineering and economical in design. The preliminary design shall

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consist of all the necessary items/ components required to complete the tower to be erected. This preliminary design shall be presented to the Employer with the line diagram and design calculation for approval. Necessary changes, as per Employer, shall be incorporated to the design by the Contractor, if necessary, without additional financial implication, and should not affect the period of completion of the project.

The line diagram which is approved by the Employer shall be released for detailed design and for preparation of shop drawing.

4.5.5 Wind Load

The Transmission line is traversing in wind Zone: 4 as per IS 802 latest and the corresponding wind velocity is 47 m/s. This wind speed is applicable up to a height of 10 m at everyday temperature of 32° C corresponding to 3 second peak gust wind. As this transmission line is traversing & encountering hilly/ ridges terrain, higher value of terrain roughness factor, K₂ =1.08, corresponding to terrain Cat-I shall be adopted. However, the Gust Response factors corresponding to Terrain –II for conductors, Earth wire, Tower and Insulator shall be adopted for accounting the wind pressure.

The above base wind speeds shall be applicable for Four circuit towers. The corresponding Design Wind Pressure on towers, conductors and insulators shall be obtained from the relation $P_d = 0.6V^2$ as follows:

•	Reliability Level	2 (150 yrs. return period)
•	Risk Co-efficient (k1)	1.00
•	Terrain Roughness Co-efficient (K ₂)	1.08

 (But Gust factors corresponding to terrain category –II shall be considered for conductors/ earth wire, Tower and Insulator for arriving the wind load)

47 m /sec

Design Wind Speed (V_d)

4.5.6 Seismic Consideration

The design of towers and foundations shall be checked for seismic forces under no wind conditions and coefficient of seismic load as per IS: 1893 and check their criticality considering minimum seismic Load magnitude of 0.36g vis-à-vis wind load designs.

4.5.7 Shade Protection (Lightning Consideration)

To protect the line and towers against lightning, the angle of shield for 132 kV Multi circuit towers shall be less than 30°.

4.6 Loads on Towers

Loads shall be computed for the following considerations as per IS: 802 (Part I/ Sec1):2015 latest & CBIP publication No: 323, Manual on Transmission Lines latest and technical specification:

- i) Classification of Loads
 - Climatic Loads under Normal Condition (Reliability)
 - Failure Containment Loads (Security Requirements)
 - Construction and Maintenance Loads (Safety Requirements)
- ii) Computation of Loads
 - Transverse Loads comprises Reliability requirements, security requirements and safety requirements.
 - Vertical Loads comprises Reliability requirements, security requirements and safety



requirements.

- Longitudinal Loads comprises Reliability requirements, security requirements and safety requirements.
- iii) Wind Load on Tower

The wind load on towers shall be worked out by dividing the tower into different panels duly considering appropriate drag coefficient and gust response factors.

iv) Wind Load on Conductor/ Ground Wire

The wind load on conductors and ground wire corresponding to wind loads at 100% design wind pressure at everyday temperature or 36% wind pressure at minimum temperature shall be worked out on each Line conductor and ground wire considering the average height of conductor/ ground wire up to clamping point on tower less 2/3 of conductor/ ground wire sag at minimum temp and Nil wind pressure.

v) Wind Load on Insulator Strings

Wind load on insulator Strings corresponding to wind loads at 100% design wind pressure at everyday temperature or 36% wind pressure at minimum temperature shall be determined from the attachment point to the center line of the conductor in case of suspension towers and up to the end of clamp in case of tension towers in the direction of the wind for design wind pressure. 100% of the area in the case of polymer insulator shall be adopted for working out the projected area of insulator string.

4.6.1 Loading Conditions

- Reliability Conditions
- Transverse Loads
- Vertical Loads
- Longitudinal Loads
- Security Conditions
 - Transverse Loads
 - Vertical Loads
 - Longitudinal Loads
 - Narrow front wind load (for Suspension Towers only QA)
- Safety Conditions
 - Transverse Loads
 - Vertical Loads
 - Longitudinal Loads

4.6.2 Specific Details of Loading under Safety Conditions

Transverse Loads

- i) Wind loads to be considered as Nil.
- ii) Mechanical tension at 32°C and Nil wind on account of line deviation shall be considered under Normal and Broken Wire Conditions

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Vertical Loads

- i) Load of 150 kg to be considered acting at each cross-arm as a provision for weight of lineman with tools.
- ii) Load of 350 kg to be considered acting at the tip of Cross-arms.
- iii) Erection load of 1000 kg at each lifting point located a distance of 600 mm from tip of cross- arm.
- iv) All bracing and redundant members of the towers which are horizontal or inclined up to 15° from horizontal shall be designed to withstand an ultimate vertical load of 150 kg considered acting at center independent of all other loads.
- v) Loads due to weight of conductors/ ground wire based on design weight span, weight of insulator strings and accessories. For broken wire condition where the load due to weight of conductor/ ground wire shall be considered as 60% of weight span.
- vi) Self-weight of tower structure up to point/ level under consideration.

Longitudinal Loads

These loads shall be taken as under

i) For normal conditions – These loads for dead end towers shall be considered as corresponding to mechanical tension of conductor/ ground wire at everyday temperature and no wind.

ii) For broken wire conditions

- a) **Suspension Towers** Longitudinal load per conductor and ground wire shall be considered as per IS 802-2015 respectively.
- b) Tension Towers Longitudinal load equal to twice the sagging tension (sagging tension shall be taken as 50 percent of tension at everyday temperature and no wind) for wires under stringing and 1.5 times the sagging tension for all intact wires (stringing completed).

4.6.3 Broken wire criteria

Broken wire conditions as applicable to Four circuit towers during the design of towers:

• Suspension Tower (0⁰ - 2⁰) (QA)

Any two phases broken on the same side and same span or anyone phase and one ground wire broken on the same side and same span whichever combination is more stringent for a particular member.

• Small (0[°] -15[°]) and medium angle tension towers (15[°] -- 30[°]) (QB, QC)

Any two phases broken on the same side and same span or anyone phase and one ground wire broken on the same side and same span whichever combination is more stringent for a particular member.

• Large angle tension towers (30⁰-60⁰) and dead-end towers (QD)

Any three-phase broken on the same side and same span, or any two phases and one ground wire broken on the same side and same span whichever combination is more stringent for a particular member.

4.6.4 Anti-cascading checks

All Tension towers shall be checked for anti-cascading/ sectional considerations with all conductors and ground wire intact only on one side of the tower.

• Transverse Loads

These loads shall be taken under NIL wind condition.

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• Vertical Loads

These loads shall be the sum of weight of conductor/ ground wire as per weight span of intact conductor/ ground wire, weight of insulator strings and accessories.

Longitudinal Load

These loads shall be pulled of conductor/ ground wire at everyday temperature and NIL wind applied simultaneously at all points on one side with zero-degree line deviation.

4.6.5 Tension Limits

Line Conductor/ ground wire tension at everyday temperature and without external load, should not exceed the following percentage of the ultimate tensile strength of the conductor:

- Initial unloaded tension 35%
- The final unloaded tension of conductors at everyday temperature for Transmission line shall not exceed 22% of UTS of conductor and 20% of UTS of ground wire.

Provided that the ultimate tension under everyday temperature and 100% design wind pressure, or minimum temperature and 36% design wind pressure does not exceed 50% of the ultimate tensile strength of the conductor/ ground wire.

4.6.6 Strength Factors Related to Quality

The reduction in strength due to dimensional tolerance of the structural sections and yield strength of steel used, the following strength factors shall be considered:

- i. If steel with minimum guaranteed yield strength is used for fabrication of tower, the estimated loads shall be increased by a factor of 1.02.
- ii. If steel with minimum guaranteed yield strength is not used for fabrication of tower, the estimated loads shall be increased by a factor of 1.05. In addition to the provision (i) above.

	Details of Structural steel				
a)	Steel Quality			IS :2062	
b)	Minimum guaranteed (kg/cm²)	yield stress	MS	2549 up to <20mm 2447 >20mm <40MM	
			НТ	3569 up to <20mm 3365>20<40mm	
c)	Maximum allowable s	stress (kg/cm2) for	MS	As above	
	net area)		HT	As above	
d)	For compression me	mber (on gross area)	MS	As IS 802-latest	
			HT		
	Details of Bolts & Nut	S			
e)	Shear stress on shar (kg/cm ²)	k of class 5.6 bolts		3160	
f)	Bearing stress on sha	ank of class 5.6bolts	MS	4440	
	(kg/cm ²)		HT	6322	
g)	Tension on net area (kg/mm²) Class 5.6	of the thread		2590	

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4.7 Slenderness Ratio L/R

The Slenderness ratio (L/R) {Ratio of maximum un-braced or unsupported length (L) to the least radius of gyration (R)} of a member shall not exceed:

a. For Compression Members

Leg members, ground wire peak and cross arm chord members:	120
Bracing and other member having calculated stress:	150
Redundant or Secondary members without calculated stress:	250

b. For Tension Members

All tension Members: 400

In determining the slenderness ratios for various members suitable provisions shall be taken into consideration for various types of end connections, eccentricity of load transfer in the members effective length of members as per the CBIP Manual Guideline Annexure-12 and 13.

Miscellaneous Design Criteria

a) Redundant Members

Redundant members, if placed at an angle less than 15⁰, are required to be checked to withstand bending also due to mid-point concentrated load of 150 kg independent of other loads.

b) Bolted Joint

In case where the bolt and structural member are of different materials, the lowest of the ultimate strength of bolt and structural member governs the breaking strength of the joint.

c) Framing

The angle between any two members common to a joint of a trussed frame shall preferably be greater than 20^o and never less than 15^o due to uncertainty of stress distribution between two closely spaced members.

d) Gusset Plates

Minimum thickness of gusset shall be 5mm, only in case when the lattice is directly connected on the gusset outside the leg member.

e) Minimum Thickness of Members

Leg & Arm Bottom	:6 mm	
Other Members	:	4 mm

f) Minimum size of Members : ISA 45x45x4mm

g) Minimum Width of Flange

Minimum flange widths for bolts of different diameter are given as under:

Bolt Día (mm)	16	20	24
Flange Width (mm)	45	50	60

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The Loading trees for Reliability, Security, Safety conditions of all towers shall be prepared and ensure that the proposed tower geometry is satisfying all essential electrical clearances before design of the tower.

The unsupported length of stub between chimney and the last bracing connection to the leg should also be checked for combined direct and bending stresses and an additional cleat of required size be provided. Supporting calculations shall also be provided. The design of stub & foundation cleats shall be designed as per the CBIP manual & ASCE 10-97, ASCE-52.

The structural assembly drawing should be prepared according to IS 696 and IS 962. The drawing shall show the complete design dimensions, member length, slope factors or triangles, section sizes, bend lines, gauge lines, diameter, length and number of bolts, spacers, washers, sizes of gusset plates, position of holes etc., and relative location of various members. Sufficient number of elevations, cross section and plan view should be presented to clearly indicate the details of joints and arrangement of members.

All members should be clearly shown, and respective identification marks allotted to each member. The drawing should be drawn to a scale large enough to convey the information adequately.

All connections should be detailed to minimize eccentricity of connections. Due consideration should be given to the additional stresses introduced in the member on account of eccentricity of connection.

Dimension of all members and on a member, the distances such as hole - to - hole, length, gauge distance etc., should be given in full integers and not in decimals.

4.8 Construction of Tower Steel work

All designs shall be such that no trouble shall arise in service from vibration or excessive deflection due to the use of too light a section.

Bolt holes shall not be more than 1.5 mm larger in diameter than the corresponding bolt diameter. The distance from the center of bolt holes to the edge of any steel section shall not be less than 1.5 times the diameter of the bolt.

All tower member joints or joints between prefabricated panels to be made at Site shall be secured with bolts, nuts and washers. As far as conveniently possible, bolt heads, rather than nuts, shall be on the outer or upper faces of support joints.

Structure cross-arms shall be so arranged that they can be disconnected from the body without disturbing the main structure body members.

The conductor landing points on cross-arms shall be so arranged that an additional hole for the attachment of conductor erection and maintenance tackle is provided adjacent to each hole for tension shackles. It shall be possible to apply full conductor tension and weight safely to these additional attachment points.

Mild steel when stored in the fabricator's stockyard prior to fabrication and galvanizing shall be marked continuously throughout its length with a light blue water paint line. In addition, the grade number of the steel shall be painted on and ringed around with paint.

Members that are capable of being fitted in more than one position on the structure shall all be of the grade of steel suitable for the most onerous loading conditions.

4.8.1 Step bolts

Two diagonally opposite legs of all structures shall be equipped with galvanized step bolts (M16 x 175mm) confirming IS:10238 on the leg at intervals not exceeding 380 mm commencing immediately above the anti-climbing device and



extending to within one meter of OPGW. Step bolt design shall be to the approval of the Employer or the Employer's Representative. Holes for removable step bolts below the anti-climbing device shall be provided at no more than 380 mm intervals on the legs to which the permanent step bolts are fitted.

Fifty (50) nos. spare step bolts shall be supplied for fixing the above holes whenever required.

4.8.2 Workmanship

4.8.3 All work shall be in accordance with the best modern practice in the manufacture and fabrication of materials covered by this specification. The Contractor shall be responsible for the correct fitting of all parts, shall replace free of cost any defective material discovered during erection and pay all costs of field corrections for such replacement. All parts of the structure shall be neatly finished and free from kinks, twists, or bends. All holes shall be made with sharp tools and shall be clean cut without torn or ragged edge. The fabrication shall be in strict compliance with the shop drawings prepared by the Contractor and approved by the Employer or the Employer's Representative.

Structural materials shall be straight and cleaned of all rust and dirt before laid out or worked in any manner. Shearing and cutting shall be performed carefully. Manually guided cutting torches shall not be used.

All bolt holes in steel members shall be punched, sub-punched, reamed or drilled before galvanizing. Holes shall be drilled instead of being punched if the thickness of the metal exceeds the diameter of the hole. All holes shall be cleancut and without torn or ragged edges. All holes shall be cylindrical and perpendicular to the member.

The diameter of the finished bolt hole shall not be greater than the normal diameter of the bolt plus 1.5mm. Plugging, welding, or slotting of mis punched, mis reamed, or mis drilled holes will not be permitted. The holes shall be located accurately so that when the members are in position the holes will be lined up before being bolted.

4.8.4 Member fabrication-galvanizing

All galvanizing shall be carried out by the hot dip process and shall conform in all respects with BS 729.

All surface defects in the steel including cracks surface laminations, laps and folds shall be removed in accordance with BS 4360/IS 2629/IS 209/IS2633. All drilling, cutting, welding, forming and final, fabrications of unit members and assemblies shall be completed before the structures are galvanized. The surface of the steelwork to be galvanized shall be free from welding slag, paint, oil, grease, and similar contaminants.

The preparation for galvanizing and the galvanizing itself shall not distort or adversely affect the mechanical properties of the material.

For all parts other than steel wires the coating shall consist of at least 610 grams of zinc per square meter of surface and be not less than 0.086 mm in thickness for steel members thickness equals to or more than 5mm.

At least 460 grams of zinc per square meter and 0.065 mm for thickness of members less than 5mm.

On removal from the galvanizing bath the resultant coating shall be smooth continuous free from gross surface imperfections such as bare, spits, lumps, blisters and inclusions of flux, ash, or dross.

During off loading and erection of supports the use of nylon or braided slings shall be used. Galvanized steel work which is to be stored in the works or on site shall be stacked to provide adequate ventilation to all surfaces to avoid wet storage staining.

Small areas of the galvanized coating damaged in any way shall be restored in accordance with the procedures to be approved by the Employer.

Tests on samples shall be carried out to BS 729/IS 4759/IS6745/IS14394. The Contractor is required to furnish Elcometer or any other appropriate equipment for verification of galvanizing thickness of tower members at site to the satisfaction and the equipment shall be the property of the Employer at the completion of all works. The price of the said equipment is deemed to be included in the contract.

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4.8.5 Bolts and nuts

No bolt of diameter less than 16mm shall be used. No screwed threads shall form part of the shearing plane between members.

When in position all bolts or screwed rods shall project through the corresponding nuts by at least one full thread, but such projection shall not exceed 10mm.

Bolts shall be galvanized after thread cutting to the same specified coating weight as specified in BS 729/IS1367/IS1368/IS12427 /IS14394

Spring washers shall confirm to IS3063, and pack & plain washers confirm IS6821. Nuts and

heads of all bolts shall be hexagonal.

All bolts, nuts and washers shall be hot dip galvanized and subsequently centrifuged (according to BS 729). Nuts shall be tapped after galvanizing and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of the nut.

After fixing, bolt heads, washers and nuts shall receive two coats of zinc rich paint. Only one type of bolt for the whole project, either mild steel or high-tension steel will be permitted in order to prevent inadvertent misuse. The Contractor shall state clearly which type of bolt his designs are based upon.

All bolts supplied for this contract will be provided with one nut and one spring washer of the approved design. Taper washers and packers are to be fitted where necessary.

The Contractor shall select two samples of each type of bolt and nut to be used on the Contract and send these samples to the Employer or the Employer's Representative for approval within one month of the effective date of the Contract. The Employer or the Employer's Representative will then reject bolt consignments, which in his opinion fall in any respect below the standard of samples submitted and approved.

4.8.6 Payment for Line Tower

Payment for the contract item, "Line tower" including any required painting, will be made at the unit bid price per tower type. For supply, the tower is divided into Basic body and leg extension. For Erection the unit price shall include all cost incurred in transportation and erection of a complete tower. Therefore, in the Price Schedule, the unit bid price shall include full compensation for all the costs incurred in furnishing all materials, equipment, labors and all other operational related to tower design, fabrication delivery etc. as specified.

4.9 Tower Earthing

4.9.1 General

In addition to the mechanical OPGW termination requirement, all steel towers shall be fitted with separate earth bonds for OPGW continuity, and the Contractor shall provide all necessary connecting facilities.

All the four legs of the tower shall be connected to the earth through the counterpoise and electrode as shown in Drawing Nos. DWG008 and DWG009.

The footing resistance shall be measured by the Contractor and approved by the Employer or the Employer's Representative for every tower prior to the stringing of the OPGW. The maximum footing resistance to the general mass of earth shall be below 10 Ohms.



Steel towers need not be fitted with a separate earth bond and earthing continuity throughout the support will therefore depend upon surface contact between members.

All towers shall be provided with a means for connecting an additional earthing device as required by the Employer or the Employer's Representative. Holes are to be provided in all supports near ground level to take bolts for earth lead connections.

All legs of every tower shall be equipped with galvanized steel wire and cast into the foundation concrete to be readily available for the connection of additional earth electrodes in the event of the initial footing resistance exceeding 10 ohms. Bidder rates for the structures shall be included for such additional works.

Galvanized steel rods shall be driven where necessary in sufficient number to ensure the combined structure footing and earth electrode resistance does not exceed 10 Ohms. Where it is necessary to drive more than one earth electrode at any support, the locations shall be to the approval of the Employer or the Employer's Representative. All earth electrodes shall be electrically bonded together using galvanized steel wire.

The tops of all electrodes shall be at least 600 mm below the surface of the normal reinstated ground level.

The connection of earth wires to the structure stub-angles shall be by bolting. Bidders shall submit details of their proposals in this regard.

4.9.2 Payment for Grounding Materials

Payment for grounding materials shall be made at the unit price bid. Therefore, in the Price Schedule, the unit bid price shall include full compensation for all the costs incurred in furnishing all materials, equipment, labors and other operational related to the scope of work of earthing as specified. Each set shall mean one complete set for each tower footing. Moreover, it shall be the responsibility to achieve the tower footing resistance value below 10 Ohm by any alternative means like fast electrode and price of such alternative means shall be deemed to be included in the price schedule.

4.10 Tower Accessories

4.10.1 Anti-climbing device

At a height of at least 3 m from floor or normal ground level (whichever is higher) an adjustable anti climbing frame shall be fitted to all faces of each tower.

The device for tower shall also prevent climbing access inside the structure body.

At each climbing leg a suitable gate shall be provided to allow access by the Employers maintenance staff.

4.10.2 Danger, Phase and Number Plate

All structures shall be equipped with a suitable framework mounted immediately above the anti-climbing device level, to accommodate the followings in a conspicuous position:

- a) One (1) Danger Sign
- b) One (1) Tower Number Sign
- c) Four (4) Circuit Plate
- d) Twelve (12) Phase Signs (Phase Color Plates)

All terminal structures shall be equipped with additional frameworks, mounted immediately above the anti- climbing device level, to accommodate a set of three phase color plates.

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All plates shall be affixed to the framework by means of galvanized bolts, nuts and lockouts. Washers should be of such material and so positioned that damage to the enamel will be prevented. The height for fixing these accessories shall not be more than 4.5 m above ground level. The corners of the number, danger & circuit plate shall be rounded off to remove sharp edges. All plates shall be manufactured from mild steel sheet with vitreous enameled finish. The letters figure and the conventional skull and bones of danger plates shall conform to IS:2551-1963 and shall be in a signal red on the front of the plate. A detailed drawing for such plates shall be prepared by Contractor subject to the Employer's approval.

Line color-coded vitreous enamel identification plates should be fitted to the climbing legs of every structure in accordance with line color code scheme to be supplied to the successful Bidder. Each plate shall be approximately 70 mm wide and shall be applied one immediately below the anti-climb device, one halfway up the towers and one immediately below the lowest cross arm.

4.10.3 Arial Patrol Sign (Aviation Sign)

The Contractor shall install Aerial Marker Balls along the length of OPGW to act as a visual warning so low flying aircraft don't run into them in the vicinity of airports or aviation route as required. The size of such aerial balls shall not be less than 91 cm to be observed from and distinctively shaped (spherical or cylindrical). Orange, Red & White are some of the most used colors in such aerial markers. After a final check survey, the Contractor shall propose the sections where such aviation signs are essential. The Employer reserves the right to approve the sections proposed by the Contractor.

Payment of such aviation signs shall be made in accordance with the BoQ and one set is meant to number of such balls in one section of line (i.e. in between two adjacent towers)

4.10.4 BIRD GUARDS

To prevent birds perching immediately above the suspension insulator string of suspension and/ or tension towers and fouling the same with dropping, suitable bird guards shall be provided at cross arm tips of all suspension towers. The bird guard arrangement shall be such that it shall either prevent the bird from perching in position where they are liable to cause the damages or ensure that if birds do perch, dropping will fall clear of the insulator string.

4.10.5 Payment for Tower Accessories

Payment for tower accessories such as anti-climbing device, danger sign, tower number sign, circuit plate, phase sign, areal patrol sign, and bird guards shall be made at the unit price. Therefore, in the Price Schedule, the unit bid price shall include full compensation for all the costs incurred in furnishing all materials, equipment, labor and other operational related to the scope of work as specified.

4.11 Final Design and Design Drawing

The detailed design shall be prepared in line with the approved line diagram, which shall be submitted to the Employer in the required number of copies.

The tower accessories drawings like anti climbing device, danger sign, tower number sign, circuit plate, phase sign, areal patrol sign, and bird guards, step bolt, D-shackle etc. shall also be prepared by the Contractor and shall be submitted to the Employer required number of copies along with the soft copies in USB Flash Drive. These drawings shall be prepared in A4 size sheet only.



Once the design is approved, the approved design drawing shall be submitted to the Employer in four copies, along with one soft copy. The overall responsibility of fabricating the tower for its correctness lies with the Bidder only and should ensure that all the tower members can be fitted without any undue strain on them.

4.11.1 Shop drawing

The shop drawings shall be prepared based on the approved design drawing. Shop drawing should contain complete information necessary for fabrication of the component parts of the structure. These drawings should clearly show the member size, length and marks, hole positions, gauge lines, bend lines, edge distances, amount of chipping and notching etc.

For gusset fabrication, separate individual item wise templates can be made to facilitate gusset fabrication as well as inspection. In case of member to be bent, shop drawing should indicate the provision for variation in length. At the design/ drawing stage itself, drawing should indicate that the degree of bend given in any member such that neither flange width nor thickness shall vary beyond permissible limits.

Items requiring steep bending may be cut and welded as per the approved welding procedure.

At the time of proto stage/ tower testing itself specific bend gauge and template to locate the holes after bending must be established for the items to be bent.

4.11.2 Bill of Material

Bill of material for each type of tower and extensions required should be prepared separately. This should indicate grade of steel (like high tensile steel, mild steel etc.), mark numbers, section sizes, member's lengths, their calculated weights, type & number of bolts, nuts and washer and their sizes, total quantities, and structural drawing numbers.

4.11.3 Marking

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.

A-BB-CC-DDD

- A = NEA's code assigned to the Bidder –Alphabet
- BB = Bidder's Mark-Numerical
- CCC = Tower Type-Alphabet + Numerical
- DD = Number mark to be assigned by Bidder -Numerical. HT =

High Tensile steel

4.11.4 Shop Erection/ Prototype Tower Assembly

Steel work should be temporarily erected horizontal or vertical so that accuracy of the member can be checked before testing the towers or commencing mass fabrication as applicable. The proto assembly is done based on approved structural shop drawings of towers, all leg extensions, stubs & templates for all types of towers.



4.12 Testing of Towers

4.12.1 General

Testing of tower generally serves as guide to good tower design and therefore shall not be considered as requisite proof test for all towers. The test shall be conducted on full scale prototype tower as per the approved loading schedules and rigging diagram. The members constituting the prototype shall be of the same grade of steel as specified in the design and fabrication shall conform to the provision stipulated in IS 802 (Part – II). The tower shall be tested on rigid foundation.

The test tower shall withstand the ultimate loads specified for various conditions.

4.12.2 Leg Anchorage

The tower shall be erected vertically on rigid foundation with as much unbraced portion of the stub protruding above ground level as provided in the drawing.

4.12.3 Calibration of Measuring Instruments

All measuring instruments shall be calibrated in a systemic manner with the help of standard weights. The calibration shall, before commencing the test on each tower, be done up to the maximum anticipated load to be applied during testing. Calibration curves for the instrument to be used during testing shall be drawn by the testing authorities and the test loads shall be suitably corrected with the help of these curves.

Calibration of load cells shall be done with Universal Testing Machine (UTM) or by using standard weights. The UTM in turn shall be calibrated once in every six months or periodically as per advice of the supplier of UTM.

4.12.4 Types of Tests

- Bolt-Slip Test
- Load Tests
 - Reliability Condition (Normal Condition)
 - Security and Safety Conditions as well as Anti-Cascade Conditions
 - Broken Wire Condition
- Destruction Test including Material test after Destruction Test

4.12.5 Method of Load Application

Load shall be applied according to approved rigging diagram through normal wire attachments, angles, or bent [plates. U bolt/ D shackle or swinging brackets (hangers) may be used in the test tower if desired by the Employer, provided that satisfactory and safe rigging is attained.

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

Loading cases (values, direction and points of application of loads) shall be determined by the Bidder and get approved from the Employer before applying to the test towers.

4.12.6 Loads and Deflection Measurement



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

Tower deflection under loads shall be measured by suitable procedure at the top cross arm level on the front side of the transverse and longitudinal faces or front and rear side of the transverse faces. Deflection reading shall be recorded for the 'before load', ' load on' and 'load off' conditions.

4.12.7 Testing Procedure

Bolt slip test – In bolt slip test, the test loads up to 50% of Ultimate Normal Condition (Reliability Condition) Loads are gradually applied and kept constant for 1 minute at these loads and then the loads are released gradually.

The initial and final reading on the scale before application and after the release of loads respectively shall be taken with the help of theodolite. The difference between these readings gives the value of the bolt slip.

Normal load/ broken wire load tests – All loads shall be applied gradually up to the ultimate design loads in the following steps and shall be released in the similar manner:

- > 25%
- > 50%
- ≻ 75%
- > 90%
- > 95%
- ▶ 100%

4.12.8 Observation Periods

Under normal and broken wire load tests, the tower shall be kept under observation for sign of failure for one minute (excluding the time for adjustment of loads) for all intermediate steps of loading up to and including 95 % of ultimate design loads.

For normal as well as broken wire tests, the tower shall be kept under observation for five minutes after it is loaded up to 100 percent ultimate loads.

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

4.12.9 Recording

The deflection of the tower shall be recorded at each intermediate and final stage of normal loads/ broken wire load test by means of a theodolite and graduated scale.

4.12.10 Destruction Test

If the Employer desired so, destruction test for the tower shall be carried out.



The destruction test shall be carried out under normal condition or broken wire condition as agreed between the Employer and the Bidder.

All the provision of the specification and IS 802 for normal and broken wire conditions shall be applicable to destruction tests of Multi circuit towers during the design of towers.

4.13 Material Quality Control

Various grades of steel used in tower, details of sections, bolts and nuts and other accessories need a detailed scrutiny and quality control procedure before being processed for fabrication, assembly etc. All structural material including nuts and bolts shall comply their respective international Standards.

Chemical composition and mechanical properties of various grade of steel used shall be clearly mentioned and those shall be in accordance with relevant IS or international standards.

Steel Sections of tested quality in conformity with IS: 2062 -2011(Designated Yield Strength250 MPa) (Designated Yield Strength 350 MPa) are to be used in towers, extensions, stubs, and stubs setting templates. The Contractor can use other equivalent grades of structural steel angle sections and plates conforming to the latest International Standards. However, use of steel grade having designated yield strength more than that of EN 10025 grade S355 JR/JO (designated yield strength 355 MPa) is not permitted, unless otherwise indicated in this specification.

For designing towers, preferably rationalized steel sections shall be used. During execution of the project, if any section is not available, the same shall be substituted by higher section. Any cost on account of the same shall be borne by the Bidder. However, design approval for such substitution shall be obtained from the Employer before any substitution and records of such substitutions shall be maintained by the Bidder.

At the time of procurement of steel other than that conforming to IS 2062-2011, green color on the edge of HT material on both sides is applied so that there is no mix up of MS and HT steel in stockyard as well as in shop. A distinct green color patch is maintained throughout and on shop sketch also, HT marking is added for identifying high tensile steel item.

4.14 Process Flow Chart for Fabrication of Towers

In general, following flow chart shall be followed for design, assembly, testing and supply of towers:



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4.15 Packing (Tower wise)

The angle section shall be wire bundled.

Cleat angles, gusset plates, brackets, fillet plate, hanger and similar loose pieces shall be tied and bolted together in multiples or securely wired through holes. Bolts, nuts washers and other attachments shall be packed in double gunny bags accurately tagged in accordance with the contents. The packing shall be properly done to avoid losses & damage during transit. Each bundle or package shall be appropriately marked. It is however recommended that the Contractor make bundle for each tower as per tower number before dispatch of tower parts to avoid member sorting problem at site.

4.16 Standards

The design, manufacturing, fabrication, galvanizing, testing, erection procedure and materials used for manufacture and erection of towers, design and construction of foundations shall conform to the following International Standards which shall mean latest revisions, with amendments/ changes adopted and published, 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 to those specified. In the case of award, salient features of comparison between the Standards proposed by the Bidder and those specified in this document will be provided by the Contractor to establish their equivalence.

The material and services covered under these specifications shall be performed as per the requirements of the relevant standard code referred hereinafter against each set of equipment and services. Other internationally acceptable standards which ensure equal or higher performance than those specified below shall also be accepted

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Employer's Requirements

SI. N0o	Title	Standards/Guides
1	Specification for Zinc	IS: 209-1992, ISO/R/752 ASTM B6
2	Galvanized Steel Barbed wire	IS: 278-1991, ASTM A131
3	Code of Practice for General Building Construction in Steel	IS: 800-2007, CSA 6.1
		IS: 802(Part1) Sec 1-2015 P1-S2-2016,
I. (a)	Code of Practice for General	ASCE 52
	Building Construction in Steel Sec 2-1992 in Overhead Transmission	IEC 826 BS 8100
	Section 1 Materials and loads	
	Section 2 Permissible stresses	
	Code of practice for use of structural steel in over- head	
4. (D)	Transmission Line: Fabrication, Galvanizing, Inspection and Packing	IS: 802-1990 (Part 2)
	Code of practice for use of Structural Steel is over load	
4. (c)	Transmission Line Towers Testing	IS: 802-1990 (Part 3, ASCE 52, IEC 652
E	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle	15, 202 1001
5	Sections.	15: 808-1991
6	Code of Practice for Design Loads (other than Earthquakes) for Buildings and Structures	IS: 875-1992
7	IS: 1363-1990 Hexagon Nuts (size range M5 to M36)	15. 1363-1990
8	Technical Supply Conditions for Threaded Steel/ Easteners	IS: 1367-1990
9	Code of practice for Painting of Ferrous Metals in Buildings:	IS: 1477-1990
0	Part-I Pre-treatment	13. 1477 1330
	Part-II Painting	
10	Electro-Plated Coatings of zinc on iron and Steel	IS [,] 1573-1991
11	Rolling and Cutting Tolerances of Hot Rolled Steel Products	IS: 1852-1993
12	Criteria for Earthquake Resistant Design of Structures	IS-1893-1991, IEEE 693
13	Plain Washers ISO/R887	IS: 2016-1992, ANSIB18-22.1
14	Steel for general structural purposes	IS: 2062-1992.
15	Ready Mixed Paint. Air Drying, Red Oxide, Zinc Chrome, Priming	IS: 2074-1992
16	Danger Notice Plates	IS: 2551-1990
17	Recommended Practice for Hot Dip Galvanizing of iron and steel.	IS: 2629-1990
18	Method of Testing Uniformity of Coating of Zinc Coated Articles	IS: 2633-1992, ASTM A123 CSA G164
19	Code of Practice for Earthing	IS: 3043-1991
20	Single coil Rectangular section Spring Washers for Bolts, Nuts	IS: 2002 1004 DIN 127
20	Screws	IS: 3063-1994, DIN-127
21	High Strength Structural Bolts	IS: 3757-1992
22	Specification for Hot zinc coatings on structural steel and other Allied	IS: 4759-1990
	products	15, 5260, 1001
23	Code of Practice for Design installation and Maintenance of	12: 2303-1331
24	Overhead Power Lines	IS: 5613-1993
	Section 1 Design Part 2,	
	Section 2 Installation and Maintenance	
25	Specification for Heavy Washers for Steel structures.	IS: 6610-1991
26	High Strength Structural Nuts	IS: 6623-1992
27	Hexagon Bolts for Steel Structure.	IS: 6639-1990, ASTM A394 CSA B334
28	Method for Determination of weight of Zinc coated iron and Steel Articles.	IS: 6745-1990, ASTM A90
29	Specification for Weldable Structural Steel (Medium & High Strength Qualities)	IS: 8500-1992
30	Step Bolts for Steel Structures	IS: 10238-1989
31	Bolts for Transmission Line Towers	IS: 12427-1988
20	Code of practice for design and construction of foundation for	15:4001 1070
32	transmission line between tower & poles.	okhariya 132 kV Transmission Line.
33	Specification for hot dip galvanized coating and fasteners	IS:5358
34	Specification for tolerance for fabrication of steel structures	IS: 7215-1992



CHAPTER - 5 TOWER FOUNDATION AND CIVIL WORKS



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5 TOWER FOUNDATION AND CIVIL WORKS

5.1 General

The Contractor shall furnish all materials, equipment and labor and perform all operations required for the design and construction of all of the concrete foundations and other relevant civil works, as specified herein and as evidently necessary to complete the work.

Before start of design of foundation, successful bidder shall carry out geotechnical investigation during detailed/ check survey of Transmission Line route primarily consists of laying trial boreholes (normally up to 6.0 meter below natural ground level) at all tower locations or as directed by the Employer to have a fair idea of soil type/ nature and subsoil water position. If the soil characteristics are changing rapidly or soil up to 6.0 meter is very weak, the depth of borehole be increased beyond 6.0 meters so as to know the soil properties/ type below the foundation. The bore log data containing information such as position of sub-soil water table, soil strata, the crop pattern in the agricultural fields where the foundation is to be laid and the suitability for founding the required foundation, shall be submitted to the Employer for according to approval for "Classification of foundation" at each location.

5.2 Foundation Design

General

The foundation for tower structure plays an important role in the safety and satisfactory performance of the structure as it transmits the load from the structure to the soil. Therefore, the foundation shall be so designed to carry the entire load as required, with sufficient factor of safety as recommended by the Code of practices.

The foundation in various types of soils shall be designed to suit the soil conditions of type, from the recommendation of the geotechnical investigation report, which has to be approved by the Employer.

Several types of foundations are used for different types of transmission towers and different types of soil. The foundation should be strong and stable, and able to take care of all the loads like dead load, live load, wind loads, seismic load, erection loads etc., causing vertical thrust, uplift as well as horizontal reaction.

The quantity of foundations in every type given in the Price Schedule is provisional only and may vary as per the result of the detailed soil test.

Foundations should be designed for a working life of 50 years and Bidders should comply in full with the requirements of these specifications in establishing his design. In all locations, all steelwork, whether part of the tower or part of the stub angle foundations shall be completely encased in concrete to ensure a cover of 100mm from any part of the stub leg or tower from a point 300mm above ground down to the base of the main foundation block. All Stubs shall have cleats designed to carry the entire stub load.

The Contractor shall design at least one foundation for each of the foundation types specified on the bid drawings for all types of towers used in the line to produce an economical family drawings and calculation for the approval of the Employer or Employer's representative before commencement of construction. Upon completion of detailed soil test, the Contractor shall select the most economical foundation subject to the approval of the Employer or Employer's representative. The general foundation design parameters are given in Schedule A. 13 and Conceptual Drawing is given in Dwg. No. DWG012.

Submittal

The Contractor shall submit for each type of foundation required number of sets of design calculations, detail drawings and reinforcing steel and concrete schedules to the Employer or Employer's representative for review and approval/ comment before construction commences. Review of the foundation designs by the Employer or Employer's representative in no way relieves the Contractor from his responsibility for an adequate foundation design, even though this specification sets forth the basic foundation design criteria. Upon receiving the Employer's or Employer's representative's comments, the Contractor shall submit to



the Employer required number of sets, electronic copy and prints of drawings of all foundation details, including reinforcing steel schedules on drawing sheet sizes, form, heading, etc., as required by the Employer for record.

Structural Design of Foundation

It comprises the design of chimney and the design of base slab/ pyramid/ block. The structure design of chimney shall be suitable for maximum bending moments due to side thrust in transverse and longitudinal directions combined with uplift (tension), down thrust (compression). The combined uplift and bending shall determine the requirement of longitudinal reinforcement in the chimney. The stub angle shall be embedded in the chimney to its full depth and anchored to the bottom slab/ pyramid. The chimney shall be designed considering the passive resistance of soil leaving 500 mm from ground level.

Design of foundation based on stub embedded in the chimney for required development length alone and the same is not taken to bottom of the foundation, is not permitted.

Structural Design of Base Slab

The base slab in RCC foundation may be single stepped or uniform. The design of concrete foundation shall be done as per Limit state method of design given in IS: 456 and CBIP manual latest.

Criteria for Structural Design of Foundation

- a) Isolated identical footings shall be provided for each leg of the tower.
- b) All foundations shall be designed to satisfy and meet the following requirements:
 - i) The chimney of the foundation shall at least be 400 mm square providing a minimum clear concrete cover of not less than 100 mm over any part of the stub angle in case of dry foundations and at least 450 mm square with minimum clear concrete cover of not less than 150 mm over any part of the stub angle in case wet, fully submerged foundations.
 - ii) The chimney top shall extend 500 mm (Minimum) above ground level and coping shall be up to 50 mm below the joint between the bottom bracing and the leg members.
 - iii) In all foundations, a lean concrete sub-base having a thickness of 100 mm and of size equal the concrete pyramid base/ RCC shall be provided under structural concrete. The lean concrete shall be of grade M-10 (1:3:6) conforming to IS: 456-2000. The lean concrete sub- base provided under the footings shall not be considered in the structural calculations.
 - iv) The embedded end of the stub angle shall have a 150 mm thick clear concrete cover up to the top of the lean concrete sub-base in the case of dry foundations and a 200 mm thick clear concrete cover in the case of wet, partially submerged and fully submerged foundations.
 - v) The depth of foundation below ground level shall not be more than 3.0 m.
 - vi) The centroidal axis of the stub shall coincide with axis of the chimney and pass through the centre of the footing base. The design of the foundation shall take into account the additional forces resulting from eccentricity introduced due to non-compliance of above requirements.
 - vii) Wherever reinforcement is provided in foundation, the clear concrete cover to reinforcement shall not be less than 50 mm.
 - viii) The slab type isolated RCC foundations shall also satisfy and meet the following requirements:
 - The structural design of foundations shall be strictly in accordance with IS: 456-2000 and other relevant IS codes.
 - The design of RCC foundations shall be carried out by Limit state method in accordance with IS: 456-2000.
 - The minimum thickness of footing slab at chimney perimeter shall not be less than 300 mm.
 - The minimum thickness of footing slab at the edges shall not be less than 150 mm as specified in IS: 456-2000.

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• In the design of the footing slabs, actual soil pressure under the footing shall be considered to calculate the maximum moments and shears at various sections. The critical sections for moments and shears shall be as specified in IS: 456-2000. The reinforcement in the footings shall be accordingly calculated and provided.

5.3 Design loads

The loads used to design the foundations shall be actual loads applied to the foundations by the towers.

The foundations shall be designed in such a manner that the factors of safety shall not be less than the following requirements:

Types of loads on foundations

The foundation may be subjected to three types of forces (ultimate loads):

- Compression or downward thrust
- Tension or uplift, and
- Lateral force or side thrust in both transverse and longitudinal directions.

The magnitudes of each type of load depend on the type of tower and configuration of the transmission lines.

Partial factor for safety of foundation 1.1



W	/eight of concrete (Kg/m ³)	Dry	Wet, PS and FS
1.	Plain(M10)	2240	1240
2.	RCC(M15)	2400	1400
3.	RCC(M20)	2400	1400

SN	Type of Soil	Angle of Earth Frustum (deg)	Unit wt of soil(Kg/m³)	Limit Bearing capacity(kg/cm ²)
1	Normal Dry soil without under cut	30	1440	25000
2	Wet soil due to presence of sub soil water /surface water	15	940	12500
3	Black cotton soil			
	a) In Dry portion	0	1440	12500
	b) In wet Portion	0	940	12500
4	Sandy soil			
	a) With clay content 0-5%	10	1440	25000
	b) With clay content 5-10%	20	1440	25000
5	Fissured rock/Soft Rock	10	940	62500
	In wet portion with under cut			
6	Hard Rock	-	-	125000



Unless specified otherwise, design and details shall comply with the latest published editions of BS /IS 6403, IS456, IS 1786, CBIP Tower manual or with other standard specifications provided they are of equal or higher standard. Support foundation designs which in the opinion of the Employer or Employer's representative do not demonstrate an acceptable type of foundation for the type of soil condition will be rejected.

5.4 Foundation type

In some sections of the proposed transmission line, the water level of terrain is high. In such cases the foundation is to be designed for fully submerged condition. If required by the Employer, the Contractor shall construct embankments for tower sites where footings are located in standing water of sloughs, potholes and marshes. No separate payments shall be made for such embankments.

Reinforced cement concrete footing shall be used for all types of normal towers/ extension towers in conformity with the present-day practices followed in the country and the specifications laid herein. All the four footings of the tower and their extensions, if any shall be similar irrespective of down thrust and uplift.

Foundation includes supply of materials such as cement, fine and coarse aggregates, water, reinforcement steel and binding wire etc. Rates quoted for foundations shall include all items of work relating to supply and installation of foundations such as form work, excavation and back filing with good soil, compaction, stub setting, shoring & timbering etc. wherever required, placing of reinforcement in position, concreting and all other works related for completion of foundation.

Classification of Foundations

General Classification of Foundations

The foundation classification shall depend upon the type of soil, subsoil water level and the presence of surface water which have been classified as follows:

a. Dry Foundation

To be used for locations where normal dry cohesive or non- cohesive soils are met and sub- soil water is met at 3.5 meters or more below the ground level.

b. Wet Foundation

To be used for locations:

- i. Where sub- soil water is met at 1.5 meters or more below the ground level.
- ii. Which are in surface water for long periods with water penetration not exceeding one meter below the ground level e.g. the paddy fields.

c. Fully Submerged Foundation

To be used at locations where sub-soil water is met at less than 1.5 meters below the ground level.

d. Dry Fissured Rock Foundation

To be used at locations where decomposed or fissured rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature is met, and sub- soil water is met at 3.5 meters or more below the ground level. Under cut type foundations are to be used for this Foundation.

e. Wet Fissured Rock Foundation

To be used at locations where decomposed or fissured rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature is met, and sub- soil water is met at 1.5 meters or more below the ground level. Under cut type foundations is to be used for this Foundation.

f. Hard Rock Foundation

The locations where chiseling, chemical breaking after drilling and blasting is required for excavation, hard rock type foundations are to be used. For these locations rock anchoring is to be provided to resist the uplift forces.

For quoting prices of Hard Rock foundations Rock level shall be assumed at 1.5 meters below the ground level.



Due to change in Rock level, no extra payment shall be payable on account of increase in concrete volume, excavation volume and weight of reinforcement, also no recovery shall be made if the actual volume of concrete, excavation and weight of reinforcement are less than that quoted in Schedule of prices. However, for design purposes, Rock level shall be considered at ground level and no over burden soil weight shall be considered for resisting the uplift.

- g. In addition to above, if required, depending on the site conditions special type foundations shall also be provided by the Contractor suitable for intermediate conditions under the above classifications to affect more economy for following reasons:
 - a) Shallow Depth or *Raised Chimney foundations* are necessarily required to suit the site condition or
 - b) Soil properties as per the soil report at a particular location are found inferior to that considered in design. However, in case, soil properties as per soil report are found superior to that considered in design, no change in foundation design/ price shall be applicable.

The proposal for special foundations shall be submitted by the Contractor based on the detailed soil investigation report to suit site conditions and approval for the same shall be obtained from the Employer. The decision of the Employer shall be final and binding with respect to the requirement of special foundation.

Payment for concreting and reinforcement bar for *raised chimney foundation* shall be made in accordance to unit rate as stated in BoQ. But no extra Payment of foundation excavation and back filling, shoring, formwork etc. shall be made on such item.

5.5 Footings Concrete

spread footing

The foundation shall be designed to carry maximum shear loads below ground level, that is, the stub legs are not to be considered as reinforcement. Allowance shall be made for the loss of uplift resistance due to overlap of frusta where applicable. Uplift foundations shall be cast against undisturbed soil for a minimum height of 250 mm and 50 mm lean concrete.

For the purpose of bidding, the Bidder shall design each type of foundation with the value of soil bearing capacity as stated in Foundation Application Schedule.

These are only reference values and are taken from a similar type of soil location from nearby site. After award of contract the Contractor shall carry out detailed soil test of support site and shall design each type of support foundation accordingly. No extra payment will be made for a change in the quantity of concrete/ rebar and other associated works due to change in design parameters.

Pile Foundation

This type of foundation is usually adopted when soil is very weak and has very poor bearing capacity or the foundation has to be located in filled up soil or tower are to be erected in the land which is prone to flash flood. Piles are long and slender members which transfer load to the deeper soil or rock of high bearing capacity avoiding the shallow soil of low bearing capacity.

The piles should be cast in place fast setting concrete which should have 28-day cubical compressive strength of 210 kg/sq.cm.

The pile should be designed for a minimum pile diameter of 900mm.

Piles in a footing should be firmly connected by horizontal tie beam of minimum 900x900mm sizes with adequate reinforcement which should be 1.5m above the existing ground level.

Though NEA has not envisaged the need of Pile foundation in this route, incases need is seen after soil test, cost along with design should be as per the BOQ and the design costis deemed to be included.

All arrangements for anchor plate (or any other arrangement) with anchor bolts etc. whichever is appropriate for the connection of the tower legs to the foundation shall be in the scope of the pile foundation.



Spread foundation in hard rock

The rock which cannot be excavated using normal tools and requires chiseling, drilling and blasting are classified as hard rock. These include hard sandstone, quartzite, granite, basalt, marble etc.

The foundation in hard rock shall be designed to carry maximum shear loads below ground level, that is, the stub legs are not to be considered as reinforcement. Allowance shall be made for the loss of uplift resistance due to overlap of frusta where applicable. The footing should be safe against overturning. In case it is unsafe against overturning, appropriate measures (e.g. counterweight) should be provided.

5.6 Stub Angle Anchor Stub

Angle

Tower Stub angles shall be of galvanized steel and thickness shall be 2mm more than the structure leg member to which it will be attached. The stub angle shall be included (with stub contribution in chimney design) in the calculation of the steel reinforcement requirements against bending and tension forces in concrete foundation design.

Only those holes in the stub which have been previously punched and galvanized at the manufacture's works will be used for the attachment of cleats. Site drilling will not be permitted.

Stub setting template

Stub setting templates, for the approval of Employer or Employer's representative, shall be provided by the Contractor. They shall be of such design and construction as to resist distortion and damage and withstand repetitive use. They shall be manufactured from mild steel angle or channel or a combination of both, of approved and adequate cross- section, and shall be equipped with central alignment notches or holes corner braces, riser braces, and stub-angles in respect of the following requirements:

- Route longitudinal center line
- Structure lateral central line
- Stub elevations (with reference to datum)
- Stub leveling
- Stub rake
- Stub hip bevels
- Stub angle spacing

No concreting shall be commenced before the stub setting is approved by the Employer or Employer's representative. After the completion of Works all the template sets shall be handed over to Employer. No extra payment for the design, manufacturing and delivery for the templates shall be claimed by the Contractor.

5.7 Excavation and Backfilling

Scope

This specification covers the general requirements of earthwork in excavation in different materials, filling back around foundations, conveyance and disposal of surplus spoils or stacking them properly as shown on the drawings and as directed by the Employer or Employer's representative and all operations covered within the intent and purpose of this specification.

General

- a. The Contractor shall furnish all tools, plants, instruments, qualified supervisory personnel, labor, materials, any temporary works, consumable, and everything necessary, whether such items are specifically stated herein, for completion of the job in accordance with specification requirements.
- b. The Contractor shall carry out the check survey of the site before excavation and set properly all lines and establish levels for foundations.

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- c. The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades on ground excavated areas and warning lamps at night to ensure safety.
- d. The item also includes for dumping of excavated materials in regular heaps, bunds, riprap with regular slopes as directed by the Employer or Employer's representative, within the lead specified and leveling the same so as to provide natural drainage. Rock/Soil excavated shall be stacked properly as directed by the Employer or Employer's representative. As a rule, all softer material shall be laid along the center of the heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.
- e. Clearing

The area to be excavated/ filled shall be cleared of trees, plants, logs, stumps, bush, vegetation, rubbish, slush etc. and other objectionable matter. If any roots or stumps of trees are met during excavation, they shall also be removed. The materials so removed shall be burnt or disposed of as directed by the Employer. Where earth fill is intended, the area shall be stripped of all loose/ soft patches, topsoil containing objectionable matter/ materials before filling commences.

f. Precious object, relics, objects of archeological importance

All gold, silver, oil, mineral, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the Employer and Contractor shall duly preserve the same to the satisfaction of the Employer and from time to time deliver the same to such person or persons as the Employer may from time to time authorize or appoint to receive the found goods.

- g. The Contractor shall excavate earth, rock, stumps, and all other materials encountered as required for construction of each foundation. The Contractor shall place all suitable excavated material in backfill or in graded embankment in the immediate area at structures. Materials found to be unsuitable for foundation backfill or grading shall be wasted and disposed of at Contractor's own cost.
- h. The Contractor shall excavate each foundation hole to the nominal excavation depth for the applicable foundation type except in case where the material being excavated is not capable of supporting 0.5 kg/sq.cm.
- i. At the nominal excavation depth, the foundation shall be carefully graded to a level plane and all loose or disturbed material shall be removed. The foundation excavation shall then be examined by the Contractor and a final determination will be made on the foundation type to be used.
- j. Excavations shall be maintained in a clean, safe and sound condition until completion of the foundation construction and shall be diked to prevent flooding by surface runoff. Suitable pumping equipment shall be provided and used to dewater excavations so that all installation work and backfilling is performed in the dry state. Any previously prepared foundation bearing surface that is softened by water runoff or otherwise contaminated before placement of the structure foundation shall be excavated and replaced at the Contractor's expense.
- k. Those excavations where the base is unstable, lies below groundwater level, or has been over excavated, the Contractor shall furnish and place a layer of crushed stone, or selected backfill, or borrow to stabilize the base for placement of foundation materials. No extra payment shall be made for over-excavation and backfilled crushed stone layer.
- I. Topsoil and excavated material that is suitable for backfill around the foundations shall be stockpiled separately for use in backfill. Material that is unsuitable for backfill shall be disposed of. The stockpiles shall be sloped to drain and shall be protected from rainfall or other elements, which render the material unsuitable for backfill.
- m. Backfill shall be placed in not greater than 20cm lifts before compaction. Each lift shall be thoroughly compacted before the following lift is placed. Pneumatic or equivalent tampers shall be used on cohesive materials; vibratory compactors shall be used on non-cohesive materials. Compaction shall achieve a density at least equal to that of the surrounding undisturbed earth. Large stones or rock fragments may be used in the backfill provided they do not interfere with proper compaction. Particles larger than 25 cm shall be placed



not nearer than 0.5 m of the structure and at least 1.0m below ground surface.

- n. Rock particles larger than 10 cm shall not be in contact with the concrete.
- o. Following completion of 75 percent of the compacted backfill portion, the remaining backfill, and topsoil shall be placed and the topsoil mounded 30 cm above the ground surface and sloped to drain. Compaction of this material will not be required. Before final acceptance of the Works, the Contractor shall refill any locations that settle below the surface of the surrounding ground.
- p. Earth is defined as material which shall include all kinds of soil containing gravel, sand, silt, moorum or shingle, gravel, clay, loam, peat, ash, etc. which can generally be excavated with the aid of shovels and pick axes. This shall also include embedded rock boulders not longer than one meter in any direction and not more than 200 mm in any of the other two directions.
- q. Rock is defined as material which shall include rock, boulders, shale, chalk, slate, hard mica, schist, laterite and all other materials which in the opinion of the Employer is rock and can be removed with picks, hammer, wedges, crowbars, pneumatic breaking equipment and blasting. This category shall also include excavation in macadam and tarred roads and pavements.
- r. Rock excavation may be done by drilling, barring, wedging, or compressed-air tools. No blasting will be permitted. The Contractor shall furnish all material and equipment to perform all the work required for excavation of rock.

For selection of rock type foundation for any tower location, the characteristics of rock shall be thoroughly investigated by the Contractor. Disintegrated rock or other types of rock such as soluble limestone, soft shale, slate, hard pan and organic rocks may not be suitable for construction of rock foundation.

s. All loose boulders, semidetached rocks (along with earthy mounds) not directly in the excavation area but so close to the area to be excavated as to be liable, in the opinion of the Employer, to fall or endanger the workman, equipment or the Works, shall be stripped off and removed away from the area of the works. Any material not requiring removal as contemplated in the work, but which in the opinion of the Employer is likely to become loose or unstable later, shall also be promptly and satisfactorily removed as directed by the Employer.

Payment:

No separate or direct payment will be made to the Contractor for preparation of site, excavation, and backfill and rock excavation of tower foundation. All costs of soil and rock excavation incurred in connection therewith shall be included in the unit bid prices for the construction of the various foundation types.

5.8 Dewatering

Scope

This specification covers the general requirements of dewatering during excavations in general.

a. All excavations shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas.

The Contractor shall remove by pumping or other means approved by the Employer or Employer's representative any water inclusive of rainwater and subsoil water accumulated in excavation and keep all excavations/trenches free of water required for further work.

Method of pumping shall be approved by the Employer or Employer's representative; but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing-in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction.

b. When there is a continuous inflow of water and quantum of water to be handled is considered in the opinion of the Employer as large, well- point system- single stage or multistage shall be adopted. The Contractor shall submit to the Employer his scheme of the well-point system including the stages, the spacing number



and diameter of well points, headers, etc., and the number, capacity, and location of pumps for approval.

Payment

No separate or direct payment will be made to the Contractor for dewatering of tower foundation and any other foundation works. All costs incurred in connection therewith shall be included in the unit bid prices for the construction of the various foundations and other civil works.

5.9 Timber Shoring

Scope

This specification covers the general requirements of timber shoring for open excavations for structure foundation.

a. Close timbering shall be done by completely covering the sides of the pits generally with short, upright members called polling boards. These shall be of minimum 25 cm x 4-cm sections or as directed by the Employer or Employer's representative.

The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal walling of strong wood at maximum 1.2 meters spacing, strutted with bellies, or as directed by the Employer or Employer's representative. The length of the bellies struts shall depend on the excavation and supported by vertical walling, which in turn shall be suitably strutted. The lowest boards supporting the sides of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

- b. Timber shoring shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit. The type of timbering shall be as approved by the Employer. It shall be the responsibility of Contractor to take all necessary steps to prevent the sides of excavations, pits, etc., from collapsing.
- c. Timber shoring may be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instruction from the Employer.

Payment

No separate payment will be made to the Contractor for timber shoring. All costs incurred in connection therewith shall be included in the unit bid prices for the construction of the various foundation types and other civil works.

5.10 Select Borrow

- a. Where the material excavated for the foundation is unsuitable for backfill or is required for construction of embankment, the Contractor shall provide and compact select borrow. Excavated material shall be disposed of at the Contractor's own expense.
- b. Material for selecting borrow shall be well-graded bank-run gravel, relatively free from clay, loam or vegetation matter and with no stones over 10 cm in maximum dimensions, or materials of equivalent strength and characteristics. Representative sample from proposed borrow sources shall be submitted to the Employer for approval of the borrow source. Approval of borrow source shall not mean automatic approval of all materials obtained from that source.
- c. The Contractor shall, at his option, use areas approved by the Employer or Employer's representative for production of select borrow or at his own expense, make arrangements for obtaining select borrow at other sources.
- d. The selected borrow shall be placed and compacted as specified for the backfill in Article 5.7 Excavation and Backfilling.

Payment:

No separate payment will be made to the Contractor for select borrow required for back filling tower foundation.



Hence, all costs incurred in connection therewith shall be included in the unit bid prices for the construction of the various foundation types and other civil works.

5.11 Foundation Construction

General requirement

All materials and labor required for the construction of foundations shall be furnished by the Contractor.

- a. The Contractor will be required to remove and replace at his expense any materials incorporated in the work that do not conform to these specifications.
- b. The Contractor shall furnish without any extra cost all materials the Employer require for testing. The cost of the tests shall be borne by the Contractor.
- c. The final selection of the type of foundation footing to be actually constructed for each particular structure will be done by the Contractor after the results of the sub-soil tests and shall be subject to the approval of the Employer.

Measurement for Foundation Payment

Measurement for payment for the Contract item, Foundations, shall be on the basis of the actual number of each type of structure foundations constructed by the Contractor.

Payment

Payment for the contract item, "Foundation", will be made at the unit price per tower, such unit price shall include full compensation for all costs incurred in furnishing all materials, equipment and labor and all other operations related to Foundation design and construction, including but not limited to:

- i) Performing detailed foundation design and preparation of construction drawings.
- ii) Supply and transport all foundation materials such as concrete, reinforcement, etc. to the job site.
- iii) Tower pegging and foundation orientation.
- iv) Excavation, dewatering, timber shoring and backfilling for the foundation.
- v) Gravel packing in the base of footings, where necessary.
- vi) Template and stub setting
- vii) Lean concrete
- viii) Construction of foundations and associated works.

Reference to standard specifications

Standards referred to in these specifications are as follows:

- a. ASTM referred to the latest edition of publications of American Society for the Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.
- b. ACI refers to the latest edition of publications of American Concrete Institute, P.O. Box 19150, Redford Station, and Detroit, Michigan 48219.
- c. BIS referrers to the latest, Bureau of Indian Standard Manak Bhawan, 9. Bahadur Shah Zafar Marg, New Delhi India.

Measurement Standards

Measurement standards referred to in these specifications are as follows:

- a. Gallons Wherever used in these specifications, gallons shall be understood to be U.S. gallons.
- b. Bag Wherever used in these specifications, bag will be understood to mean 50-kg bag of Portland cement.



Concrete shall be composed of cement, sand, coarse aggregate, water, and admixtures, if required, all well mixed and brought to the proper consistency.

Concrete

The Contractor shall design and test concrete mixes, which have 28-day cubicle compressive strength of 210 kg/ sq.cm.

- a. At least one month prior to the placement of any concrete, the Contractor shall make a set of test concrete compressive strength test cubes for each design mix under field conditions. The test cubes shall be made and tested in accordance with the applicable standards.
- b. The concrete mix shall be of such proportions as to produce a plastic and workable mix which will not separate during the placing and will finish well without using excessive quantities of mixing water. Addition of water to compensate for stiffening of concrete before placing will not be permitted. Uniformity in concrete consistency from batch to batch will be required.
- c. After the test results are known for the field condition test cubes, the Contractor shall submit these results to the Employer or Employer's representative and the Employer or Employer's representative will notify the Contractor of the approval of test results and the acceptable design mixes.
- d. When placing concrete in hot weather, the recommendations of the American Concrete Institute's publication "Recommended Practice for Hot Weather Concreting"(ACI 605) or equivalent shall be followed insofar as the Employer or Employer's representative may direct.

The use of set accelerators will be at the Employer's or Employer's representative's discretion. For concrete placed during extremely hot weather, the aggregate shall be cooled by frequent water spraying in such a manner as to utilize the cooling effect of evaporation. Concrete with a temperature of 35 degree centigrade or higher before placement will be rejected and shall be wasted at the Contractor's expense.

e. Submerge concrete

Concrete to be placed under water shall be deposited by tremie, and only after it has been determined by the Employer or Employer's representative that placing of concrete in an unwatered excavation cannot be practically accomplished by any other means. The tremie will not be allowed to drop below the level of water outside. Under no circumstances will concrete be allowed to drop through water within the tremie.

The tremie shall be watertight and sufficiently large to permit a free flow of concrete. The bottom of the tremie shall be as near to the surface against which the concrete is to be placed as practicable and the tremie shall not be raised until seal has been established by the concrete sufficiently to prevent the entry of water of the tremie. The discharge of the tremie shall be kept submerged in concrete at sufficient depth so as to maintain an adequate seal during underwater placement. Placing of concrete shall proceed without interruption until underwater placing in the foundation has been accomplished. As placing of concrete under water progresses, the Contractor shall remove water displaced by the concrete when the top of the concrete being placed by tremie reaches the elevation of the water table level; no further placement by tremie shall be performed.

- f. The concrete used as lean concrete or base concrete shall be mentioned on respective drawings. The aggregate size shall be 40 mm nominal. Base concrete shall be well compacted. The top surface of base concrete shall be leveled before placing the reinforcement.
- g. During excavation, if excavation exceeds the required depth or if any loose pocket of earth is met below the base of footing, then the loose earth shall be removed, or excavation depth be increased till normal hard soil is met as per satisfaction of the Employer. This extra depth shall be filled with lean concrete. No extra shall be paid on account of this extra excavation and lean concrete.
- h. The cement concrete used for foundation shall be of grade M-20 (1:1.5:3) nominal Mix (1:1.5:3) conforming to IS 456 using 20mm size coarse aggregate shall be adopted.
- i. The Water Cement ratio shall be minimum 0.50 and maximum 0.55.
- j. For volumetric use of ingredients for concrete mix, the contractor along with the Mix Design shall intimate



the size of measuring boxes along with the Mix design.

- k. The nominal of Mix Design shall not absolve the contractor from the responsibility of achieving the required strength, workability etc. during actual execution. In case of failure of concrete samples, the work done is liable to be rejected. In such a case the contractor shall recast the foundation at the same location by dismantling the rejected foundation or at a nearby location as directed by the Employer. In case of honey combing, the contractor shall do the pressure grouting as directed and to the full satisfaction of the Employer. The construction of a new foundation in place of rejected one and pressure grouting if done shall be without any extra payment.
- I. The water used for mixing concrete and for curing purposes shall be fresh, clean, and free from oils, acids and alkalis, organic materials or other deleterious substance. Potable water is generally preferred. Saltish or brackish water shall not be used. Water used shall conform to clause 5.4 of IS 456.

Cement and Aggregates

In locations where conditions do not require high sulphate resistance, cement shall conform to the requirements of ASTM C150 Type T or equivalent (IS263, IS 8112, IS 12269)

- a. In locations where, in the opinion of the Employer or Employer's representative, the conditions require the use of high sulphate resistance cement, cement conforming to the requirements of ASTM C150 Type V or equivalent shall be used. No extra payment will be made to the Contractor for the use of high sulphate resistance cement.
- b. The aggregates shall consist of clean, natural material or, subject to the approval of the Employer or Employer's representative, manufactured aggregates may be used.
- c. Aggregates shall be separated into sand and coarse aggregate before being used. The Employer or Employer's representative will permit no pit or crusher run materials without prior approval.
- d. Natural fine aggregate or sand shall be graded within the following limits and the fineness module be between 2.5 and 2.8 as per IS 383:

Sieve size		Amounts Finer than	
Laboratory (U.S Std. Sieve)		Each weight Percent	
3/8	(9.5mm)	100	
4	(4.75mm)	95 to 100	
8	(2.36mm)	80 to 100	
16	(1.18mm)	50 to 85	
30	(600 micron)	25 to 60	
50	(300 micron)	10 to 30	
100	(150 micron)	2 to 10	

Natural coarse aggregate shall be graded within the following limits, depending upon the clear spacing between reinforcing bars.

U.S. Sta	ndard Sieve	Nominal 1-1/2"	Nominal 3/4" (19mm)
2"	(50.8mm)	100	



U.S. Standard Sieve		Nominal 1-1/2"	Nominal 3/4" (19mm)
1-1/2"	(25-38mm)	95-100	
1"	(25mm)	70-95	100
3/4"	(19mm)	35-70	90-100
3/8"	(9.5mm)	10-30	20-55
No.4	(4.75mm)	0-5	0-10
No.8	(2.36mm)		

Slump

All concrete used shall have a slump of maximum 120 mm and minimum 75 mm at the time of placing. The water cement ratio shall be determined by consideration of the specified strength, the water reducing admixtures, the slump required for proper placement, air entraining requirements the available and maximum allowable aggregate size and its specific gravity, and the amount of water carried on the aggregates.

The slumps and maximum sizes of aggregate as well as the computation of trail mixes shall be as described in the America concrete Institute Recommended Practice for Selected Proportions for concrete (ACI 613).

Storage of material

Cement and aggregates shall be stored at the Site of the work in such manner as to prevent deterioration or intrusion of foreign matter in Contractor's own cost. Special care shall be taken in storing cement to keep it thoroughly dry at all times.

- a. Cement that has been caked in storage is still usable only if, when pressed between the thumb and fingers, it powders readily. Otherwise, its use will not be permitted.
- b. When reinforcing steel is delivered to the job site in advance of the Contractor's requirements, the Contractor shall provide suitable protection to prevent rust developing on the reinforcing steel as it will be Contractor's responsibility to remove the rust.

Concrete mixing and placing

Before any concrete mixing is begun, all equipment for mixing, transporting and debris shall be cleaned of all dirt and debris. All dirt and debris shall also be removed from the places to be occupied by the concrete.

- a. All mechanical equipment shall be checked before starting a concrete pour to ascertain whether it is in good operating condition and if not shall be tuned up, or repaired, or replaced to the satisfaction of the Employer or Employer's representative. Also, the stock of construction material (cement, aggregate and sand) shall be checked before starting the concrete work to ascertain whether or not it is in sufficient quantity for one foundation work.
- b. When a foundation location is ready for concrete placement, the Employer shall be notified at least 24 hours prior to concreting so that he may inspect to assure that the excavation is free of water, mud and debris; that the bottom surface of the excavation is well leveled and compacted; and where required, a crushed stone sub-base has been placed; that the reinforcing steel is properly secured in place; and that the formwork is properly braced.
- c. Rock surfaces shall be as flat as possible and projecting ridges shall be leveled off before the concrete is placed or spaces between the ridges shall have been previously filled with concrete to form a horizontal surface.



- d. The Contractor shall see that all material that is to be embedded in the concrete has been placed before the concrete is placed. The Contractor shall be responsible for the accurate location of all embedded materials. Any work inaccurately or improperly set shall be relocated and reset at the Contractor's expense.
- e. All batching components of the concrete shall be accurately measured. Measuring on a weight basis is preferred, however, measuring on a volume basis will be allowed as long as careful controls are maintained. Weight measurements shall be made using standard batching equipment for large quantities and wheelbarrow scales for small quantities. Volume measurements shall be made in batching boxes. The batching boxes shall be as large as is practical.
- f. The batch mixer shall be rotated at a speed recommended by the manufacturer and mixing shall be continued for at least one and one-half (1-1/2) minutes after all materials are in the mixer, unless the size of the batch is over 1.2 cum., when additional mixing time shall be required as advised by the Employer. A mechanically-operated batch mixer shall be used for mixing unless otherwise approved by the Employer.
- g. The tempering of concrete which has partially hardened, that is, remixing with or without additional cement, aggregate or water, will not be permitted.
- h. Concrete shall be conveyed from the mixer to the place of final deposit within 30 minutes by methods which will prevent the segregation or loss of the materials. After 30 minutes of mixing the concrete shall be rejected and replaced by fresh concrete without any extra cost to the Employer.
- i. Equipment for chuting, pumping and pneumatically conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete at the delivery end without separation of the materials. The chutes shall never be on a slope that is steeper than two vertical to three horizontal. Conveying equipment shall not have any aluminum parts that come in contact with the concrete.
- j. When the concrete is to be placed on hard rock or other concrete, after the existing surface has been properly cleaned and otherwise prepared, the existing surface is to be wetted until it is saturated. The first batch of concrete placed shall be a grout obtained by omitting the coarse aggregate from the mix and reducing the water as required. The grout shall be evenly spread on the water-saturated surface and then the concrete shall be deposited continuously and as rapidly as practicable.
- k. The concreting shall be carried on at such a rate that the concrete is at all time plastic and flows readily into the spaces between the bars and so that each successive layer properly bonds with its predecessor. Successive layers shall be placed within 15 minutes of the preceding layer.
- I. When placing foundations with drops over 2 meters, hoppers and trunks must be provided of a size to allow for proper placing.

No less than four hoppers of any size shall be available and used, if requested, and enough sections of trunk shall be furnished to reach within 500 mm of the bottom of the foundation.

- m. The concrete shall be compacted during and after depositing by vibration. The concrete shall be thoroughly worked around embedded materials.
- n. All concrete must be consolidated by means of internal vibration except where the Employer has given written permission to use some other method of consolidation. The type and make of vibrator must have a speed of at least 6,000 vibrations per minute (VPM) when the machine is being supplied at its rated voltage, air pressure, etc. The Contractor shall at his own expense, furnish sufficient transformers, compressors, etc. of approved type to operate all vibrators at the voltage, pressure, etc., specified by the manufacturer.
- o. The Contractor shall always have at least two vibrators in operating condition at the location of the concrete placement. The Contractor shall make one set of concrete compressive strength test cubes for each structure or as directed by the Employer or Employer's representative. There shall be three cubes to a set and the cubes shall be made in accordance with ASTM C31. Only one cube shall be made from any one batch containing less the 1/2 cubic meters of concrete. The Contractor shall also make one set of concrete compressing strength test cube for each new batch of cement purchased two weeks before using that cement.



After the cubes have aged at least 24 hours in the field, the Contractor shall deliver them to a location designated by the Employer where they will be tested in accordance with ASTM C39/IS 516. If two of the cubes tested at 28-day tests indicate a compressive strength of 210kg/sq.cm (3,000 psi) or more, the remaining cubes shall be discarded. If the 28-day compressive strength indicates a compressive strength of less than 210kg/sq.cm., the Employer or Employer's representative will determine what remedial measures are necessary and the Contractor shall perform the remedial measures at his own expense. The remedial measures may include, but are not limited to, the replacement of the entire foundation. Payment of foundation works shall only be initiated after submission of satisfactory cube test report to the satisfaction of the Employer.

Concrete formwork

Forms shall be used, wherever necessary, to confine the concrete for structures and shape it to the required lines, or to insure against contamination of the concrete by materials caving or sloughing from adjacent surfaces left by excavation.

- a. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall be maintained rigidly in position. Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Molding strips shall be placed in the corners of forms so as to produce chamfered edges on permanently exposed concrete surfaces. All exposed surfaces may be formed with any material of adequate strength and tightness to hold the wet concrete in proper position and prevent the loss of mortar.
- b. If plywood or steel forms are not readily available, the Contractor with Employer's special recommendation may substitute wood planking provided exposed surfaces are rubbed to remove ridges on exposed surfaces.
- c. The Contractor shall provide templates, which firmly hold the stub angles within 10 mm of the horizontal side setting dimensions and within 5 mm of the required elevation during the placing of the concrete. Details of the templates shall be submitted to the Employer or Employer's representative at least one month before the commencement of any foundation construction. The bottom portion of the structure may be used for this purpose providing that adequate cribbing and bracing are supplied for support.
- d. Before concrete is placed, the surfaces of all forms shall be oiled with a form oil that effectively prevents sticking and will not stain the concrete surfaces. For wood forms, form oil shall consist of straight, refined, pale paraffin mineral oil. For steel forms, form oil shall consist of refined mineral oil compound.
- e. Forms shall be removed only when the strength of the concrete is such that form removal will not result in cracking, spelling, or breaking of edges of surfaces, or other damage to the concrete. Usually, formwork shall be removed after 48 hours from concreting times. Any concrete damaged by form removal or otherwise shall be repaired immediately without any extra cost to the Employer.

Concrete finishing and curing

- a. The exposed top surfaces of all concrete foundation piers shall be slightly sloped to prevent the accumulation of water.
- b. Immediately after the removal of forms, the holes left by form tie rod fasteners shall be filled with mortar and all damaged or defective concrete shall be repaired or removed and replaced to the satisfaction of the Employer or Employer's representative. Improperly consolidated concrete shall be removed by chipping, and the chipped openings or recesses shall be of such depth and shape as required by the Employer or Employer's representative to ensure that the patching material placed in the openings or recesses will be thoroughly keyed and bonded to the concrete. "Dry pack" mortar shall be used for filling relatively deep required for the replacement of defective concrete where surface dimensions of the chipped openings or recesses are relatively large. The depth of chipped recesses for concrete patches shall extend at least 25 mm beyond the nearest reinforcing steel.
- c. To ensure proper curing, all concrete shall be kept moist for a period of at least 10 days. A burlap or an equivalent material or a curing compound shall be applied over exposed concrete surfaces. The burlap shall be always kept moist. If the foundation is backfilled before the one-week curing time has elapsed, the burlap protection shall remain on the exposed projection.

Membrane curing compound

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Membrane curing compound shall be applied uniformly by spray, leaving no pinholes or gaps, at a rate not to exceed 4.91 square meter per liter. The curing compound shall be applied after finishing operations are completed and surface moisture has disappeared. If forms are removed prior to 7 days after placing the concrete, the uncovered surfaces shall be coated with the curing compound as specified herein.

- a. Foundation shall not be backfilled before they have been inspected to see that they are free from surface defects and voids, or that the defects and voids have been properly repaired.
- b. The foundations shall not be subjected to any loads in addition to those existing at the time of the placing of the foundation concrete until the curing period has elapsed.

Torsteel Reinforcing Bar

All torsteel-reinforcing bars shall conform to the requirements of Grade fe-415 (IS :1786) and shall be fabricated in accordance with the "Manual of Standard Practice" of the Concrete Reinforcing Steel Institute.

- a. Mill scale, rust, oil and mud shall be removed from reinforcing steel by firm rubbing with burlap or equivalent treatment before the reinforcing steel is placed.
- b. The minimum center-to-center distance between parallel bars shall be two and one-half (2-1/2) times the diameter of the bars. In no case shall the clear spacing between bars be less than 25 mm nor less than one and one-third (1-1/3) times the maximum size of coarse aggregate.
- c. All torsteel-reinforcing bars shall have a protective concrete cover of not less than:
 - 50 mm on the bottoms of footings and on any surface of concrete that will be exposed to salt water.
 - 50 mm concrete exposed to weather or ground.
- d. Torsteel reinforcing bar shall be accurately located and shall be secured in position by the use of annealed iron wire of no less than No.16 gauge and shall be supported in a manner that will keep the reinforcement away from the exposed concrete surfaces. Concrete blocks shall be used to support the reinforcing steel in the foundation mat; broken stones or wooden blocks shall not be used for supporting the reinforcing steel.

Payment

No separate or direct payment will be made to the Contractor for concrete, lean concrete, tests, form works, etc. reinforcement bars of tower foundation. All costs incurred in connection therewith shall be included in the unit bid price for the construction of the various types of towers.

5.12 Foundation Protection Works

The Contractor shall suggest for foundation protection works where needed. The Employer will evaluate and give instructions for the protection design. The Contractor shall design the protection work and submit design of such protection works for Employer's or Engineer's approval.

Random rubble stone masonry including excavation (1:5 cement concrete)

The stone shall be hand placed with uncoursed close joints to the lines and grades as designed. The rubble stone shall be placed with 1:5 cement mortar after having joints thoroughly moistened. The surface joints shall be finished with 1:3 cement mortar.

After completion of masonry wall, it shall be cured with water for more than 10 hrs.

Weepholes with Perforated Poly Vinyl Chloride (PVC) pipes of 10 cm in diameter shall be made in each 2 sq. m. of slope surface of the masonry wall or as required by site conditions. The upper surface of the masonry wall shall be finished smoothly with concrete. The perforated pipe shall be extended at least 30 cm on both ends from the stone masonry wall & in the backfilling end the perforated PVC shall be covered with gravel at least 30 cm in all-around.



The sides of the stone masonry wall should be backfilled, compacted and leveled as directed by Engineer.

Payment:

Measurement for payment of Random rubble stone masonry works shall be made on the basis of actual placed volume of stone masonry in cubic meters. Payment shall be made for the number of cubic meters measured as provided at the unit price specified in the schedule. The unit price shall include all labor, tools and equipment, materials including furnishing, transporting, and placing the materials, installation of PVC pipes, excavation, gravel packing and all other cost necessary for the performance and completion of the work.

5.12.1 Stone bound in galvanizing wire netting (Gabion) including excavation

The standard type of gabion shall be a flexible hot dip galvanized gabion of the type and size specified below. It is made of wire mesh of the type and size and selvedge as specified in the following:

- The mesh shall be hexagonal woven mesh with the joints formed by twisting each pair of wires through three and half turns.
- The size of mesh shall conform to the standard specification issued by the factory and shall be not greater than 1/3 of the smallest stone filled in the gabion.
- All wire used in the fabrication of the gabions and in the wiring operations during construction shall be "Mild steel wire", i.e. wire having average tensile strength of 44 kg/sq.mm.
- The diameter of the wire used in the fabrication of the netting shall be at least 3.0 mm depending on the design requirement.
- All wires used in the fabrication of the gabions and in the wiring operations during construction shall be hot dip galvanized.

All edges of the standard gabions including end panels and the diaphragms, if any, shall be mechanically selvedge in such a way as to prevent unraveling of the mesh and to develop the full strength of the mesh. The wire used for the selvedge shall have a diameter greater than that of the wire used to form the mesh. The wire will having a diameter of 3.0 mm and the selvedge wire shall have diameter equal to or greater than 3.9 mm.

The stone for the gabion shall be taken from the quarry or river deposit material or as approved by the Employer or Employer's representative. The rock shall be of compact, firmly bound and uniformly grain texture and absolutely weather-resistance, shall not have cracks, holes, laminations, or detrimental materials. The stone blocks shall be of natural irregular cubical shape. The thin sliced blocks shall not be accepted. The size of the stone shall be at least 10 cm.

The sides of the gabion wall should be backfilled, compacted, and leveled as directed by Employer / Employer's representative.

The standard gabion shall have the following dimension:

Length		:	2.0 meter
Width	:		1.0 meter
Height		:	1.0 meter

Sufficient lacing and connecting wire shall be supplied with the gabions for all the wiring operations to be carried out in the construction of the gabion work. The quantity of such wire is estimated to be 8% of the gabion supplied. The 2.4 mm lacing wire shall be used for the gabion made of wire gauge 3.0 mm.

Payment:

Measurement for payment of gabion works shall be made based on actual placed volume of gabions in cubic meters. Payment shall be made for the number of cubic meters measured as provided at the unit price specified in the schedule. The unit price shall include all labor, equipment, materials, excavation, backfilling with compaction and all other costs necessary for the performance and completion of the works.

5.12.2 M20 Concrete Nominal Mix 1:1.5:3 for Protection works

Complete Concrete Works shall be performed as per Article 5.11 "Foundation construction-concrete". The concrete mix shall be as mentioned in BOQ.

Complete steel reinforcement work shall be performed as per IS 456.

Complete Form Work shall be performed as per Article 5.11 "Foundation construction-form works". Payment:

Measurement for payment of "Concrete protection works" shall be made based on actual placed volume of concrete in cubic meters. Payment shall be made for the number of cubic meters measured as provided at the unit price specified in the schedule. The unit price shall include all labor, equipment, materials, excavation, backfilling with compaction and all other costs necessary for the performance and completion of the works.

4.12.4 Benching, Slope Cutting and revetment works:

This section covers the cutting of slopes where sufficient electrical ground clearance of the line is not available. After slope cutting, revetment wall shall be constructed as directed by Engineer. The back filling of the revetment wall shall be done with leveling.

Payment:

Measurement for payment of "Slope cutting and revetment Works" works shall be made based on actual cut volume of slopes in cubic meters. Payment shall be made for the number of cubic meters measured as provided at the unit price specified in the schedule. The unit price shall include all labor, equipment, materials, revetment walls and all other cost necessary for the performance and completion of the works.



CHAPTER - 6 LINE CONDUCTOR



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6 LINE CONDUCTOR

6.1 General

ACSR "BEAR" conductor for 132 kV transmission line from Parwanipur to Pokhariya shall be fully type tested and in production for at least five (5) years.

6.2 Conductor Specification

All conductors shall be of aluminum conductor steel reinforced (ACSR) construction and shall be manufactured in strict conformity with BS 215 (Part 2). Bidders must offer conductor from reputable and experienced manufacturers with not less than five years manufacturing experience and the manufacturers shall possess manufacturing and testing facilities for producing the offered conductor at the time of bidding.

The steel core and the first layer of aluminum of ACSR conductors shall be greased. The grease shall be of neutral type and at a temperature of 100-degree centigrade. The grease shall neither flow within nor extrude from the conductor. The grease shall retain its properties as resistance to oxidization and chemical stability at all service temperatures.

The outermost layer of all conductors shall be stranded with right hand lay.

The correct tension must be maintained on the stranding machine when spinning the cable to avoid the possibility of bird caging during stringing. Any conductor not complying may be rejected at the discretion of the Employer.

The purity of the aluminum shall be the highest commercially available and not less than 99.5%, the copper content not exceeding 0.04%. The Contractor shall submit certificates of analysis giving the percentage and nature of any impurities in the metal from which the wires are made. Aluminum wires shall be made to BS 2627 and steel wires to BS 4565.

Precautions shall be taken during the manufacture, storage, and erection of steel-cored aluminum conductors to prevent the possibility of contamination by copper or other materials, which may adversely affect the aluminum. The manufacture of steel-cored aluminum conductors shall be carried out in a portion of the factory specially set aside for such purposes. Machinery previously used in the manufacture of copper or copper bearing conductors shall not be used for the manufacture of these aluminum or steel wires.

6.2.1 Conductor drum lengths

Conductors shall be supplied on drums of approved construction and the drums shall be securely battened to protect the conductor. Drum battens shall not be removed until the drum is properly mounted at the drum station on the line and battens shall be immediately refitted to the drum if any surplus conductor is left thereon.

Each drum shall be marked with length and size of the conductor and in addition, the conductor manufacturing batch number shall be inscribed on the drum. Empty drums shall become the property of the Employer and be returned by the Contractor to the Employer's stores nominated by the Employer. The maximum length of conductor shall not exceed 2 km per drum.

6.2.2 Creep of ACSR-conductors

When stringing ACSR-conductors, the creep shall be adopted into account using suitable method for stringing the conductor to a higher tension. This is expressed as a temperature difference corresponding to the estimated creep of 21° c

6.2.3 Details of ACSR Conductors

The ACSR Conductor shall generally conform to BS: 215(Part-2) /IS: 398 (Part-II) except where otherwise specified herein.



The details of the ACSR BEAR Conductor are tabulated in schedule A.10 of Chapter-11.

6.2.4 Joints in Wires:

a. Aluminium Wires

No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However, joints in the 12-wire inner layer of the conductor unavoidably broken during stranding provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor lengths. These joints shall be made by cold pressure butt- welding and shall be such that no two such joints are within 15 meters of each other in the completely stranded conductor.

b. Steel Wires

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand nor strand joint or strand splices in any length of the complete stranded steel core of the conductor.

6.2.5 Materials

The Aluminium strands shall be hard drawn from electrolytic aluminum rods having a purity of not less than 99.5% and a copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in IEC: 889-1987.

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or basic open-hearth process, the electric furnace process, or the basic oxygen process and shall conform to the following requirements as to the chemical composition:

Element	% composition
Carbon	0.50 to 0.85
Manganese	0.50 to 1.10
Phosphorus	Not more than 0.035
Sulphur	Not more than 0.045
Silicon	0.10 to 0.35

The steel wire stands shall have the same properties and characteristics as proscribed for regular strength steel wire in IEC:888-1987.

The zinc used for galvanizing shall be electrolytic high-grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS: 209.

6.2.6 Packing

The conductor shall be supplied in non-returnable, strong, wooden drums provided with lagging of adequate strength, constructed to protect the conductor against all damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The drums shall generally conform to IS: 1778, except as otherwise specified hereinafter.

The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5 KN.

The Bidder should submit their proposed drum drawings along with the bid.

For conductors, one standard length not exceeding 2,000 m shall be wound on each drum.



All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative treatment shall be applied to the entire drum with preservatives of a quality which is not harmful to the conductor.

The flanges shall be of two-ply construction with each ply at right angles to the adjacent ply and nailed together. The nails shall be driven from the inside face flange, punched, and then clenched on the outer face. The thickness of each ply shall not vary by more than 3 mm from that indicated in the figure. There shall be at least 3 nails per plank of ply with maximum nail spacing of 75 mm. Where a slot is cut in the flange to receive the inner end of the conductor the entrance shall be in line with the periphery of the barrel.

The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.

Barrel studs shall be used for the construction of drums. The flanges shall be holed, and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.

Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk. The ends of barrel shall generally be flushed with the top of the nuts.

The inner cheek of the flanges and drum barrel surface shall be painted with bitumen-based paint.

Before reeling, cardboard or double corrugated or thick bituminized water-proof bamboo paper shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with waterproof thick bituminized bamboo paper to preserve the conductor from dirt, grit and damage during transport and handling.

A minimum space of 75 mm for conductor shall be provided between the inner surface of the external protective tagging and outer layer of the conductor.

Each batten shall be securely nailed across grains as far as possible to the flange, edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nails shall not protrude above the general surface and shall not have exposed sharp, edges or allow the battens to be released due to corrosion.

The nuts on the barrel shall be tack welded on one side in order to fully secure them. On the second end, a spring washer shall be used.

A steel collar shall be used to secure all barrel studs. This collar shall be located between the washers and the steel drum and secured to the central steel plate by welding.

Outside the protective lagging, there shall be minimum of two binders consisting of hoop iron/galvanized steel wire. Each protective lagging shall have two recesses to accommodate the binders.

The conductor ends shall be properly sealed and secured on the side of one of the flanges to avoid loosening of the conductor layers during transit and handling.

As an alternative to wooden drum Bidder may also supply the conductors in non-returnable painted steel drums. After preparation of steel surface according to IS: 9954, synthetic enamel paint shall be applied after application of one coat of primer. Wooden/Steel drum will be treated at par for evaluation purposes and accordingly the Bidder should quote in the package.



6.2.7 Marking

Each drum shall have the following information stenciled on it in indelible ink along with other essential data:

- Contract/ Award letter number.
- Name and address of consignee.
- Manufacturer's name and address.
- Drum number.
- Size of conductor.
- Length of conductor in meters.
- Arrow marking for unwinding.
- Position of the conductor ends.
- Distance between outer-most Layer of conductor and the inner surface of lagging.
- Barrel diameter at three locations & an arrow marking at the location of the measurement.
- Number of turns in the outer most layer.
- Gross weight of drum after putting lagging.
- Tear weight of the drum without lagging.
- Net weight of the conductor in the drum.
- Material Inspection & Clearance certificate Number.
- The above should be indicated in the packing list also.

6.2.8 Verification of Conductor Length

The Employer reserves the right to verify the length of conductor in any conductor drum to be supplied by contractor.

6.3 Accessories of Line Conductor

The following are the accessories for ACSR Bear Conductor. 2.5% extra fasteners and retaining rods shall be provided.

6.3.1 Mid Span Compression Joint

Mid Span Compression Joint shall be used for joining two lengths of conductor. The joint shall have a resistively less than 75% of the resistivity of equivalent length of conductor. The joint shall not permit slipping off, damage to, or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor.

The joint shall be made of Steel and aluminium sleeves for joining the conductor. The aluminum sleeve shall have aluminum of purity not less than 99.5%. If the whole of the sleeve is not to be compressed, then tapered aluminium filler plugs shall also be provided on the line of demarcation between compression and non-compression zone. The steel sleeve should not crack nor fail during compression. The Brinell Hardness of steel sleeve shall not exceed 160. The steel sleeve shall be hot dip Galvanized.

6.3.2 Repair Sleeve

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminum and shall have a smooth surface. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece.



The edges of the seat as well as the keeper piece shall be so rounded that the conductor strands are not damaged during installation.

6.3.3 Vibration Damper

Vibration dampers of 4R-stockbridge type with four (4) different resonances spread with the specified Aeolian frequency band width corresponding to wind speed of 1 m/s to 7 m/s shall be used at suspension and tension points on each conductor in each span to damp out Aeolian vibrations as mentioned herein after.

Alternate damping systems or offering equivalent or better performance also shall be accepted provided the manufacturer meets the qualifying requirements stipulated in the Specifications. Relevant technical documents to establish the technical suitability of alternate systems shall be furnished by the Bidder along with the bid.

One damper minimum on each side of conductor shall be used for ruling design span.

The clamp of the vibration damper shall be made of high strength aluminum alloy of type LM-6 or equivalent. It shall be capable of supporting the damper and prevent damage or chafing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the conductor without damaging the strands or causing premature fatigue failure of the conductor under the clamp. The clamp groove shall be in uniform contact with the conductor over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the conductor when the clamp is installed. Clamping bolts shall be provided with self-locking nuts and designed to prevent corrosion of threads or loosening in service.

The messenger cable shall be made of high strength galvanized steel/ stainless steel with a minimum strength of 135 kg/sq mm. It shall be of preformed and post formed quality to prevent subsequent droop of weight and to maintain consistent flexural stiffness of the cable in service. The number of strands in the messenger cable shall be 19. The messenger cables other than stainless steel shall be hot dip galvanized in accordance with the recommendations of IS: 4826-1979 for heavily coated wires.

The damper mass shall be made of hot dip galvanized mild steel/ cast iron or a permanent mold cast zinc alloy. All castings shall be free from defects such as cracks, shrinkage, inclusions and blowholes etc. The surface of the damper masses shall be smooth.

The damper clamp shall be cast over the messenger cable and offer sufficient and permanent grip on it. The messenger cable shall not slip out of the grip at a load less than the mass pull-off value of the damper. The damper masses made of material other than zinc alloy shall be fixed to the messenger cable in a suitable manner in order to avoid excessive stress concentration on the messenger cables which shall cause premature fatigue failure of the same. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion. The damper mass made of zinc alloy shall be cast over the messenger cable and have sufficient and permanent grip on the messenger cable under all service conditions.

The damper assembly shall be so designed that it shall not introduce radio interference beyond acceptable limits.

The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed under Annexure-A, shall have to be submitted by the Bidder along with his bid. The technical particulars for vibration analysis and damping design of the system are as follows.

The damper placement chart for spans ranging from 100 m to 1100 m shall be submitted by the Bidder. Placement charts should be duly supported with relevant technical documents and sample calculations.

The damper placement charts shall include the following: -

a. Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per conductor per span.

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- b. Placement distances clearly identifying the extremities between which the distances are to be measured.
- c. Placement recommendation depending upon type of suspension clamps (viz Free center type/ Armor grip type etc.)
- d. The influence of mid span compression joints, repair sleeves and armor rods (standard and AGS) in the placement of dampers.

6.4 Tests

The following acceptance and routine tests and tests during manufacture shall be carried out on the conductor. For this clause, the following shall apply.

Acceptance tests shall mean those tests which are to be carried out on samples taken from each lot offered for predespatch inspection, for the purpose of acceptance of that lot.

Routine tests shall mean those tests, which are to be carried out on each strand/ spool/ length of the conductor to check requirements which are likely to vary during production.

Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the manufacturer to ensure the desired quality of the end product to be supplied by him.

For all acceptance tests, the acceptance values shall be the values guaranteed by the bidder in the guaranteed technical particulars of his proposal or the acceptance value specified in this specification, whichever is more stringent for that particular test.

6.4.1 Design (Type) Tests

Only type tested conductor and equipment should be offered. Type test reports as specified in Chapter-2 of this specification shall be submitted by the Bidder along with the bid. The type test report includes:

- a) Surface condition test
- b) Test for ultimate breaking load on stranded conductor
- c) Stress-strain test
- d) Measurement of diameter of individual aluminum and steel wires.
- e) Measurement of lay ratio.
- f) Breaking load of individual wires.
- g) Ductility test
- h) Wrapping test
- i) Resistance test and
- j) Galvanizing test

6.4.2 Acceptance Tests

- a) Visual and dimensional check on drum
- b) Visual check for joints scratches etc. and lengths of conductor by rewinding
- c) Dimensional check on steel and Aluminium strands
- d) Galvanizing test on steel strands
- e) Torsion and elongation test on steel strands
- f) Check for lay-ratios of various layers



- g) Breaking load test on steel and aluminum strands
- h) Wrap test on steel and aluminum strands
- i) DC resistance test on aluminum strands
- j) UTS Test on welded joint of strands

Note: All the tests except (j) shall be carried out on Aluminium and steel strands after stranding only.

6.4.3 Routine tests

- a) Check to ensure that the joints are as per specification.
- b) Check that there are no cuts, fins etc. on the strands.
- c) Check that drums are as per specification.
- d) All acceptance tests as mentioned above to be carried out on each coil.

6.4.4 Tests during manufacture

- a) Chemical analysis of zinc used for galvanizing
- b) Chemical analysis of aluminum used for making aluminum strands

6.4.5 Testing Expenses

The entire cost of testing for the acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted unit price except for the expenses of the inspector/ Employer's representative.

6.4.6 Test Reports

Record of routine test reports and acceptance tests shall be submitted to the Employer for approval.

Test certificates of tests during manufacture shall be maintained by the manufacturer. These shall be produced for verification as and when desired by the Employer.

6.4.7 Inspection

The representative of the Employer shall always be entitled to have access to the works and all places of manufacture, where conductor shall be manufactured and representative shall have full facilities for unrestricted inspection of the manufacturer works, raw materials and process of manufacture for conducting necessary tests as detailed herein.

No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived by the Employer in writing. In the latter case also the conductor shall be dispatched only after satisfactory testing for all tests specified herein have been completed and the test results have been approved by the Employer.

The acceptance of any quantity of material shall in no way relieve the manufacturer and the contractor of any of his responsibilities for meeting all requirements of the specification and shall not prevent subsequent rejection if such material is later found to be defective.

6.5 Standards

The conductor shall conform to the following International Standards, which shall mean latest revisions, with amendments/ changes adopted and published, unless specifically stated otherwise in the Specification.



In the event of the supply of conductor conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In the case of award, salient features of comparison between the standards proposed by the Supplier and those specified in this document will be provided by the Supplier to establish their equivalence.

SI. No.	Title	International Standard
1.	Specification for zinc	BS: 3436-1986 IS: 209-1992
2.	Specification for Aluminium Conductors for Overhead Transmission Purposes	IEC: 1089-1991 BS: 215-1970 IS: 398-1982
3.	Aluminum Conductor Galvanized Steel Reinforced and All Aluminium Alloy Conductors	BS: 215-1970 IEC: 1089-1991 IS: 398-1990 Part-II and IS:398-1994 Part-4
4.	Reels and Drums for Bare Conductors	BS: 1559-1949 IS: 1778-1980
5.	Method of Tensile Testing of Steel Wire	ISO 6892-1984 IS: 1521-1991
6.	Recommended Practice for Hot Dip Galvanizing of Iron and Steel	IS: 2629-1990
7.	Method of Testing Uniformity of Coating on Zinc Coated Articles	IS: 2633-1992
8.	Galvanized Coating on Round Steel Wires	IEC: 888-1987 BS: 443-1969 IS: 4826-1992
9.	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS: 433-1969 ISO 1460 – 1973 IS: 6745-1990
10.	Method of Radio Interference Tests on High Voltage Insulators	IEC: 437-1973 NEMA: 107-1964 CISPR IS: 8263-1990
11.	Zinc Coated steel wires for stranded Conductors	IEC: 888-1987

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CHAPTER - 7 INSULATOR AND ACCESSORIES



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7. INSULATOR AND ACCESSORIES

7.1 Composite Long Rod Insulator

The composite long rod type insulators shall be fully type tested and have been in production for at least five years.

The insulators shall be of puncture-proof type. These insulators shall be made of a core with fiberglass reinforced resin and sheds of HT Silicon Rubber. They shall be of light weight and high tensile strength. They must withstand safely all operating stresses even in the presence of Ozone and UV radiation. The composite material shall be of inherent stability.

To cope with lightning over-voltages, the insulator sets have to be designed with respect to insulation coordination according to IEC 60071-1, which determines the gap between the grounded fittings and the live parts.

The insulators shall be matched with the accessories to be used. The insulator shall confirm to IEC 61109 "Composite insulators for A.C. overhead lines with a nominal voltage greater than 1000V".

Bidder shall quote such composite insulators which have proven use under foggy/ humid operational conditions. The Bidder shall furnish evidence in the form of certification from the power utilities that the similar type of product supplied to them had been performing satisfactorily. The Bidder shall also submit certified test report for an accelerated ageing test of 5000 hours such as that described in Annexure-C of IEC-61109 and other type test reports.

The parameters characterizing the insulators profile shall be as follows:

SI no	Description	Unit	70KN**	120kN**
1	Size and Designation of Ball & Socket assembly	mm	16mm (Alt B)	20mm
2	Core Diameter	mm	20	20
3	Nominal length	mm	1450	1595
4	Minimum Creepage distance	mm	4495	4495
5	Number of grading rings	Nos	1	1
6	Nominal outer Diameter of Ring (open type)	mm	200	200
7	Depth of Grading ring	mm	100-125	100-125

Table 7.1

"**" Electromechanical strength of insulator string along with hardware fittings (kN).

The core dia of composite insulators mentioned at Row No.2 is for indicative purpose. The bidder shall offer composite long rod insulators of suitable core dia, not less than the value specified above, to meet specified E&M and torsion strength requirements.



			_			
			Standard Technical particular value			
Sino	Description	Linit	Single I	Double I	Single	Double
31110	Description	Unit	suspension	suspension	Tension	Tension
			String	string	String	String
1	No of Insulator units	Nos	1x1	2x1	1x1	2x1
0	PF Withstand voltage under wet		275			
2	conditon	(rms)	275			
3	Impulse Withstand Voltage dry					
	Positive	kVp	650			
	Negative	kVp	650			
4	Dry Arcing Distance	mm	1200			
5	Mechanical Strength	KN	70	2x70	120	2x120

Standard Technical Particulars of 132kV Insulator Strings

7.2 Materials

7.2.1 Core

It shall be a glass-fiber reinforced (FRP rod) epoxy resin rod of high strength. Glass fibers and resin shall be optimized. The rod shall be electrical grade corrosion resistant (ECR), boron free glass and shall exhibit both high electrical integrity and high resistance to acid corrosion.

7.2.2 Housing & Weather sheds

The FRP rod shall be covered by a seamless sheath of a HT-silicone rubber compound of a thickness of minimum 3mm. The housing & weather sheds should have silicon content of minimum 30% by weight. It should protect the FRP rod against environmental influences, external pollution, and humidity. It shall be extruded or directly molded on the core. The interface between the housing and the core must be uniform and without voids. The strength of the bond shall be greater than the tearing strength of the polymer. The manufacturer shall follow non-destructive techniques (N.D.T.) to check the quality of jointing of the housing interface with the core. The technique being followed with detailed procedure and sampling shall be furnished along with the bid. The details for this shall be finalized during detailed engineering and finalization of MQP.

The weather sheds of the insulators shall be of alternate shed profile. The weather sheds shall be vulcanized to the sheath (extrusion process) or molded as part of the sheath (injection molding process) and free from imperfections. The vulcanization for extrusion process shall be at high temperature and for injection molding shall be at high temperature & high pressure. Any seams / burrs protruding axially along the insulator, resulting from the injection molding process shall be removed completely without causing any damage to the housing. The track resistance of housing and shed material shall be class 1A4.5 according to IEC60587. The strength of the weather shed to sheath interface shall be greater than the tearing strength of the polymer. The composite insulator shall be capable of high pressure washing.

7.2.3 End Fittings

End fittings transmit the mechanical load to the core. They shall be made of malleable cast iron, spheroid graphite or forged steel. They shall be connected to the rod by means of a controlled compression technique. The manufacturer shall have in-process Acoustic emission arrangement or some other arrangement to ensure that there is no damage to the core during crimping. This verification shall be in-process and done on each insulator. The gap between fitting and sheath shall be sealed by a flexible silicone rubber compound. The system of attachment of end fitting to the rod shall provide superior sealing performance between housing and metal connection. The sealing must be humidity proof and durable with time.

7.2.4 Grading Rings

Grading rings shall be used at both ends of each composite insulator unit for reducing the voltage gradient on and



within the insulator and to reduce radio and TV noise to acceptable levels. The size and placement of the metallic grading rings shall be designed to eliminate dry band arcing/corona cutting/ exceeding permissible electrical stress of material. The bidder shall furnish calculations along with the proposed placement and design of corona ring in support of the above. Grading rings shall be capable of installation and removal with hot line tools without disassembling any other part of the insulator assembly.

The supply of grading rings shall preferably be in the scope of the composite insulator supplier.

7.3 Dimensional Tolerance of Composite Insulators

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows:

- ± (0.04d+1.5) mm when d≤300 mm.
- ± (0.025d+6) mm when d>300 mm.

Where, d being the dimensions in millimeters for diameter, length or creepage distance as the case may be. No negative tolerance shall be applicable to creepage distance.

7.4 Details of Hardware Fittings

Single suspension, Double Suspension, Single tension, and Double tension hardware fittings shall be supplied suitable for attaching to hanger/ strain plate fixed to tower. Each hardware fittings shall be supplied complete in all respects and shall include the following hardware parts:

- a. Suitable arcing horn specified in hereinafter.
- b. Suitable Yoke plate complying with the specification given hereinafter.
- c. Sag-Adjustment plate for double tension hardware fittings.
- d. Suspension and dead-end assembly to suit conductor size.
- e. Provision for attaching balancing weights on the line side yoke plate of single suspension pilot hardware fittings.
- f. Other necessary fittings viz D-shackles, eye links, extension links, ball clevis, socket clevis, clevis eye, U clevis and chain link etc. to make hardware fittings completer.

7.5 Ball and Socket Designation

The dimensions of the balls and sockets shall be of 16 mm designation for 70 kN & 20 mm designation for 120 kN disc insulator in accordance with the standard dimensions stated in IS: 2486 - (Part - II)/IEC:120.

7.6 Pin and Cap

Pin and Cap shall be designed to transmit mechanical stresses and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric, of such design that it will not yield or distort under load conditions.

The design shall be such as to permit easy removal of replacement of either insulator units or fittings under the live line conditions.

7.7 Interchangeability

The composite long rod insulators inclusive of the ball and socket fittings shall be of standard design suitable for use with the hardware fittings of any make conforming to relevant IEC Standards.

7.8 Security Clip

Security clip for use with ball and socket coupling shall be of R-shaped hump type which shall provide positive



locking of the coupling as per IS: 2486-(Part-III)/IEC: 372. The legs of the security clips shall be spread after installation to prevent complete withdrawal from the socket. The locking device should be resilient, corrosion resistant and of suitable mechanical strength. There shall be no risk of the locking device being displaced accidentally or being rotated when in position. Under no circumstances shall locking device allow separation of insulator units or fittings.

The hole for the security clip shall be countersunk and the clip shall be of such design that the eye of clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required to pull the security clip into its unlocked position shall not be less than 50N (5 kg) or more than 500N (50 kg).

7.9 Corona and RI Performance

All surfaces must be clean, smooth, without cuts, abrasions, or projections. No part shall be subjected to excessive localized pressure. The insulator metal parts shall be so designed and manufactured that it shall not generate any Radio Interference beyond specified limit and not produce any noise generating corona formation under the operating conditions.

7.10 Arcing Horn/ Intermediate Arcing Horn

The arcing horn / Intermediate Arcing Horn shall be ball ended rod type.

The air gap shall be adjusted to ensure effective operation under actual field conditions.

7.11 Yoke Plate

The strength of yoke plates shall be adequate to withstand the minimum ultimate tensile strength as specified in the bid drawings.

The plates shall be either triangular or rectangular in shape as may be necessary. The design of yoke plate shall take into account the most unfavorable loading conditions likely to be experienced as a result of dimensional tolerances for disc insulators as well as components of hardware fittings within the specified range. The plates shall have suitable holes for fixing corona control rings/ grading ring/ arcing horn. All the corners and edges should be rounded off with a radius of at least 3 mm. Design calculations i.e. for bearing & tensile strength, for deciding the dimensions of yoke plate shall be furnished by the bidder. The holes provided for bolts in the yoke plate should satisfy shear edge condition as per Clause No. 8.10 of IS: 800-1984.

7.12 Sag-Adjustment Plate

The sag-adjustment plate to be provided with the double tension hardware fitting shall be of three plate type. The sag adjustment plate shall be provided with a safety locking arrangement. The device shall be of such design that the adjustment is done with ease, speed, and safety.

The maximum length of the sag adjustment plate from the connecting part of the rest of the hardware fittings shall be 520 mm. The details of the minimum and maximum adjustment possible and the steps of adjustment shall be clearly indicated in the drawing. An adjustment of 150 mm minimum at the interval of 6 mm shall be possible with the sag adjustment plate.

Design calculations for deciding the dimensions of sag adjustment plate shall be furnished by bidder. The hole provided for bolts should satisfy shear edge condition as per Clause No.8.10 of IS: 800-1984.

7.13 Suspension Assembly

The suspension assembly shall be suitable for ACSR 'BEAR' Conductor.

The suspension assembly shall include free center type suspension clamp along with standard preformed armor rods or armor grip suspension clamp; except for Pilot insulator string for which only suitable Envelope type suspension clamp shall be used.



The suspension clamp along with standard preformed armor rods set shall be designed to have maximum mobility in any direction and minimum moment of inertia to have minimum stress on the conductor in the case of oscillation of the same.

The suspension clamp along with standard preformed armor rods/ armor grip suspension clamp set shall have slip strength for ACSR 'BEAR' Conductor.

The suspension assembly shall be designed, manufactured, and finished to give it a suitable shape, so as to avoid any possibility of hammering between suspension assembly and conductor due to vibration. The

suspension assembly shall be smooth without any cuts, grooves, abrasions, projections, ridges, or excrescence, which might damage the conductor.

The suspension assembly/ clamp shall be designed so that it shall minimize the static & dynamic stress developed in the conductor under various loading conditions as well as during wind induced conductor vibrations. It shall also withstand power arcs & have the required level of Corona/RIV performance.

Bids offering suspension assemblies with magnetic power loss more than 4 watts except for envelope type clamps for which magnetic power loss more than 8 watts at sub-conductor current of 600 amps shall be liable to be rejected. The Bidders are requested to enclose test certificates for magnetic power loss test along with the bid.

In case, the magnetic power loss of the suspension assembly obtained during type testing of the same exceeds the value guaranteed by the Bidder in his bid, the material shall be rejected outright or the same shall be accepted after suitable liquidated damages for non-performance calculated at the rate of US\$ 4.68 per suspension assembly for each watt of additional power loss, which shall be recovered from the contract price.

7.13.1 Free Centre Type Suspension Clamp

For the Free Center Suspension Clamp seat shall be smoothly rounded and curved into a bell mouth at the ends. The lip edges shall have rounded beads. There shall be at least two U-bolts for tightening the clamp body and keeper pieces together.

7.13.2 Standard Preformed Armor Rod Set

The Preformed Armor Rods Set suitable for ACSR 'BEAR' Conductor shall be used to minimize the stress developed in the sub-conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from the suspension clamp as a result of unbalanced conductor tension in adjacent spans and broken wire condition. It shall also withstand power arcs. Chafing and abrasion from suspension clamp and localized heating effect due to magnetic power losses from suspension clamps as well as resistance losses of the conductor.

The preformed armor rods set shall have right hand lay and the inside diameter of the helices shall be less than the outside diameter of the conductor to have gentle but permanent grip on the conductor. The surface of the armor rod when fitted on the conductor shall be smooth and free from projections, cuts, and abrasions etc.

The pitch length of the rods shall be determined by the Bidder but shall be less than that of the outer layer of conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristic wholly independent of the skill of linemen.

The amour rod shall not lose their resilience even after five applications.

The conductivity of each rod of the set shall not be less than 39% of the conductivity of the International Annealed Copper Standard (IACS).

7.13.3 Armor Grip Suspension Clamp

The Armor grip suspension clamp shall comprise of retaining strap, support housing, elastomer inserts with



aluminum re-enforcement and AGS preformed rod set.

Elastomer insert shall be resistant to the effects of temperature up to 75^o C, Ozone ultraviolet radiation and other atmospheric contaminants likely to be encountered in service. The physical properties of the elastomer shall be of an approved standard. It shall be electrically shielded by a cage of AGS preformed rod set. The elastomer insert shall be so designed that the curvature of the AGS rod shall follow the contour of the neoprene insert.

The AGS preformed rod set shall be as detailed in above in general except for the following.

7.13.4 Envelope Type Suspension Clamp

The seat of the envelope type suspension clamp shall be smooth rounded and suitably curved at the ends. The lip edges shall have a rounded bend. There shall be at least two U-Bolts for tightening the clamp body and keeper pieces together. Hexagonal bolts and nuts with split pins shall be used for attachment of the clamp.

7.13.5 Dead End Assembly

The dead-end assembly shall be suitable for ACSR Bear Conductor.

The dead- e n d assembly shall be compression type with provision for compressing jumper terminal at one end. The angle of jumper terminal to be mounted should be 300 with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contract and avoid local heating due to I²R losses. The resistance of the clamp when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor.

Die compression areas shall be clearly marked on each dead-end assembly designed for continuous die compressions and shall bear the words 'COMPRESS FIRST' suitably, inscribed near the point on each assembly where the compression begins. If the dead-end assembly is designed for intermittent die compressions, it shall bear identification marks 'COMPRESSION ZONE' AND 'NON-COMPRESSION ZONE' distinctly with arrow marks showing the direction of compressions and knurling marks showing the end of the zones. Tapered aluminum filler plugs shall also be provided at the line of demarcation between compression & non-compression zone. The letters, number and other marking on the finished clamp shall be distinct and legible.

7.14 Fasteners: Bolts, Nuts and Washers

All bolts and nuts shall conform to IS: 6639-1972/ISO-R-272-1968. All bolts and nuts shall be galvanized. All bolts and nuts shall have hexagonal heads, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.

Bolts up to M 16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 MPa minimum as per IS: 12427. Bolts should be provided with washer face in accordance with IS: 1363 part-i/ ISO-4016-1979 to ensure proper bearing.

Nuts should be double chamfered as per the requirement of IS: 1363 Part-III, 1984. It should be ensured by the manufacturer that nuts should not be over- tapped beyond 0.4 mm oversize on effective diameter for size up to M 16.

Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.

All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm gripping of the component parts but no further. It shall be ensured that the threaded portion of the bolt protrudes not less than 3 mm and not more than 8 mm when fully tightened. All nuts shall fit and tight to the point where shank of the bolt connects to the head.



Flat washers and spring washers shall be provided wherever necessary and shall be of a positive lock type. Spring washers shall be electro-galvanized. The thickness of washers shall conform to IS: 2016-1967.

The Bidder shall furnish bolt schedules giving thickness of components connected, the nut and the washer and the length of shank and the threaded portion of bolts and size of holes and any other special details of this nature. To obviate bending stress in bolt, it shall not connect aggregate thickness more than three times its diameter. Bolts

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

Fasteners of grade higher than 8.8 are not to be used.

7.15 Maintenance

The long rod insulators offered shall be suitable for employment of hot line maintenance technique so that usual hot line operation can be carried out with ease, speed, and safety.

All insulators shall be designed to facilitate cleaning and insulators shall have the minimum practical number of sheds and grooves. All grooves shall be so proportioned that any dust deposit can be removed without difficulty either by wiping with a cloth or by remote washing under live line condition.

7.16 Workmanship

All the material shall be of the latest design and conform to the best modern practices adopted in the extra high voltage field. Suppliers shall offer only such insulators as are guaranteed by him to be satisfactory and suitable for the Transmission lines specified and will give continued good service.

The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners to limit corona and radio interference.

The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

The core shall be sound and free of cracks and voids that may adversely affect the insulators.

Weather sheds shall be uniform in quality. They shall be clean, sound, smooth and free from gross defects and excessive flashing at parting lines.

End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively sealed to prevent moisture ingress, effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth with the projecting points or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform to distribute the loading stresses uniformly.

All ferrous parts shall be hot dip galvanized to give a minimum average coating of Zinc equivalent to 600 gm/ sq. m and shall be in accordance with the requirement of IS:2629 and shall satisfy the tests mentioned in IS:2633. The zinc used for galvanizing shall be of Grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous, and free from imperfections such as flux, ash, rust stains, bulky white deposits, and blisters. The galvanized metal parts shall be guaranteed to withstand at least six successive dips each lasting for one (1) minute duration under the standard Preece test. The galvanizing shall be carried out only after any machining.

7.17 Equipment Marking

Each Composite Long Rod Insulator shall be legibly and indelibly marked with the trademark of the manufacturer, name of Employer and month & year of manufacture. The guaranteed combined mechanical and electrical strength shall be indicated in kilo Newton followed by the word 'kN' to facilitate easy identification and to



ensure proper use.

One 10 mm thick ring or 20 mm thick spot of suitable quality of paint shall be marked on the cap end fitting of each composite long rod insulator of particular strength for easy identification of the type of insulator. The paint shall not have any deteriorating effect on the insulator performance. Following codes shall be used as identification mark:

: Orange

For	120 kN long rod	[.] Green
101		. Oreen

7.18 Bid Drawings

The Bidder shall furnish a full description and illustration of the material offered.

The Bidder shall furnish along with the bid the outline drawing of each insulator unit including a cross sectional view of the insulator shell. The drawing shall include but not limited to the following information:

- a) Long rod diameter and ball to ball spacing with manufacturing tolerances
- b) Minimum Creepage distance with positive tolerance
- c) Protected creepage distance
- d) Eccentricity of the long rod unit
- e) Axial run out
- f) Radial run out
- g) Unit mechanical and electrical characteristics
- h) Size and weight of ball and socket parts
- i) Weight of composite long rod units
- j) Materials
- k) Identification mark
- I) Manufacturer's catalogue number

After award of the Contract, the Contractor shall submit full dimensioned insulator drawings containing all the details to Employer for approval. After getting approval from Employer and successful completion of all the type tests, the Supplier shall submit 10 more copies of the same drawing to the Employer for further distribution and field use at Employer's end.

After award of the Contract, the Contractor shall also submit fully dimensioned insulator crate drawing for different type of insulators.

7.19 Tests

The acceptance of any quantity of material shall in no way relieve the bidder of any of his responsibilities for meeting all requirements of the specification and shall not prevent subsequent rejection if such material is later found to be defective.

The sample taken from any numbers of crates for carrying out any type of tests will be to the supplier account.

The equipment should be offered type tested. The Bidder shall submit type test reports as specified in section- 2 of these specified along with the bid.

7.19.1 Design Tests on Composite Long Rod Insulator Units

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The design tests are intended to verify the suitability of the design, materials, and method of manufacture (technology).

(a)	Tests on interfaces and connections of metal fittings (Tests to be IEC: 611) performed on the same samples in the sequence given below)			
	i.	Test s		
	ii.	Dry po	ower frequency voltage test	
	iii.	Prestre	essing	
		a.	Sudden load release test	
	b. Thermal mechanical test			
		C.	Water immersion test	
	iv.	Verifica	ation tests	
		a.	Steep front impulse voltage test	
		b.	Dry power frequency voltage test	
(b)	Assem	bled cor	re load time test	IEC: 61109
	i.	Detern assem	nination of the average failing load of the core of the bled unit	
	ii.	Contro		
(c)	Brittle fracture resistance test			Annexure-A
(d)	Test of housing, Tracking and erosion test			IEC: 61109
(e)	Tests f	for the co	ore material	IEC:61109
	i. Dye penetration test			
	ii.	Water	diffusion test	
(f)	Flamm	ability te	est	IEC:61109
(g)	Recovery of Hydrophobicity test			Annexure-A
(h)	Mechanical Load Time test and test of tightness between end firings and IEC:61109 insulator housing			IEC:61109
(i)	Silicone content test Annexure-A			Annexure-A
(j)	High Pressure washing test Annexure-A			Annexure-A

7.19.2 Type Tests on Composite Long Rod Insulator Units

The electrical type tests shall be performed only once on insulators satisfying the electrically defined criteria for one type and shall be performed with arcing devices if they are in integral part of the insulator type.

The electrical type tests shall be repeated only when one or more of the above characteristics are changed.



a)	Dry l	ightning impulse withstand voltage test	IEC : 61109 & IEC : 60383	
b)	Wet	Power – frequency test	IEC : 60383	
c)	Mec	hanical load-time test	IEC : 60383	
d)	Corc	ona and RIV test under dry condition	IEC : 60437 & IEC : 60383	
e)	Vibration Test		Annexure-A	
f)	Silicone content test		Annexure-A	
	i.	Flammability test	IEC : 61109 & IEC : 60383	
	ii.	Recovery of Hydrophobicity test		

7.19.3 Acceptance Tests:

For Composite Long Rod Insulators

(a)	Verification of dimensions	IEC : 61109
(b)	Galvanizing test	IEC : 60383
(c)	Verification of locking system	IEC : 60383
(d)	Verification of tightness of interface between end fittings and insulator housing and of specified mechanical load	IEC : 61109
(e)	Recovery of Hydrophobicity	Annexure-A
(f)	Silicone content test	Annexure-A

In the event of failure of the sample to satisfy the acceptance test(s) specified in above, the retest procedure shall be as per clause 7.6 of IEC 61109.

7.19.4 Routine Tests

For Composite Long Rod Insulator Units

a)	Identification of the composite insulators	As per IEC : 61109
b)	Visual Inspection	As per IEC : 61109
c)	Mechanical routine test	As per IEC : 61109

7.19.5 Tests during Manufacture

On all components as applicable



a) Chemical analysis of zinc used for galvanizing

As per Annexure-A



As per Annexure-A

b) Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.



As per Annexure-A

c) Chemical analysis hardness tests and magnetic particle inspection for forgings



d) Tracking and erosion test on insulating material

IEC 60587



7.19.6 Testing Expenses

The entire cost of testing for type, acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted Ex-works/ CIF Price.

In case of failure in any type test, if repeated type tests are required to be conducted, then all the expenses for deputation of Inspector/ Employer's representative shall be deducted from the contract price. Also, if on receipt of the Supplier's notice of testing, the Employer's representative does not find 'plant' to be ready for testing the expenses incurred by the Employer for re-deputation shall be deducted from contract price.

7.19.7 Sample Batch for Type Testing

The Supplier shall offer material for sample selection for type testing only after getting Quality Assurance Program approved by the Employer. The Supplier shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection. The sample for type testing will be manufactured strictly in accordance with the Quality Assurance Program approved by the Employer.

Before sample selection for type testing, the Supplier shall be required to conduct all the acceptance tests successfully in presence of Employer's representative.

7.19.8 Schedule of Testing

The Bidder has to indicate the schedule of following activities in their bids:

- a) Submission of drawing for approval.
- b) Submission of Quality Assurance Program for approval.
- c) Offering of material for sample selection for type tests.
- d) Type testing.

7.19.9 Additional Test

The Employer reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Supplier's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material complies with the Specifications.

The Employer also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Supplier's premises or at any other test Centre. In case of evidence of non-compliance, it shall be binding on the part of the Supplier to prove the compliance of the items to the technical specifications by repeat tests or correction of deficiencies or replacement of defective items, all without any extra cost to the Employer.

7.19.10 Co-ordinate for testing

The Contractor/ Supplier shall have to co-ordinate testing of insulators with hardware fittings to be supplied by other Supplier and shall have to guarantee overall satisfactory performance of the insulators with the hardware fittings.



7.19.11 Guarantee

The Contractor/ Supplier of insulators shall guarantee overall satisfactory performance of the insulators with the hardware fittings.

7.19.12 Test Reports

Copies of type test reports shall be furnished along with one original. One copy shall be returned duly certified by the Employer only after which the commercial production of the concerned material shall start.

Copies of acceptance test reports shall be furnished. One copy shall be returned duly certified by the Employer, only after which the material shall be dispatched.

Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Employer's representative, if so desired by the Employer.

Test certificates of test during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when desired by the Employer.

7.19.13 Inspection

The Employer's representative shall always be entitled to have access to the works and all places of manufacture, where insulator, and its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Supplier's and sub-Supplier's works, raw materials, manufacture of the material and for conducting necessary test as detailed herein.

The material for final inspection shall be offered by the Supplier only under packed condition.

The Employer shall select samples at random from the packed lot for carrying out acceptance tests. The lot should be homogeneous and should contain insulators manufactured in 3-4 consecutive weeks.

The Supplier shall keep the Employer informed in advance of the time of starting and the progress of manufacture of material in their various stages so that arrangements can be made for inspection.

No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived by the Employer in writing. In the latter case also the material shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

The acceptance of any quantity of material shall be no way relieve the Supplier of his responsibility for meeting all the requirements of the specification and shall not prevent subsequent rejection, if such material are later found to be defective.

7.20 Packing and Marking

All insulators shall be packed in suitable PVC/ plastic tubes/ any other suitable packing along with temporary wrap-on shields/ shrouds for each insulator unit. The packing shall provide protection against rodents. The shields/ shrouds shall be for protection during transport and for preventing bird pecking during erection. Further, the shields/ shrouds shall be made of opaque, weatherproof material of adequate strength and shall be color coded. The shields/ shrouds shall have smaller diameter than the insulator to stay in place against winds & weather and shall be designed to leave only the end fittings exposed for attachment of insulator to tower and line hardware until line construction is complete. The shield/ shroud shall have suitable pull off loop for easy detachment just prior to charging of the line without causing any damage to the insulator. The bidder Supplier shall furnish detailed design of the packing and shield/ shroud along with attachment and detachment procedure in this regard. For marine transportation, crates shall be pelleted.

The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.



Suitable cushioning, protective padding, or tonnage or spacers shall be provided to prevent damage or deformation during transit and handling.

The Supplier shall guarantee the adequacy of the packing and shall be responsible for any loss or damage during transportation, handling, storage, and installation due to improper packing.

All packing cases shall be marked legibly and correctly to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each case/ crate shall have all the markings stenciled on it in indelible ink.

7.21 Standards

The insulator strings and its components shall conform to the following International Standards which shall mean latest revision, with amendments/ changes adopted and published, unless specifically stated otherwise in the Specification.

In the event of supply of insulators conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In the case of award, salient features of comparison between the standards proposed by the Bidder and those specified in this document will be provided by the Supplier to establish equivalence.

SI. No.	Title	International Standard	
1.	Specification for zinc	BS: 3436 IS: 209-1992	
2.	Method of Chemical Analysis of Slab Zinc	BS: 3436 IS: 406-1991	
3.	Porcelain insulators for overhead Power lines with a nominal voltage greater than 1000 V	BS: 137- (I&II) IEC: 60383 IS: 731-1991	
4.	Methods of High Voltage Testing	IEC:60060-1 IS:2071 Part (I) – 1993 (Part(II)- 1991 Part(III)- 1991	
5.	Specification for Insulator fittings for Overhead Power Lines with a nominal voltage greater than 1000V	BS: 3288 IEC: 60120	
	General Requirements and Tests Dimensional Requirements	IEC: 60372 IS: 2486 Part- I-1993 Part- II-1989 Part-III-1991	
	Locking Devices		
6.	Recommended Practice for Hot, Dip Galvanization for iron and steel	ISO-1461 (E) IS:2629-1990	
7.	Testing of Uniformity of Coating of zinc coated articles	IS:2633-1992	



8.	Dimensions for Disc Insulators	IEC: 60305 IS:3188-1988
9.	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles	BS: 433-1969 ISO:1460-1973 IS:6745-1990
10	Methods of RI Test of HV insulators	IEC: 60437 NEMA Publication No.07/ 1964/ CISPR IS:8263-1990
11	Methods for Switching Impulse test on HV insulators	IEC: 60506 IS:8269-1990
12	Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC: 60575
13	Salt Fog Pollution Voltage Withstand Test	IEC: 60507
14	Residual Strength of String Insulator Units of Glass or Ceramic Material for Overhead Lines after Mechanical Damage of the Dielectric	IEC: 60797
15	Guide for the selection of insulators in respect of polluted conditions	IEC:60815



ANNEXURE 7-A TESTS ON COMPLETE STRINGS WITH HARDWARE FITTINGS

1.1 Corona Extinction Voltage Test (Dry)

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 154 kV (rms) line to ground under dry condition. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC: 383.

1.2 Test (Dry)

Under the conditions as specified under (1.2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 154 kV line to ground under dry condition. The test procedure shall be in accordance with IS: 8263/IEC: 437.

1.3 Mechanical Strength Test

The complete insulator string along with its hardware fitting excluding arcing horn, corona control ring, grading ring and suspension assembly/ dead end assembly shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to, remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached, and the value recorded.

1.4 Vibration Test

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 meters. In the case of suspension string a load equal to 600 kg shall be applied along the axis of the suspension string by means of turn buckle. The insulator string along with hardware fittings and two sub-conductors (each tensioned at 43 kN shall be secured with clamps. The system shall be suitable to maintain constant tension on each sub-conductor throughout the duration of the test. Vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulators string (more than 10 Hz) by means of vibration inducing equipment. The peak-to-peak displacement in mm of vibration at the antinode point, nearest to the string, shall be measured and the same shall not be less than 1000/ f1.8 where f is the frequency of vibration in cycles/ sec. The insulator string shall be vibrated for not less than 10 million cycles without any failure. After the test the insulators shall be examined for looseness, fatigue failure and mechanical strength test. There shall be no deterioration of properties of hardware components and insulators after the vibration test. The insulators shall be subjected to the Mechanical performance test followed by mechanical strength test as per relevant standards.

2.0 Composite Long rod Insulator Units

2.1 Brittle Fracture Resistance Test

Assembled core load time test with container that contains 1n-HNO₃ concentric acid that is applied at the naked rod. The rod should be held at 80% of SML for the duration of the test.

The rod should not fail within the 96-hour test duration.

2.2 Recovery of Hydrophobicity Test

1) The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the HC classification. Dry the sample surface.



- 2) Treat the surface with corona discharges to destroy the hydrophobicity. This can be done utilizing a high frequency corona tester, Holding the electrode approximately 3mm from the sample surface, slowly move the electrode over an area approximately 1" x 1". Continue treating this area for 2 3 minutes, operating the tester at maximum output.
- 3) Immediately after the corona treatment, spray the surface with water and record the HC classification. The surface should be hydrophilic, with an HC value of 6 or 7. If not, dry the surface and repeat the corona treatment for a longer time until an HC of 6 or 7 is obtained. Dry the sample surface.
- Allow the sample to recover and repeat the hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment.

2.3 Silicone content test

The minimum content of silicon as guaranteed by supplier shall be verified through FT-IR spectroscopy & TGA analysis or any other suitable method mutually agreed between Employer & Supplier in Quality Assurance Program.

2.4 High Pressure washing test

The test is to be carried out at 3800 kPa with nozzles of 6 mm diameter at a distance of 3m from nozzles to the insulator, followed by a dry power frequency voltage test as per IEC 61109.

3.0 Tests on All components (As applicable)

3.1 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingot shall be chemically analyzed as per IS: 209-1979. The purity of zinc shall not be less than 99.95%.

3.2 Tests for Forgings

The chemical analysis hardness tests and magnetic particle inspection for forgings will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Employer in Quality Assurance Program.

3.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognized procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Employer in Quality Assurance Program.

3.4 Autoclave Test

For cement used in the assembly of the insulators six samples from different batches shall be tested in accordance with ASTM C-151. The cement shall have an expansion less than 0.12%.



ANNEXURE 7-B BASIC INSULATION LEVELS OF INSULATORS SYSTEM

PARTICULARS

Transmission Line				
А	System Voltage	132 kV		
В	Maximum Voltage	145 kV		
С	Rated Lightning Impulse withstand (dry)	650 kVp (max)		
D	Rated Power frequency withstand voltage (wet)	275kV rms		


CHAPTER - 8 OPTICAL GROUND WIRE (OPGW) AND OPTICAL TERMINAL EQUIPMENT (OTE)



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8 OPTICAL GROUND WIRE & OPTICAL TERMINAL EQUIPMENT

8.1 General

The scope of work comprises of supply, installation, testing and commissioning of Optical Fiber Ground Wire (OPGW), including necessary accessories for fiber termination and splicing, for 21 km long Parwanipur -Pokhariya 132 kV Transmission Line.

Bidders shall offer OPGW and their accessories from reputed manufacturer. The contractor shall ensure complete supervision by competent technical personnel(s) of the OPGW manufacturer during installation, testing and commissioning of the whole OPGW system in totality under the project. The supervision shall also include the on-site training to the Employer's Representative(s).

8.2 Technical Requirements

The optical fiber ground wire (OPGW) shall have supporting cross section of 68 mm². The ground wire of the 132 kV line shall be a steel wire (or Aluminium clad steel wire) with an OPGW Composite Fiber Optic communication cable in the center. The Optical Fiber Cable, containing 48 single-mode optical fibers shall be embedded loosely inside the protective tube. The protective tube shall be of aluminum alloy or stainless steel. Both fiber optic and stranding part of OPGW shall comply with this Specification, and with the following standards:

Single mode fibers	ITU-T (former CCITT) G. 652
Optical fiber cables	IEC 60793-1 & 2
	IEC 1089/91, IEC 60889/87
Stranding part	IEC 60104/87; BS 3242

The earth wire shall be suitable for the climatic conditions with no attenuation changes or negative effects on the cable, and compatible with the stringing condition of the phase conductor. Under no condition shall the OPGW sag exceed the conductor sag.

The optical fiber shall be made of germanium doped silica glass or pure silica glass. It shall have a primary coating made of silicone or similar material with physical and mechanical properties at least those of silicone (acrylic or similar).

The tube shall be made of suitable material sufficiently strong to hold its shape and provide protection for the optical fibers against deformation and friction. The strength member of the fiber optic cable shall provide protection against buckling, kinking and strain. The material to be used shall be fiber reinforced plastic.

The direction of lay of the outer layer of strands shall be right hand. Lay ratio of any layer shall be not greater than the lay ratio of the layer immediately beneath it. The make-up of ground wire shall be such that the strand shall remain and shall not twist when the conductor is cut. The earth wire shall be manufactured so that no twisting occurs when subjected to axial loads, i.e. when unrolling and stringing.

All wires used in the manufacture of the earth wire shall be free from protrusion, sharp edges, abrasion and any other imperfections.

No jointing of the aluminum clad steel wires shall be permitted.

There shall be no joints or splices in any optical fiber in any reel length of the complete optical cable. The

creep characteristic of the finished earth wire shall be of virtually unvarying uniformity.

Optical fibers



All fiber installed as a part of this Contract shall have a minimum life of 30 years from the date of final acceptance.

The OPGW shall include a minimum of 48 fibers. The main optical characteristics of the OPGW are mentioned in schedule A.11 of Chapter - 11.

The other characteristics of the OPGW shall be as follows:

Outer diameter	:	>11.4 mm
Cable weight	:	approximately =>487 Kg/ km
Calculated breaking load	:	=>86.6 kN
Modulus of elasticity	:	as per construction
Coefficient of thermal expansion	:	as per construction
Nominal short time current capacity at		
Initial/final temperature 20/200 °C	:	5.6 kA (min)
DC resistance at 20 °C	:	Not more than 1.00 ohm/ km

Attenuation

The attenuation coefficient for wavelengths between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than + 0.05 dB/km.

The attenuation coefficient for wavelengths between 1535 and 1565 shall not exceed the attenuation coefficient at 1550 mm by more than + 0.05 dB/km. The attenuation of the fiber shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.1 dB.

The cable shall consist of single mode dual-window color coded optical fibers. There shall be no factory splices within the cable structure.

8.3 Optical Fiber Identification

Color-coding is essential for identifying individual optical fibers and groups of optical fibers. Individual optical fibers within a fiber unit and fiber units will be identifiable using a color-coding scheme. The color- coding system shall be discernible throughout the design life of the cable.

Each cable shall be traceable of each fiber back to the original fiber manufacture's fiber number and parameters of the fiber.

If more than the specified numbers of fibers are included in any cable, the cable manufacturer shall test the spare fibers and any defective fibers shall be suitably bundled, tagged, and identified at the factory by the fiber manufacturer.

8.4 Buffer Tube

Loose tube buffer construction shall be applied. A buffer for protection from physical damage shall surround the individually coated optical fiber(s) during fabrication, installation, and performance of the cable. The fiber coating and buffer shall be strippable for splicing and termination. The inside diameter of the buffer tube shall be of appropriate size to allow free movement of the fibers during cable Contraction or elongation resulting from thermal, tensile or vibration loads.

Buffer tubes shall be sleeved over multiple fibers forming a fiber unit. A fiber unit may consist of up to 6 fibers, individually identifiable utilizing the color code in conformance with EIA 359 A.



8.5 Optical Fiber Termination and Splicing

Suitable splice boxes (enclosures) shall be provided to encase the optical cable ends and fusion splices in a protective, moisture and dust free environment. The splice boxes shall be designed for the storage and protection of a minimum of 12 fibers cables and provide access through locked doors.

Fiber-optic cable of adequate length shall be provided so that all splicing can be performed at ground level at the towers. All splicing and necessary material shall be included in the price schedule presented by the Contractor.

8.6 Outdoor Splice Boxes

Splice boxes provided by the Contractor for outdoor use shall be suitable for use with the cable type provided as part of this Contract. The splice boxes shall be appropriate for mounting on steel structures and accommodate pass-through splicing and fiber terminations.

The splice box, including organizer/ splice trays, shall be designed to seal and protect the fiber cable splices from the environment defined in this specification and it shall provide easy access for any maintenance function.

All splice boxes shall be of metal construction that are clean and smooth finished, treated to resist rust, accommodate the storage of a minimum of 3 meters of coiled fiber and allow easy access to the splice trays. In addition, there shall be a steel frame to coil up about 10 meters of OPGW outside the protection box.

8.7 Test

The testing must be done by recognized equipment and it shall be possible to produce a computerized print out from the computer and the software, all of which (lap top computer, printer, and software) must be included in the testing, commissioning or installation unit prices.

There are different test series to assure the quality of OPGW:

- Routine test (in-process testing according to internal quality plan)
- Factory acceptance test (FAT, witnessed by customer)
- Type test (only in case of a basic new design, repetition in exceptional cases)



OPGW tests shall be in accordance with applicable standards or agreements between Employer and Contractor / manufacturer.

As a general rule the tests will be performed according to IEC 60794-4-10. However, if necessary, tests can be done according to IEEE Std1138.

8.8 Maintenance

To maintain the cable the Contractor shall propose and provide suitable equipment and necessary training for the Employer personnel to execute the work.

8.9 Joints

Number of Joints shall be kept to a minimum. Approved equipment and methods must be used to test the cable from both ends.

8.10 Particular Requirement for OPGW Earth Wire fittings and accessories

The associated fittings and other accessories have to satisfy the specific function of OPGW and fiber optics requirements for a total integrity of their components. The best way to achieve these goals shall be in application of suitable performed products. A brief description of the accessories is as follows:

a. Suspension Assembly: Suspension assembly shall consist of:

- > armor grip suspension clamp (aluminum alloy hyper formed armor rods and suspension clamp);
- > associated hardware for earth wire suspension:
- > Flexible grounding loop connection.

b. Tension Assembly: The tension assembly shall consist of:

- > Hyper formed alum weld dead end grip;
- > associated hardware for earth wire attachment (shackle, link, clevis, clamps);
- > Flexible grounding loop connection.

c. Vibration Dampers

Dampers where necessary, shall be of Stockbridge type installed complete with the armor rods of the size suitable to the earth wire size.

d. Fiber Optic Splice Closure-Joint Box

The fibre optic splice closure allows clamping of the cables to be spliced. It shall have following characteristics:

- The splice capacity for minimum 12 single-mode fibers from metal free optical cable with loose tube construction;
- waterproof housing of the closure aluminum or stainless-steel construction with protection class IP 65 of IEC 60529.
- > box and cable glands tightened by sealing compound.

Installation height shall be 1.5 m above the anti-climbing devices of the towers.

e. Fiber Optic Hood Closure-Terminal Box

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The fiber optic splice closure allows termination of OPGW on the substation gantry and interface with the underground fiber optic cable leading into the control building. It shall have the following characteristics:

- the cable glands for accepting of one metal free optical cables with minimum 12 single-mode fibers and loose tube construction;
- waterproof housing of the closure aluminum or stainless-steel construction with protection class IP 65 of IEC 60529;
- box and cable glands tightened by sealing compound.

It shall be installed on the terminal gantry 1.5 m above ground level.

8.11 Payment for OPGW and accessories

Payment for the supply and installation for the contract item "Optical fiber ground Wire (OPGW) and accessories" will be made at the unit bid price. Therefore, in the Price Schedule, the unit bid price shall include full compensation for all the costs incurred in furnishing all materials, equipment, labors, and all other operations related to OPGW conductor and accessories fabrication, delivery etc.

8.12 OPGW Tests

The following tests shall be conducted once on sample/ samples of OPGW for every 50 km of production from the manufacturing facility:

- Structure and dimension test
- Transmission characteristics test
- Characteristics test of ACS
- UTS test

8.13 Indoor Splice box/ Optical Distribution Frame Construction and Design

The indoor splicing box/ optical distribution frame shall be of the wall mounted type and accommodates passthrough the splicing and interconnection for the equipment.



CHAPTER - 9 ERECTION, STRINGING AND MISCELLANEOUS WORKS



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9 ERECTION, STRINGING AND MISCELLANEOUS WORKS

9.1 ERECTION OF STEEL TOWERS

All towers shall be vertical under the stresses set up by the completed overhead line.

Precautions shall be taken to ensure that no parts of the structures are strained or damaged in any way during erection and drifting shall not be allowed.

Support members, which arrive on Site with slight distortions due to handling in transit, shall be straightened by the Contractor using an approved means and offered to the Employer or Employer's representative for inspection and subsequent acceptance or rejection before erection commences.

Suitable ladders shall be used whenever necessary during erection, but such ladders and removable step bolts shall be removed when erection is not in progress.

Spanners used during erection shall be well shaped and fit closely on the hexagon to avoid damaging nuts and bolt head.

Reaming or drilling for correction of mismatched holes will not be allowed without the written approval of the Employer or Employer's representative.

The Contractor shall ensure that a rigid bolt-checking program is carried out on all supports. On completion of initial assembly of towers, an organized bolt checking team shall check all bolts for tightness from the structure top downwards.

Bolt checking shall be carried out within one week from the time the support is erected. The bolt tightening shall be as follows:

Size of Bolt	Tightening Torque (kg.cm.)
16	1000-1200
20	1400-1800

Throughout the course of support erection, the Contractor shall ensure that unbraced members are adequately supported by stays or guys or temporary struts prior to being braced.

The bracing of all four sides of the support shall be completed before guys are removed and before any erection of a higher section of the tower is commenced.

In no case the tower structure shall be erected seven days after completing the foundation concrete work, and until proper backfilling and compaction.

The Contractor shall notify the Employer two weeks before the supports are ready for inspection. The inspection and correction of defects if any shall be complete before the start of the stringing operation.

Damaged galvanizing shall be repaired on site by galvanizing paint and as specified in accordance with Article 1.7 of General Technical Specification.

All bolts and nuts below the anti-climbing device shall be properly punched such as to provide safety against opening of the nut-bolts even with the wrench set. The punched area shall immediately be coated with zinc paint.



9.1.1 Payment

Payment for the contract item Steel tower erection will be made at the unit price bid "Erection of tower and leg extensions". Therefore, in the schedule the unit bid price shall include full compensation for all cost incurred in furnishing all materials, tools, labors etc. for erection work related to this item.

9.2 CONDUCTORS STRINGING

At least 3 months before conductor stringing commences, the Contractor shall submit to the Employer a detailed account of his proposed stringing procedure which should include details of temporary support stays and compensation for initial stretch and long-term creep of the conductors.

Full use shall be made of maximum conductor lengths to reduce the number of mid span joints to a minimum.

There shall not be more than one joint per conductor in any one span, and Midspan joints shall not be less than 15 meters from any conductor clamp. No Midspan joints shall be used:

- > In section of less than 3 spans between tensions supports.
- In spans over navigable rivers, buildings, power lines, telecommunication lines, public roads and in any span subject to special way leave conditions or in any adjacent span.

Conductor repair sleeves shall not be used without the permission of the Employer or Employer's representative.

The conductors, joints and clamps shall be erected using the approved tools and in such a manner that no birdcaging, over tensioning of individual wires or layers or other deformation or damage to the conductors occurs. Clamps or other devices used in erection shall be of approved design and shall allow no relative movement of strands or layers of the conductors.

The Contractor shall keep a record of all conductor joints giving the location, the date of assembly and the name of the lineman responsible for the jointing. Where records of joints made by a particular lineman show a repeated performance below that required, the Contractor shall cease to employ the lineman on jointing operations and shall immediately replace him with other qualified personnel.

Phase conductors and OPGW shall be erected with such sags that everyday temperature in still air and 20 degree C temperature with maximum wind pressure, the final tensions shall provide factors of safety on the ultimate tensile strength of the conductor. The Contractor shall submit erection and final sag and tension charts for each type of conductor. These charts shall plot inter-related curves of tensions against equivalent span lengths, and actual span lengths against sags, at temperatures of 0° C, 20°C, 32°C, 40°C, 60°C and 80°C in still air conditions, and shall show details of conductor size, conductor breaking load, and conditions of loading.

In calculating the sags and tensions, allowance shall be made for the elasticity and coefficients of expansion of the conductor materials.

The term "final tension" shall mean the tension existing in a line conductor, for any given condition of loading after sufficient period in service to allow for "bedding down" stretch and creep to take place. For purposes of calculating creep allowance this shall be taken as ten years from erection.

The "equivalent span" method shall be used, in which the tension in any section length is that which would apply to a single span equal to the square root of the length arrived at by dividing the sum of the cubes of the individual span lengths, in the section considered, by their sum. The calculated tensions at the time of initial erection shall be increased by an approved amount to allow for settling of the conductors, other means may be adopted subject to the approval of the Employer or Employer's representative.



At the end of the guarantee period the specified ground clearance plus the conductor creep age allowance shall not be infringed, in addition, the sag of any phase conductors in the same span.

Where required by the Employer, prior to the issue of the Operational Acceptance Certificate, the Contractor shall be responsible for checking that the relative sags of the conductors are within the specified tolerance. Such checks shall be carried out at selected points along the route as required by the Employer. Clearances between conductors and ground and between jumpers and structures shall be checked by the Contractor during erection and before handing over the line.

The Contractor shall provide dynamometers, sighting boards and levels suitably mounted for clamping to support steelworks and other approved apparatus necessary for the proper checking of the work. When required by the Employer, dynamometers shall be tested and if necessary, recalibrated at the Contractor's expense.

During the progress of the work, the Contractor shall record on approved schedules the particulars of the sagging of conductors on each section of the route. These schedules shall show the support numbers of the section, individual span lengths, the equivalent span, the design, and erection sags, together with the mean actual sag of the phase conductor as well as the temperature, and the dates of the stringing and checking. At the end of the Contract six sets of these schedules shall be handed to the Employer.

Blocks for running out conductors shall be of approved type and shall be robust and fully running.

The wheel of the running out block shall have a diameter of not less than 20 times the outside diameter of the conductor and shall be fabricated from aluminum.

The Contractor shall provide as a minimum sufficient running blocks commensurate with stringing the longest section of the project.

Jumper-loops shall be cut to length such that the loop arcs at the points of departure from tension-clamp are naturally tangential to the tension-clamp departure angle.

All conductor, connections and clamps shall be treated with approved jointing grease to prevent galvanic corrosion between dissimilar metals and to inhibit aluminum surface oxidization.

After the line conductors have been finally tensioned to their correct sags, the Contractor shall erect vibration dampers at the recommended distance from the conductor clamps.

The Contractor shall identify the spans where aeronautical signs on the earth wire may need. However, instruction from the Employer to put such signs at any span shall be fulfilled.

Payment **ent**

Payment for the contract item conductor stringing will be made at the unit price bid "Stringing of Conductor". Therefore, in the schedule the unit bid price shall include full compensation for all cost incurred in furnishing all materials, equipment, and labor for installation of insulators strings, jumpers, hardware, stringing and any other related works to this item. No additional payment will be made for any restringing and rearrangement of the existing circuit necessitated by the interconnection of the existing line with the Tee-off tower for the new line. Measurement for the payment shall be based on the four-circuit conductor km calculated by addition of the horizontal distance between towers.

<u>Shutdown</u>

For the stringing work of the lines, the Contractor shall request the Employer for the shutdown of existing transmission and/ or distribution lines, where necessary, at least 15 days in advance. The request letter or form shall include the place of work and duration of shutdown needed. The period of shutdown shall be as



minimum as possible. The Employer has the right to decrease the justified period of shutdown, if the requested period of shutdown by Contractor is excessive and to shift the date of shutdown.

The Contractor shall complete the work, during the shutdown within the stipulated time period. If the Contractor fails to complete the work within the stipulated time limit, the Employer will claim the amount of money arising from the loss of energy not transmitted or distributed.



CHAPTER- 10 INSPECTION, TESTING AND COMMISSIONING



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10 INSPECTION, TESTING AND COMMISSIONING

10.1 Scope

The whole of the Works supplied under the Contract shall be subject to inspection and testing by the Employer or their Representative during manufacture, erection and after completion. The inspection and tests shall include, but not be limited to, the requirements of this Chapter of the Specification.

All appliances, apparatus, supervision, labor and services necessary to carry out all tests shall be provided by the Contractor unless specifically stated otherwise.

All expenses related to the factory tests of steel structures, conductor and insulator string shall be borne by the Contractor.

10.2 Quality, Assurance, Inspection and Testing

To assure that the supply and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his subcontractor's premises or at the 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 Employer after discussions before the award of the Contract. A quality assurance program of the Contractor shall generally cover, but not be 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-contractors' services including vendor analysis, source inspection, incoming raw materials inspection, verification of materials purchases.
- e. System for shop manufacturing including process controls and fabrication and assembly controls.
- f. Control of non-conforming items and system for corrective actions,
- 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 the release of manufactured products to the Employer.
- I. System for maintenance of records.
- m. System for handling storage and delivery.
- n. A quality plan detailing the specific quality control procedure adopting for controlling the quality characteristics relevant to each item of supply.

The quality plan shall be mutually discussed and approved by the Employer after incorporating necessary corrections by the Contractor as may be required.

10.2.1 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 Employer's inspection of material/ equipment.



The Employer, through his duly authorized representatives, reserves the right to carry out Quality Audit and Quality Surveillance of the systems and the procedures of the Contractor's and the subcontractor's Quality Management and Control Activities.

10.2.2 Inspection, Testing, and Inspection Certificates

The provisions of the clauses on Test and Inspection of the GCC and SCC shall be applicable to the supply and erection portions of the Works. The Employer 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 inspected at Site following the latter, material is found defective, then the Contractor shall bear the cost of this inspection and reinstatement according to specification.

10.3 Guarantees

Bidders shall state and guarantee the technical particulars listed in the Schedules of Technical Particulars and Guarantees forming a part of the other sections. These guarantees shall be binding and shall not be departed from without the written permission of the Employer. The tolerances permitted in the BS, ISO or ANSI will apply unless stated otherwise.

10.4 Test at Manufacturers Works

10.4.1 General

Where no specific test is specified then the various items of materials and equipment shall be tested in accordance with the relevant, , British, IEC, Indian or American Standards. Where no appropriate standard is available, tests shall be carried out in accordance with the maker's standard practice which must meet with the approval of the Employer.

At least thirty days (30) notice in writing shall be given to the Employer of the readiness of plant for test or inspection and every facility shall be provided by the Contractor and sub-Contractor(s) to enable the Employer or their Representative to carry out the inspections and witness the tests. This includes progress, test rig and packing inspection.

Inspection of equipment will not be carried out unless copies of the relevant sub-orders, drawings and test procedures have been approved by the Employer.

No equipment shall be packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected, or inspection has been waived by the Employer.

Functional electrical and mechanical tests shall be carried out on the completed plant after assembly in the Works. The extent and method of recording the results shall be agreed by the Employer in sufficient time to enable the tests to be satisfactorily witnessed or to make any change to the proposed program of tests.

All instruments and apparatus used in the performance of the tests shall be to the approval of the Employer and, if required by the Employer, shall be calibrated to an agreed standard at a laboratory of National standing to be nominated by the Contractor and approved by the Employer.

The cost of carrying out such calibration shall be borne by the Contractor in all cases.

10.4.2 Material Tests

Requirements for the testing of castings and forging are detailed elsewhere in the Specification. Representative samples of all plates, bars and pipes etc. which form components of the equipment/ accessories shall be tested as required by the relevant standard or code at the request of the Employer.



10.4.3 Test Certificates

Sets of all principal test records, test certificates and performance curves shall be supplied to the Employer in number of copies within the time frame mentioned in Chapter-2 of this specification.

These test records, certificates and performance curves shall be supplied for all tests, whether they have been witnessed by the Employer or his Representative. The information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate refers and should also bear the contract reference title. Specified requirements shall be shown on each certificate for comparison with actual test results.

When all equipment has been tested, test certificates from all Works and Site tests shall be compiled by the Contractor into volumes and bound in an approved form complete with index. Two copies of each volume shall be supplied to the consultant and four copies to the Employer.

10.5 Type Test

Type tests are required to prove the general design of the equipment. Type test reports of test performed on similar equipment shall be acceptable. But in case some type tests are required by the Employer, these tests prescribed shall be carried out at the Contractor's cost.

10.5.1 Tests on Tower

Tests on each type of towers to be supplied, shall be made at the manufacturer's plant. The number of tower test, if required, is given in the price schedule.

The Contractor shall give Employer not, less than 30 days advance notice, in writing or by fax, of the date when towers will be ready for tests. Employer reserves the right to waive the requirement for performing any or all tests. Should Employer exercise this right, the applicable unit prices for performing the test will be deducted from the total contract sum. The Contractor will not be entitled to any additional compensation by reason of such waiving.

Each test shall be performed in accordance with the following requirements:

- a. Tower: The tower shall be fabricated from approved detail drawings in a manner as close to final production procedures as is practicable. The tower shall be complete in every detail.
- b. Erection: The tower shall be erected on rigid foundation using the specified tower and bolts and nuts shall be tightened to the specified torque. The vertical axis through the center of gravity of the erected tower shall not be out of gravity of the erected foundation and shall not be out of plumb by more than 1 cm for every 500 cm height.
- c. Rigging: The Contractor shall submit for approval as to compliance with the specifications, diagrams showing the proposed methods of applying loads and measuring deflection.
- d. Loading: All test loads corresponding to conductor and overhead ground wire loading shall be applied directly to the regular attachment. Details shall be provided for these loads. Test wind loads equivalent to wind loads on the tower shall be applied where convenient and in such a manner that the summations of applied load and overturning moment are as close as possible to the actual behaviors as designed. Extra compressible members are not allowed for use of applying wind loads on tower. To ensure application of full-test loads to the tower, friction losses in rigging shall be added to the rigging loads.
- e. Load Programs: The contractor shall program the tests to most favorably demonstrate that the towers will carry all design loads and conditions specified in the loading diagrams. Test wind loads on tower shall be the same as applied in design calculation.
- f. Deflection Measurements: Deflections shall be recorded for the "before-load", "load-on" and "load- off" condition to provide longitudinal and transverse deflections at the tower top canter, at the elevation of the middle cross arm (s) and at least one intermediate point of tower body.



- g. Design Load Tests: The initially applied loads and the increment of loading shall be 25 percent of the loads given in the loading diagrams. Each load increment shall be maintained for not less than two minutes for each assumption except under maximum (full) design loads the period of five minutes shall be maintained and during which time there shall be no slacking off or adjustment of the loads. Should it become necessary to adjust the loading, the two- or five-minutes period shall start after the loading is stabilized and constant. All test loads shall be removed completely before the loads for testing under different assumptions are applied.
- h. Destruction Tests: After the successful completion of the load tests, the tower shall be further tested to destruction by increasing the transverse loads under any condition specified by Employer in increments not to exceed five per cent of full design transverse loads. The vertical and/or longitudinal load (s) is kept constant at their full design values while deflections are being recorded.
- i. Modification of Tower Components: Any conspicuous yielding or any failure of any part of the tower under any of the tests specified in the sub-article shall be considered a defect. If a defect develops, the Contractor shall modify his design of the tower and send it to Employer for approval. The modified tower shall then be retested at the Contractor's expense (including the cost of witness, if any) until satisfactory results are obtained.
- j. Material Tests: Steel materials used for tested towers shall be subject to tension or bend test in accordance with ASTM A370. Tests shall be performed by the Contractor at no additional cost to Employer. The test specimens shall be selected as follows:
 - > Two sets selected from the destructed members of each tested tower.
 - > Two sets selected from the undisturbed members of each tested tower.
- k. Reports: The Contractor shall furnish four certified copies of full reports of all tower and material tests, the calibration of the dynamometers or gauges, including clear photographs of the test set- ups and nature of all failures, diagrams showing deflection of towers at each interval of loading, details diagrams deflection records.

10.5.2 Insulators

• Impulse voltage withstand and flashover tests

The insulators for Impulse Voltage withstand tests shall be tested applying five standard 1.2/ 50 waves as specified in BS 137 and BS 923. If there is no flashover or puncture the insulator shall be deemed satisfactory. If there is more than one flashover the insulator shall be deemed not to comply with BS 137. In the event of one flashover occurring, a new series of ten impulses shall be applied. The insulator shall be considered to comply with BS 137 if during the second series of tests there is no flashover or puncture.

10.5.3 50% Flashover tests shall be carried out per BS 137

Additional tests will be required to show that the specified impulse level is obtained when the insulator strings are mounted on the structure. Bidders should note that the impulse test rig will therefore require earthen metalwork to simulate the proposed power configuration.

Flashover tests to determine the optimum lift shall be carried out to avoid cascade over as many line end insulators as possible.

10.5.4 Dry power frequency withstand

The Dry power frequency withstand test shall be carried out as specified in BS 137. The test voltage shall be maintained for one minute and the insulator shall be considered satisfactory if no flashover or puncture occurs.



10.5.5 Wet power frequency voltage withstand tests

The wet power frequency withstand test shall be carried out as specified in BS 137. The test voltage shall be maintained for one minute and the insulator shall be considered satisfactory if no flashover or puncture occurs.

10.5.6 Radio interference tests

Radio interference tests shall be carried out in accordance with IEC 437.

10.6 Insulator Fittings

Tensile tests, resistance tests and galvanizing tests shall be carried out in accordance with the requirements of BS 3288 Part 1 and BS 729.

10.7 Conductors

The conductors shall be tested in accordance with the requirements of BS: 215 or IS:398.

10.8 Routine Test

All equipment shall be subjected to routine tests at the manufacturer's work and shall include but not be limited to the following:

10.8.1 Operational tests

All equipment shall be tested after complete assembly to ensure the correct operation.

10.8.2 Clamps, joints and insulator fittings

Sample parts selected at random by the Employer shall be subjected to such tests as the Employer may direct in order to demonstrate compliance with Specifications and BS 3288 as applicable.

10.8.3 Insulators, fittings, and conductor overall tests

A complete mechanical test of insulator string, fittings, and section of conductor for suspension and tension sets at each voltage level will be required. The complete units shall withstand load tests including the safety factors specified. Tests other than mechanical tests on the complete unit may be required at the discretion of the Employer.

10.9 Cost of tests at manufacturer's works

The costs of making any test to be conducted at the manufacturer's works shall be borne by the Contractor. This shall apply to tests performed at the site or elsewhere.

After receiving the prior information about the completion of manufacturing at the factory, the Employer will depute his personnel to the Contractor's factory to witness the fabrication, assembly and testing of any or all parts of major equipment. The number of the Employer's personnel and equipment to be witnessed will be as listed below. The duration of such visits shall be as per inspection/ testing requirements but not less than seven days.

-	Prototype testing of Tower type QA,QB,QC&QD	2 persons, 1 visit
-	Conductor	2 persons, 1 visit
-	OPGW	2 persons, 1 visit
-	Insulators	2 persons, 2 visit
-	Hardware/ fittings	2 persons, 1 visit



The travelling expenses of the inspectors nominated by the Employer will be borne by the Employer. However, the Contractor shall bear all the expenses (including travelling expenses as per NEA norms) occurred due to the repetition of the tests required due to:

- ➢ Failure of the test;
- > Test facilities not ready at the time of inspection or mismatch of test schedule/program provided by the Contractor.

10.10 Site Tests

10.10.1 Measurement of footing resistance

Before stringing the conductor, the footing resistance of each support shall be measured with an earth resistance measuring instrument to the approval of the Employer.

10.10.2 Measurement of earth electrode resistance

Where the footing resistance is found to exceed 10 ohms additional earth electrodes or counter poise conductors are to be installed and the combined earth electrode and footing resistance measured together and recorded using the same test instrument. Additional electrodes are to be installed to obtain a maximum resistance value of 10 ohms. If the desired value of the earth resistance is not achieved by the above method, the Contractor shall reduce the earth resistance to bring the value equal or below 10 Ohm with alternative mean of fast electrode. The cost of the supply and installation of the fast electrode shall be deemed to be included.

10.10.3 Measurement of line impedance

Positive and zero sequence impedance measurement tests shall be carried out after final line inspection has been completed. Failure to conduct the impedance test shall result in non-issuance of the completion certificate. The measurement tests shall be carried out on all new lines covered by this Contract, by the Contractor and at his cost.

10.10.4 Conductor joint tests

In the case of tension clamps, joints, and bi-metal terminals the resistance of each part shall be measured by instruments supplied by the Contractor and approved by the Employer. The resistance of such fittings shall not exceed 75% of the electrical resistance of the equivalent length of conductor. The tests shall be carried out in the presence of the Employer. Stringing shall not commence until suitable instruments are on Site, approved by the Employer and ready for use.

10.10.5 Measurement of galvanizing thickness

The Contractor shall have available on Site for the Employer's use an instrument suitable for the accurate checking of galvanizing thickness. The gauge shall be available from the time of arrival of the first consignment of steel work until the issue of the Operational Acceptance Certificate. The cost of the gauge and other operating expenses are deemed to be included in the Contract Price and the gauge will remain the property of the Employer.

10.10.6 Tests on completion

Acceptance tests shall be carried out on Site by the Contractor on each section of the Works. These tests shall immediately follow the commissioning of each section of the Works.

The lines shall be energized at full working voltage before handing over and the arrangement for this, and such other tests as the Employer shall desire to make on the complete line, shall be assisted by the Contractor who shall provide such labour, transport and other assistance as is required without any extra charge. Apparatus for special tests shall be provided by the Contractor.

The Contractor shall submit to the Employer at least two months before the anticipated commencement of acceptance tests his detailed proposal for carrying out acceptance tests.



10.10.7 Test instrumentation

The method of measuring all quantities and qualities and the measurement tolerances shall be in accordance with the appropriate BS, ISO or ANSI.

The terminal conditions required for establishing whether the guarantees are met shall be measured by precision test equipment to be installed by the Contractor in addition to the permanent measuring equipment where supplied under the contract.

The overall design of the Works shall provide for the installation and use of test equipment so as not to interfere with the plant loading or delay the guaranteed completion dates.

All the precision test equipment to be used for carrying out tests shall be calibrated against standard instruments before the tests, and if required by the Employer, also after the tests. Calibration records shall be available for inspection by the Employer or his Representative.

During the design stage of the plant, the contractor shall give details of measurements to be made to substantiate that the performance of the plant meets the requirements of the specification and in particular shall submit for approval a schedule of performance test instrumentation necessary to demonstrate the guarantees.

10.10.8 Test reports

For each of the specified tests the contractor shall agree the test figures with the Employer and shall submit for approval triplicate copies of the test report containing a complete analysis of the test results within one month of the completion of the relevant test. Eight copies of the final approved report shall be submitted to the Employer.

10.11 Commissioning Test

The contractor shall be responsible for checking that total and relative sags of conductors are within the specified tolerances. Such checks shall be carried out at positions along the route selected by the Employer and the contractor shall provide the necessary surveying instruments to enable the checks to be carried out with the line in service without any extra charge.

The commissioning tests are as follows:

10.11.1 Measurement of line parameters

The line insulation resistance shall be measured on each individual section of the lines before the jumper loops are closed and again on the whole lines when they are completed.

The electrical parameters of the lines such as resistance, reactance, susceptance etc. shall be measured in a manner to be approved by the Employer, sufficiently accurately to enable the positive, negative and zero sequence impedance to be determined for the lines.

The lines shall then be energized at the proposed operating voltage from the Employer's system or generating station and the charging current measured and other such tests performed as the Employer may require making on the completed line.

The contractor shall carry out all these tests in the presence of the Employer, and shall provide all the necessary labor, transportation, apparatus, instruments and other assistance as required, without any extra charge.

10.11.2 High voltage tests

The overhead lines shall be tested with DC voltage applied between each phase and earth by means of a DC high voltage testing unit and without cleaning of the insulators. Bidders shall state leakage current

expected for such tests, for the different section of lines and taking into consideration and atmospheric conditions.



The contractor shall supply the necessary apparatus, instruments and the D.C. high voltage supply and the testing unit including those required for carrying out test and should be shown in the schedules in Volume I.

The test voltage shall be applied for five minutes for 132 kV overhead lines and shall be as follows: Line

Voltage	D.C Test Voltage to Earth
132 kV	187 kV

The electric power necessary for the tests at Site shall be supplied by the Employer on condition of availability. The contractor shall satisfy himself that all connections are good before switching power and shall be responsible for and make good any damage that may arise because of faulty connections.

All D.C. measuring apparatus, instruments including D.C. high voltage testing unit will be subject to checking and calibration by the Employer before starting the high voltage D.C. current test, catalogues, and details to be submitted with offer. Full details and catalogue of the proposed high voltage D.C. testing equipment shall be submitted for approval before shipping the test equipment.

10.12 Field test quality plan

A field test quality plan is given in appendix-10.1. The Contractor shall provide necessary information to the Employer/ site engineer so that the tests are conducted, and results recorded well.



APPENDI	K - 10.1: FIELD QUALIT	Y PLAN FOR 1	FRANSMISSION	LINES	
					-

S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testin g Extent	Counter Check/ Test by Employer	Accepting authority in Employer
1.	Detailed Survey	a. Route alignment	Optimization of route length	a. Preliminary survey.b. Topographical mapc. Tower Spotting Data	Contractor	100% at Field	100% based on record documents	To be notified by the Employer
		b. Route profiling & tower spotting.	 Ground clearance. Cold wt. Span Hot wt. Span Hot wt. Span Sum of Adj. Span (wind span) Angle of Deviation. 	a. Sag templateb. Tower Spotting datac. Route alignment	Contractor -do- -do- -do-	100% at Field -do- -do- -do-	100% based on record documents -do- -do- -do-	To be notified by the Employer
2.	Check Survey	Tower Location & Final Length	i) Alignment	a. Route alignment	Contractor	100% at Field	i) All angle towers in plains and 50% in	To be notified by the Employer

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S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testin g Extent	Counter Check/ Test by Employer	Accepting authority in Employer
			ii) Final Length	b. Tower Schedule c. Profile	-do-	-do-	hilly terrains. ii) Final length to be checked on 100% basis based on records/documents	
3.	Detailed Soil Investigatio n	a. Bore log	 Depth of bore log SPT Test Collection of samples 	As per Employer Specification	Contractor	100% at Field	To witness 20% at Field	To be notified by the Employer
3	Tower Foundation	b. Tests on samples	As per tech. Specs.	As per Employer Specification	Lab appd. By Employer	100% by testing lab	Review of lab test results	To be notified by the Employer
		1. Cement	1. Source approval	Source meeting Employer Specification/Approv ed vendor	Contractor	As proposed by Contractor	To verify the proposal based on the supply made and factory test results.	-do-
			2. Physical tests	As per specification	Samples to be taken jointly with Employer and tested at Employer approved	Review of all MTC's and one sample for every 500 MT	100% review of lab test results	-do-

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S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testin g Extent	Counter Check/ Test by Employer	Accepting authority in Employer
					Lab			
			3. Chemical Tests Chemical composition of Cement	-do-	Contractor to submit MTC	100%% review of MTC by Contractor	100% review of MTC	-do-
		2. Reinforcement Steel	1. Source approval	To be procured from main producers only.	Contractor	As proposed by Contractor	To review the proposal based on the test reports.	-do-
			2. Physical and Chemical analysis test	As per specification	Contractor to submit MTC	All MTC's	100% review of MTC	-do-
		3. Coarse Aggregates	1. Source approval	Source meeting Employer Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the test results of Joint samples tested in Employer approved lab	To review the proposal based on the documents	To be notified by the Employer

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S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testin g Extent	Counter Check/ Test by Employer	Accepting authority in Employer
			2. Physical tests	As per document at Annexure-3 of this FQP at page 16	Samples to be taken jointly and tested in Employer approved lab	One sample per lot of 200 cum or part thereof	100% review of lab test results	- do-
		4. Fine aggregate	1. Source approval	Source meeting Employer Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the results of Joint samples tested in Employer approved lab.	To review the proposal based on the documents.	- do-
			2. Physical test	As per Annexure-4 of this FQP at page 17	Samples to be taken jointly and tested in Employer approved lab	One sample per lot of 200 cum or part thereof	100% review of lab test results	- do-

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5. Water 1. Cleanliness Employer Contractor 100% visual Verification at random - do-	
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S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testin g Extent	Counter Check/ Test by Employer	Accepting authority in Employer
			(Water shall be fresh and clean)	Specification		check at Field		
			2. Suitability of water for concreting	Employer Specification	Contractor	100% Visual Check at Field	Verification at random	- do-
		Foundation Classification	 Visual observation of soil strata Ground water level History of water table in adj. Area/surface water 	Employer Specification	Contractor	100% at Field	100% at Field	- do-
			4. Soil Investigation wherever required					
		1. Bottom of excavated earth	Depth of foundation	Appd. Drawings.	Contractor	100% at Field	100% check by Employer	- do-
		2. Stub setting	1) Centre Line	-do-	-do-	-do-	-do-	-do-
			2) Diagonals					

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S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testin g Extent	Counter Check/ Test by Employer	Accepting authority in Employer
4.	Tower Erection	1. Materials a. Tower member/bolts & nuts/washers/ac cessories	Visual checking for1. Stacking2. Cleanliness3. Galvanizing4. Damages	Appd. Dwg./BOM	Contractor	100% at stores	100% verification of records	- do-
		2. Erection of Super-structure	1. Sequence of erection	As per Appd. Drawings/ Employer specification	Contractor	100% at field	100% check	- do-
			2. Check for completeness	-do-	-do-	-do-	-do-	-do-
			3. Tightening of nuts and bolts	-do-	-do-	-do-	-do-	-do-
			4. Check for verticality	-do-	-do-	-do-	-do-	-do-
			5. Tack welding for bolts & nuts	Employer Specification	Contractor	100% at Field	100% Check	- do-
		3. Tower footing resistance (TFR)	TFR at locations before and after earthing.	Employer Specification	Contractor	100% at Field	20% locations to be verified	- do-

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S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testin g Extent	Counter Check/ Test by Employer	Accepting authority in Employer
5.	Stringing	1. Materials						- do-
		a. Insulators	1. Visual check for cleanliness/glazing/ cracks/and white spots.	Employer Specification	Contractor	100% at Field	100% verification of records and to carry random checks 10%	- do-
			2. IR Value	(min. 50M Ohms)	-do-	One test per sample size of 20 for every lot of 10,000	To verify Contractor's records 100% and joint check 20% of total tests	-do-
			3. E&M test	-	Insulator supplier	a. 20 per 10,000 for discs b. 3 per 1500 for long rod	Collection of samples, sealing them and handing over by Employer to Insulator supplier	Tests to be witnessed/ Appd. at Manufacturer's works
			4. Traceability (Make/batch No./Locations where installed)	Packing list/CIP	Contractor	100% at field	100% Review of records	To be notified by the Employer (NEA)
		b. Conductor	On receipt, 1. Visual check of drum.	Packing list	Contractor	100% at stores	20% check	To be notified by the Employer (NEA)

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S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testin g Extent	Counter Check/ Test by Employer	Accepting authority in Employer
			2. Check for seals at both ends, and Employer sticker on outer end	-do-	-do-	-do-	-do-	-do-
			3. Check depth from top of flange to the top of the outer most layer	-do-	-do-	-do-	-do-	-do-
		c. OPGW	Check for seals at both ends	Packing list	Contractor	100% at stores	20% check	-do-
		2. Field activity						
		a. Before Stringing	Readiness for stringing	Stringing procedures as per Employer specification	Contractor	Readiness certificate to be submitted by the Contractor	Review of Certificate	-do-
		b. During stringing	(Conductor /OPGW)					-do-
			1. Scratch/cut check (Visual)	Appd. Drawings/ Employer Specification.	Contractor	100% at Field	100% record & Field check 20%	-do-

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S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testin g Extent	Counter Check/ Test by Employer	Accepting authority in Employer
			2. Repair sleeve	-do-	-do-	-do-	-do-	-do-
			3. Mid span Joints	-do-	-do-	-do-	-do-	-do-
			4. Guying (in case of towers not designed for one side stringing)	Appd. Guying arrangement/ Employer specification.	-do-	-do-	100%	-do-
		c. After stringing	Check for,					
			1. Sag/Tension	Sag tension chart/tower Spotting data	-do-	-do-	100% record & Field check 20%	-do-
			2. Electrical clearances	As per appd. Drawings/ Employer specifications	-do-	-do-	-do-	-do-
			i) Ground clearance	-do-	-do-	-do-	-do-	-do-
			ii) Live metal clearance etc.	-do-	-do-	-do-	-do-	-do-
			3. Jumpering	-do-	-do-	-do-	-do-	-do-

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S. No.	Description of Activity	Items to be Checked	Tests/ Checks to be done	Ref. documents	Check/ Testing Agency	Check/Testin g Extent	Counter Check/ Test by Employer	Accepting authority in Employer
			4. Copper bond	As per Appd. Drawings/ Employer Specification	Contractor	100% at Field	100% record & Field Check 20%	-do-
			5. Placement of damper	As per Specification/ drawings/ placement chart	-do-	-do-	-do-	-do-



APPENDIX - 10.2: PRE – COMMISSIONING PROCEDURES FOR TRANSMISSION LINES

1.1 Introduction

Over all procedure, safety rules, Statutory Requirements, dispatch procedures, switching sequences, observations, passing criteria and documentation of test results have been documented in this APPENDIX- II.

The detailed inspection and handing over documents are required to be checked for the entire length of transmission line before energization.

The detailed inspection/ test procedures for each activity have been elaborated in Chapter 10 and Appendix-I separate chapter of this documentation. The contents are as following:

- 1. Definition
- 2. Overall Procedures
- 3. Safety procedures
- 4. Inspection
- 5. Statutory Requirements
- 6. Handing over
- 7. Protective system
- 8. Dispatch procedures
- 9. Switching procedures
- 10. Testing
- 11. Energization
- 12. De-energization
- 13. Observations and duration
- 14. Passing criteria
- 15. Documentation

1.2 Definition

"Main Transmission Lines" means all high pressure cables and overhead lines (not being an essential part of the distribution system of a licensee) transmitting electricity from a generating station to another generating station or a sub-station, together with any step-up and step-down transformers, switch-gear and other works necessary to and used for the control of such cables or overhead lines, and such buildings or part thereof as may be required to accommodate such transformers, switch-gear and other works and the operating staff thereof;

"Power System" means a system under the control of the Government or any other statutory body of Generating Company or other agency and having one or more: -

- Generating station; Or
- > Main transmission lines and sub-stations; Or
- > Generating stations and main transmission lines and substations;

"Load Dispatch Centre" means the Centre so designated where the operation of Integrated Nepal Power System constituting the country's power system is coordinated;

"Sub-Station" means a station for transforming or converting electricity for the transmission or distribution thereof and includes transformers, convertors, switchgear, capacitors, synchronous condensers, structures cables and other appurtenant equipment and any buildings used for that purpose and the site



thereof, a site intended to be used for any such purpose and any buildings used for housing the staff of the sub section;

"Tie-Line" means a line for the transfer of electricity between two power systems together with switchgear and other works necessary to and used for the control of such line.

1.3 Overall Procedure

First it is to be ascertained that the transmission line to be energized is ready for operation and has been properly handed over (released) in writing. This will include all safety aspects, statutory clearance, and final inspection by the Employer and regulatory body, if any.

Instructions for the work and supervision are given by the test leader (Line in charge). However all switching and all operational activities will be executed by the regular operators.

Line charging instructions received from LDC are clearly understood by the Line in charge and doubts, if any, are to be clarified prior to the energization of the line.

Once the line is handed over for charging no work shall be permitted without a valid WORKPERMIT.

When the whole system has been energized, including the AC line, it will be kept in this state for 8 hours or more for "soaking" with continuous inspection and monitoring.

1.4 Safety Procedures

Energization implies an abrupt and serious change in the working conditions in the plant. To avoid serious accidents, thorough information must be imparted to all personnel involved in the construction of transmission line. It should be ensured that due publicity has been made to the public in all the villages/ areas along the line route cautioning them against climbing the towers etc. and that the line is proposed to be charged on so and so date. It is also to be confirmed that the AGENCIES involved in the construction activities shall not carry out any job on the said line without a valid WORK PERMIT.

It shall be ensured before charging that all men, material, Tools and plants and any temporary earthing on any part of the entire length of line are removed.

It must be ensured that any power supply/ low voltage charging used as anti-theft measure must be disconnected and isolated to avoid accidental connection.

All equipment tests and pre-commissioning tests must have been completed, terminated (in case cables were isolated for testing purpose) and documented.

The system must be formally declared ready for energization and handed over for operation in writing.

1.5 Inspection

Before the line is scheduled to be handed over for the pre-commissioning/ energization the same shall be inspected by representatives of EMPLOYER and Construction Agency as follows:

Such an inspection shall include:

- I. Right of way/ way leave/ electrical clearance
- II. Foundation and Revetments/ Protection Work
- III. Tower and Tower accessories
- IV. Hardware Fittings
- V. Insulators
- VI. Conductors and Earth wire

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- VII. Accessories for conductor and Earth wire
- VIII. Aviation Warning Signals (Lights/ globules/ painting)

1.5.1 Right of Way/ Way Leave/ Clearance

Right of way/ Way leave clearance

Ensure that no tree/ tree branches are falling within the zone of minimum clearance specified as per Fig. 1.



Guidelines of forest/ environmental rules shall be followed to avoid excessive tree cutting i.e. all the trees should be cut from ROUTE level in the 3-meter corridor below each line Conductor/ Earth wires. In the balance corridor, Trees' branches are only to be lopped to attain the specified clearance as per Table no 1.

CLEARANCE FOR RIGHT OF WAY

TRANSMISSION VOLTAGE IN KV	MINIMUM RIGHT OF WAY (IN MTRS)
132	9 m right and 9 left (Total 18m)

1.5.2 Electrical Clearance

In case of line crossings, clearance between lowest conductor of line and top conductor of the other line shall be adequate as per CBIP Transmission Line Manual: Jumpers in the tension tower are properly intact with conductor and form a parabolic shape in order to achieve adequate clearance from super steel structure.

1.5.3 Ground clearance

Normally at the time of construction adequate clearance is provided between lowest conductor and ground, but due to delay in charging/ commissioning there are chances of dumping/ heaping soil, earth and concrete etc. or staking bricks etc. which may cause reduction in ground clearance. In such cases the stored materials shall be removed.



Ensure that there is no temporary or permanent construction of houses or shades below the line. If the same has been constructed they shall be removed before charging.

The ground profile at the time of commissioning shall be checked with the profile approved at the time of check survey.

Ground clearance of lowest conductors at critical points/ wherever the lowest conductor is touching the ground shall be checked in the field from any of the prevalent method and the values of ground clearance at these critical points shall be recorded in the prescribed format.

In case of hilly Terrain and for building clearance, the side clearance from conductors and jumpers at critical points shall also be checked and recorded for all phases of conductor/ earth wire towards hill/ building side.

1.5.4 Clearance for Telephone line crossings

The minimum clearances between the conductors of the power line and telecommunication lines are as per CBIP Transmission Line Manual.

1.6 Foundation and Revetments/ Protection Work

1.6.1 Foundation

There shall not be any damage/ uneven settlement of foundations. For this, tolerances in levels of all four stubs should not exceed the criteria provided in the Annexure-C of IS -5613 (Part -3/Section 2):1989.***

It is to be ensured that the back filling of foundation is properly done. Soil shall be filled over all legs up to ground level.

Extra surface earth after foundation back filling shall be removed from legs of the tower beyond a lead distance of 30 meters. Any crack or break in chimney, if found, shall be repaired.

1.6.2 Revetments/ Protection

Cracks/ damages to revetments shall be repaired.

Wherever revetments are provided, weep holes shall have slope such as to flush out the deposited water away from tower platform.

In case of hilly terrain, the benching area should be levelled properly. The area around tower shall have proper slope for drainage of rainwater.

1.7 Tower and Tower Accessories

1.7.1 Normal Tower

After completion of a transmission line, all the towers shall be thoroughly checked before charging the line. Special attention shall be given to the points as mentioned below: -

• Deformed/ Buckled/ missing/ Rusted Members and Nuts and Bolts

It is to be ensured that no members are bent, deformed or rusted have been used in towers and if so, the same shall be replaced.

If any members are found missing, a new member shall be Fixed as per erection drawing of Towers.

Nuts shall be sufficiently tightened for the required Torque specified in the Approved Drawing. Minimum 2/3 complete threads shall be projected outside the nut. All bolts shall have their nuts facing outside of the tower for Horizontal connection and Downwards for Vertical connections.



Nuts & bolts shall be properly tack welded/ punched as per the specification and proper zinc rich paint shall be applied. It shall be ensured that the circular length of each welding shall be at least 10mm.

It shall also be ensured that all extra blank holes provided on tower members are filled with correct size of nuts & bolts.

1.7.2 Special Towers

In addition to the above checks for towers, ladders and platforms provided in special towers shall be properly tightened and no foreign material shall be left out on such platforms.

1.7.3 Earthing of Towers

Ensure that proper earthing of tower has been done and earthing strip is neither damaged nor broken and is properly fixed to the stub.

In case of counter poise earthing, it is to be ensured that earth wire is sufficiently buried in the ground and no where it has drag out during cultivation. The length of counterpoise is normally 30 meters as per Technical Specification.

Before charging of the line, ensure that resistance is below 10 ohms. If the value (before stringing) has been recorded higher than 10-ohm earthing shall be changed to counterpoise type.

Earthing of special towers shall be verified as per approved drawings applicable for special towers/ special foundation. (In case of anchor foundation bolt/ anchor plate welded with last leg of special tower.)

1.7.4 Tower accessories

All the danger plates, number plates, circuit plates, and phase plates shall be in position & and as per the specification.

All plates shall be properly tightened.

It shall be ensured that phase plates are fixed in correct phase sequence. Especially at transposition towers, the phase plates in the correct phase sequence shall be provided at each tower or end tower as per the specification of the line.

It shall be ensured that the anti-climbing device (ACD) is provided, at the suitable height of the tower. In case of barbed wire ACD, barbed wire shall be tightly fixed.

It shall be ensured that the step bolts (for normal towers) are provided up to the peak of tower. Any missing step bolts shall be replaced.

Fixing of birds guards (wherever applicable) shall be ensured.

1.8 Hardware Fittings

Tightening of all bolts and nuts are to be checked up to specified torque. Check the

fixing of all security clips (W/R type clips).

Surface condition of corona control rings and distance/ alignment between Tower side arcing horn (wherever applicable) and line side arcing horn/ corona control ring to be checked as per approved drawings.

To restrict the swing of jumpers, the provision of Pilot strings in case of Tension Towers shall be verified from the approved drawings.



1.9 Insulators

All the damaged/ broken insulator discs shall be replaced. Unusual deflection in suspension strings if observed shall be rectified using appropriate counterweights.

The insulators shall be cleaned before charging.

IR value of insulators of at least 5 insulators at random shall be checked by 5/10 kV Megger.

1.10 Conductors and Earth Wires

Surface of the conductors shall be free from scratches/ rubs. Ensure that conductor strands are not cut and opened. Wherever strands are found cut/ damaged/ scratched, they must be repaired with repair sleeves/ repair protective rods in case the nos. of damaged strands are within specified limits (normally up to 1/6th nos. of strands in the outer layer).

1.11 Accessories for Conductor and Earth Wires

1.11.1 Joints

All joints on conductor/ earth wires shall be away from the tower at a distance of at least 30 meters or as provided in the Technical specification (TS).

Ensure that no more than one joint in a conductor is provided in one span.

Ensure that no mid span joint is provided in major crossings for main roads, railway crossing, and major rivers etc. or as provided in Technical Specification.

Ensure that all mid span joints on conductors/ earth wire and repair sleeves of compression type are free from sharp edges, rust and dust. Wherever grease is specified the same shall be applied in the joints.

1.11.2 Clipping

Ensure that conductor is not over tightened in the suspension clamps Spacers,

vibration dampers and copper bonds.

Vibration Dampers (VD, shall be verified as per the damper placement chart. All loose/ displaced VD shall be properly tightened / relocated and missing VDs shall be provided.

1.11.3 Jumpers

Verify Electrical clearance of jumpers to tower body as per design.

All the jumpers shall be checked properly. In case, jumpers (conductor/ earth wire) are found loose, it shall be tightened adequately.

1.11.4 Foreign material

Ensure that all foreign materials via dead bird. Fallen tree branches, bird nests etc. on conductors, earth wires, Jumper, insulator string, cross arms are re-moved.

1.11.5 Others

It shall be ensured that all temporary/ local earthing, guys, T & P (Tools and Plants), foreign material and other loose material which were used during stringing/ tower erection have been removed.



In case there is any change in the ground profile before commissioning of line from the approved profile, the extra earth/ obstruction/ temporary sheds/ any other construction shall be removed.

1.12 Aviation Warning/ Obstruction Signals (Lights/ Globules/ Painting)

It shall be ensured that following measures have been taken in the line/ Towers falling within obstruction zone of civil aviation and defense establishments as per their requirement and the specification.

1.12.1 Day markers

Painting of Full/ Top portion of Towers with Red/ Orange and White Paints. Globules

on earth wires have been provided.

1.12.2 Night markers

It shall be ensured that proper aviation lights at the peak level/ at specified heights of towers have been provided along with Solar panels/ Battery banks/ Control cubicles and other accessories as per specification. The functioning of lights with simulation to be checked/ verified.

1.13 Statutory Requirement

The concerned authorities shall be informed before commissioning the lines and their approval obtained in accordance with Statutory Provisions.

1.14 Handing Over

The transmission line shall be inspected prior to energization and a formal handing over document to be jointly signed by the Employer and Employer's representative. However, all contractual taking over has to be resolved separately as per the terms and conditions of the contract. The Handing over shall be limited to the completion of Erection and ready for Energization.

Any outstanding points or remaining activities are to be listed jointly. The remaining activities/ outstanding points are classified in the following category:

Details of the Sections:

- A. List of outstanding activities remaining in any part of the line
- B. A list of temporary arrangements introduced.
- C. Check list records properly documented, completed and signed.
- D. Soft copies of Profile, Route Alignment, Tower Design, Structural Drawings, Bill of Materials, Shop Drawings, stringing charts (initial and final as applicable) etc. of all towers/ line submitted to the Employer.

With the outstanding activities mentioned above are solved or with only minor points without influence on the charging remain, handing over of the transmission line shall be accepted by the pre- commissioning team. This handing over for energization with or without remaining activities shall be made by the group head to the commissioning in charge in writing.

1.15 Protective System

Before energization it must be ascertained that all protective systems for the unit to be energized are operative.

This includes confirmation that the protections have been properly tested and that the tests have been documented.



It also includes verification by inspection or otherwise, if necessary, by repetition of trip test, that the protections are actually functionally enabled. This verification serves to prevent that energization takes place of a unit where a protection has been disabled for test or other reason.

1.16 Switching Procedure

For each activity the instructions to the operators and the communications to the dispatchers will be made in writing or by confirmed telephone messages. The switching procedures first to be properly documented step by step and understood by everybody involved in the switching operation prior to the energization. Any clarification required in the procedures must be resolved. The format established by the Employer for switching orders and operational data logging shall be followed.

The implication of this is that every activity must be listed and described, so that complete information is available for detail investigation, if required in future.

1.17 Testing and Measurement Procedures

1.17.1 Earth Resistance Measurement

Normally Earth tester is used for measuring:

a. Soil resistivity

Prior to the testing of soil resistivity and earth resistance the operation manual of the testing instrument available at site may be referred and procedures to be adopted for measurement of soil resistivity and earth resistance.

A typical Earth tester has 4 terminals. C1, P1, C2, P2 and 4 similar electrodes are driven in the ground at equal distances and connected to the instruments in the order of C1' P1 and P2, C2. Then the handle is rotated, or button is pressed and the reading of the resistance is read on the instrument scale. If R is the resistance measured, then the

Specific resistivity = $2 \pi a R$

Where "a" is the distance between the electrode and R is the resistance in ohms measured on the instrument.

b. Earth resistance

In order to measure earth resistance of electrode of the substation it could be connected to C1 and the value of R could be read in the scale with the rotation of the handle of the instrument. This will give the earth resistance. The value as far as possible shall be below 10 Ohm. To improve the value, water shall be sprinkle at the earthing pit.



fig: 2 Test connection for a four terminal Megger



1.17.2 Other Tests

Before commissioning of the lines, the following tests may be carried out.

Insulation Resistance Test

This test may be carried out with the help of a 10 or 12 kV instrument, preferably power driven to ascertain the insulation condition of the line. In case 5 kV instrument is used for insulation resistance measurement it shall be ensured that the induced voltage (CVT reading) is LESS than the instrument withstanding capacity otherwise it is likely that the instrument may be damaged.

This Test is to be carried out First prior to the continuity test.

Measurement of Insulation Resistance

One of the most common devices used for testing electrical insulation is the Instrument Insulation Tester.

The DC test voltage is generated by a permanent magnet generator. This generator is turned either by hand or by an electric motor. In either case a slip clutch maintains the generator speed at a constant value so long as the slipping speed is exceeded. A constant voltage is important when the insulation under test has a high capacitance. Common generator output voltage is 500, 1000, 2500 and 5000 volts.

Many insulation-testers have a "guard" terminal as well as "line" and "earth". The guard terminal is useful shall one wish to exclude part of the insulation under test from the measurement. This is possible since current flowing to the generator via the guard circuit does not pass through the deflecting coil.

Another use of the guard circuit is to shield the "line" lead between the insulation tester and the apparatus under test. This prevents leakage to ground from the "line" lead which would invalidate the insulation tester reading.

Insulation resistance is the ratio VDC/IDC.VDC is applied across two conductors separately by the insulation under test.

IDC is the current flowing through/over the insulation. For healthy and clean insulation, the insulation tester reading is in mega-Ohms to infinity. For dirty in, insulation and defective, moist insulation the insulation tester shows a very low insulation resistance value.

The insulation tester test gives clear indication about the health, cleanliness and dryness of the line/equipment insulation.

5 kV insulation tester or 10 kV insulation tester or 12 kV insulation tester may be used for the Transmission line keeping all safety requirements, permit to work, clearance from statutory bodies and other conditions prevailing at the Sub-station where charging of the line is being coordinated.

Conductor Continuity Test

The objective of this test is to verify that each conductor of the overhead line is properly connected electrically (the value of electrical resistance of line does not vary abnormally from that of a continuous conductor of the same size and length). The electrical resistance of the conductor shall be measured with a Whetstone bridge or other suitable instrument, if available taking the safety aspects of Equipment as well as testing Engineer.

A simple method of continuity test is illustrated below:

Once the insulation test is completed and the results confirms no short circuit carry the following:

RECEIVING END

RESULTS (OHMS)

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CLOSE R-Ph GS	Insulation Resistance R- Ph	ZERO/LOW
OPEN Y – Ph GS	Insulation Resistance Y-Ph	HIGH
OPEN B-Ph GS	Insulation Resistance B-Ph	HIGH
OPEN R-Ph GS	Insulation Resistance R-Ph	HIGH
CLOSE Y – Ph GS	Insulation Resistance Y-Ph	ZERO/LOW
OPEN B-Ph GS	Insulation Resistance B-Ph	HIGH
OPEN R-Ph GS	Insulation Resistance R-Ph	HIGH
OPEN Y-Ph GS	Insulation Resistance Y-Ph	HIGH
CLOSE B-Ph GS	Insulation Resistance B-Ph	ZERO/LOW

Notes:

- 1. GS means GROUND SWITCH.
- 2. During above test all other GS shall remain open.

If the above test results are OK, it confirms the continuity of the line.

The continuity Test of the line with proper phase indication or phase marking can be checked by continuity test as described below:

SENDING END	RECEIVING END INSULATION RESISTANCE BETWEEN	RESULTS (OHMS)
CONNECT R&Y PHASE	R PHASE & Y PH	ZERO OR LOW
B-PHASE & ALL GS OPEN	Y PHASE & B PH	HIGH
	B PHASE & R PH	HIGH
CONNECT R & B PHASE	R PHASE & Y PH	HIGH
Y PHASE & ALL GS OPEN	Y PHASE & B PH	HIGH
	B PHASE & R PH	ZERO OR LOW
CONNECT Y & B PHASE	R PHASE & Y PH	HIGH
R-PHASE & ALL GS OPEN	Y PHASE & B PH	ZERO OR LOW
	B PHASE & R PH	HIGH

If the test results are OK, it confirms that marking of the phases are in order.

Phase Sequence

Once the line is charged from one end, without closing the Breaker at the other end the Phase sequence is to be checked from the CVT/ PT output by the help of Phase Sequence Meter.

In case there are other feeders available Phase sequence is to be RECHECKED by the measurement of secondary voltage of both the Feeders (New line & available charged line).

Let the secondary Voltage of CVT/ PT is 110 volts (ph to ph) for both the Circuit. In case of correct Phase Sequence, the voltage reading shall be as follows:



NEW CIRCUIT	OLD CIRCUIT	VOLTAGE
R-Phase	R-Phase	0
R-Phase	Y-Phase	110
R-Phase	B-Phase	110
Y-Phase	R-Phase	110
Y-Phase	Y-Phase	0
Y-Phase	B-Phase	110
B-Phase	R-Phase	110
B-Phase	Y-Phase	110
B-Phase	B-Phase	0

In case the results are not matching the phase sequence in to be rechecked and reconfirmed before closing the breaker.

1.18 Energization

Execution of the energization is simply the last event in the switching sequence, switching of the close control button for the relevant circuit breaker.

1.19 De-Energization

Instructions about de-energization will be given only if this is part of the test. Otherwise, de-energization will be considered part of regular operation.

1.20 Observation and Duration

Visual and audible inspection (look and listen) of the relevant equipment and reading of permanent instrumentation will be made.

The system shall be charged for at least for 8 hours. During this time continuous monitoring and inspection will be maintained in the control room, auxiliary systems areas and switch yards.

This will include frequent, scheduled inspection of all equipment and reading of all permanent instruments and recorders, and surge arrester counters, especially system parameters as per standard procedures adopted by the Employer.

1.21 Passing Criteria

Neither insulation breakdown nor protective system actions must occur. No irregular equipment behaviors (noise, vibration, high temperature) is permitted.

Corona discharges may not be "unreasonable". Local discharges that may be attributable to sharp points shall be carefully located and recorded. After termination of the energization the equipment shall be closely inspected and the points rounded or covered.

No unscheduled changes of system nor of equipment parameters is permitted during the 8-hour energized condition.



Measurement of Line Parameters

The Contractor shall conduct measurement of Line parameters as per international practice.

High voltage Tests

The Contractor shall conduct high voltage tests as per international practice.

1.22 Documentation

Switching and operational activities will be recorded in a regular manner in the operator's log. Likewise, all readings of permanent instruments, Copies of this log, notes on special observations from inspections and other measurements will constitute the test records.



CHAPTER - 11 TECHNICAL SCHEDULE

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11 TECHNICAL SCHEDULE

11.1 Schedule A.1

System and Line Data

ITEM	DESCRIPTION	UNIT	DATA
1.	System Data		
1.1	System Nominal Voltage	kV	132
1.2	System Maximum Voltage	kV	145
1.3	System Nominal frequency	Hz	50
1.4	Line Data		
1.4.1	Parwanipur to Pokhariya 132 kV Multi Circuit Tower	Km	22
1.4.2	Line Conductor		ACSR – BEAR single
1.4.3	Ground Wire		OPGW

Altitude and Basic Insulation Level

The proposed 132 kV Transmission line traverses through plain landscape of Bara and Parsa districts of Nepal. The variations of altitudes of the proposed 132 kV transmission line ranges from approximately 112.13 m to

108.7 m above MSL.

132 kV Transmission Lines in different altitude zones shall be designed in compliance with the following Basic Insulation Levels (BIL)

Altitude Zone	ude Zone Highest Voltage for Equipment Um in kV		Lightning Impulse withstand voltage – kV (peak value)		
	(rms value)	Required	Selected	Required	Selected
Altitude up to and including 1000 m	145	275	275	650	650

11.2 Schedule A.2

DESIGN DATA



ITEM	DESCRIPTION	UNIT	DATA
1.	Temperature		
1.1	Maximum ambient temperature	0C	50
1.2	Minimum ambient temperature	0C	0
1.3	Maximum temperature of conductor	0C	80
1.4	Everyday temperature of conductor	0C	32

Wind Load

ITEM	DESCRIPTION	UNIT	DATA
1.	Temperature		
1.1	Design Wind Speed (Vd)	m/s	47 (Wind Zone:4 as per IS:802)
1.2	Reliability Level		2 (150 years return period)
1.3	Risk Co-efficient (k1)		1
1.4	Terrain Roughness Co-efficient (K2)		1.08
But Gust factors corresponding to terrain category –II shall be considered for conductors/ earth wire, Tower and Insulator for arriving the wind load.			

The corresponding Design Wind Pressure on towers, conductors and insulators shall be obtained from the relation $Pd=0.6V^2$.

11.3 Schedule A.3

MINIMUM CLEARANCES

The followings are the minimum clearances between live conductors and other objects, which correspond to the maximum conductor sag conditions at different altitude zones. Design minimum ground clearance shall be considered with 7.0m.

ITEM	DESCRIPTION	Clearance
1.	Normal ground for pedestrians only	6.33
2.	Residential areas	6.5
3.	Roads and streets	7.0
4.	Highways	12.2
5.	To metal clad or roofed buildings or building or	6.0



	structures upon which a man may stand	
6.	Power lines (above or below)	3.5
7.	Telecommunication lines	3.5
8.	River and other areas (above maximum flood)	6.5

For other objects not listed in the Schedule the requirements for minimum clearances shall comply also with NESC (NATIONAL ELECTRIC SAFETY CODE).

Approximately 0.5m shall be added to the clearance values above to allow for survey and drawings error while

spotting the towers. Crossing of houses, huts and other objects with soft roofing is not allowed.

11.4 Schedule A.4

TOWER TYPES

Altitude less than 1000	Deviation Angle	Typical Use
QA	0 deg2 deg.	To be used as tangent Tower up to 2 deg deviation
QB	0 deg15 deg	a) Tension Tower with Angle deviation from 0 to 15 deg.b) Section towerc) To be designed for anti- cascading condition.
QC	15 deg30 deg	 a) Tension Tower with Angle deviation from 15 to 30 deg b) Tension tower for uplift forces resulting from a uplift span as per weight span specified in Schedule-A4, Chapter-11. c) To be designed for anti-cascading condition.
QD	30 deg60 deg	 a) Tension tower Angle deviation from 30 to 60 deg. b) Tension towers for uplift forces resulting from an uplift spam as per weight span specified in Schedule-A4, Chapter-11. c) Complete Dead-end with 0 to 15 Degree deviation on both sides.



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2.	DESIGN SPANS		WEIGHT SPAN (m)				
ITEM	TOWER TYPE	BASIC SPAN (m)	WIND SPAN (m)	Normal Condition (Maximum)	Normal Condition (Minimum)	Broken Wire Condition (Maximum)	Broken Wire Condition (Minimum)
2.1	QA	320	320	600	200	360	100
2.2	QB	320	320	900	-900	540	-540
2.3	QC	320	320	900	-900	540	-540
2.4	QD	320	320	900	-900	540	-540

11.5 Schedule A.5

TOWER OUTLINE CONFIGURATION

Refer Drawing No. DWG011.

11.6 Schedule A.6

FACTOR OF SAFETY

ITEM	DESCRIPTION	MINIMUM FACTOR OF SAFETY
1.	Tower Foundations	
1.1	All types of suspension (QA) and small angle (QB) towers	1.1
1.2	All types of other tension towers (QC, QD)	1.1
2.	Conductors and Insulators	
2.1	Conductors based on ultimate tensile strength	1.428(70%)
2.2	Conductors based on ultimate tensile strength at still air every –day temperatures	4.545 (22%)
2.3	Dead end compression clamps and compression splices based on conductor ultimate tensile strength	0.95
3.	Ground Wires	
3.1	Ground wire based on earth wire ultimate tensile strength	2.0



Employer's Requirements

3.2	Ground wire at still air everyday temperature based on earth wire ultimate tensile strength	5.0
3.3	Complete tension assembly at ground wire maximum working tension	4.0
3.4	Complete suspension assembly at maximum vertical load	4.0

11.7 Schedule A.7

TOWER PARTICULARS

ITEM	DESCRIPTION	UNIT	MINIMUM VALUES
1.	Unit Stresses		
	The quality of steel used for support members and bolts		
1.1	Structural Steel:		
1.1.1	Structural Members		
	i. Tension based on net sectional area (MS)	kg/cm ²	2600
	ii. Tension based on net sectional area (HT)	kg/cm ²	3600
	iii. Axial compression based on gross sectional area	kg/cm ²	As per IS:802
1.1.2	Connection bolts		
	i. Shear on gross area (Class 5.6)	kg/cm ²	3160
	ii. Bearing (on Mild Steel) (Class 5.6)	kg/cm ²	4440
	iii. Tension on net area of threaded portion (Class 5.6)	kg/cm ²	2590
2	Slenderness Ratios (L/R)		
	The slenderness ratio of unsupported length of steel comp of gyration.AS per IS 802-P1S2 (2016)	ression members	s to their least radius
2.1	Main members	NA	120
2.2	Diagonals, Horizontal	NA	150
2.3	Redundant members	NA	250
2.4	Members loaded in tension only	NA	400



11.8 Schedule A.8

TOWER MEMBERS PARTICULARS

The minimum thickness and diameter of material used in members and bolts shall be as follows:

ITEM	DESCRIPTION	UNIT	MAXIMUM VALUES
1.	Calculated members	mm	45x45x4
2.	Redundant members	mm	45x45x4
3.	Thickness of legs, members in cross arms and in ground wire peaks	mm	6
4.	Diameter of bolts for member carrying stress	mm	16
5.	Diameter of bolts for redundant members without calculated stress	mm	16
6.	Gusset plates	mm	5

11.9 Schedule A.9

LONG ROD POLYMERIC INSULATORS

The minimum thickness and diameter of material used in members and bolts shall be as follows:

ITEM	DESCRIPTION	UNIT		
			Altitude ≤ 1,000m	
1.	Insulator type		Com	nposite Log Rod
2.	Highest system voltage	kV		145
3.	System frequency	Hz		50
4.	Rated lightning impulse withstand voltage	kV _{peak}	650	
5.	Rated power frequency withstand voltage(wet)	kVrms	270	
6.	Minimum Creepage distance as multiplied arcing distance	-		3.5
7.	Minimum mechanical failing load			



Employer's Requirements

ITEM	DESCRIPTION	UNIT	
			Altitude ≤
			1,000m
7.1	Suspension rod	kN	70
7.2	Tension rod	kN	120
8.	Overall length of insulator string		As per standards
9.	Standards		IS/ IEC

11.10 Schedule A.10 LINE CONDUCTOR

ITEM	DESCRIPTION	UNIT	DATA
1.	ACSR "BEAR"		
1.1	Conductor size	mm ²	326.1
1.2	Conductor type		ACSR BEAR
1.3	Number and size of wires		
1.3.1	Aluminum	No. Dia mm	30 3.38
	1 st Aluminum Layer	No.	18
	2 nd Aluminum Layer	No.	12
1.3.2	Steel	No. Dia mm	7 3.35
	Core Steel	No.	1
	1 st Steel Layer	No.	6
1.4	Cross section		
1.4.1	Aluminum	mm ²	264.4
1.4.2	Steel	mm ²	61.7
1.4.3	Total	mm ²	326.1
1.5	Conductor diameter	mm	23.45
1.6	Ultimate strength	Kg	11,340
1.7	Standard mass of conductor	Kg/km	1214
1.8	Electrical D.C. resistance at 20 ®C	Ohm/km	0.1093
1.9	Standard unjointed length on reel	m	2,000
1.10	Modulus of Elasticity	kg/Sq mm	8,200
1.11	Mass of zinc coating	gm/sq. m	195
1.12	Co-efficient of Linear Expansion	per °C	17.8 x 10 ⁻⁶
1.13	Direction of Lay of outer	-	Right Hand
1.14	Standards	BS215 part 2 IEC61089/S 39	98 Part 2

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11.11 Schedule A.11

Optical Fiber Ground wire (OPGW)

Fibre Description:	Dual-Window Single-Mode 48 fibers	
Mode Field Diameter @ 1310nm:	8.6 to 9.5 μm (± 0.6μm)	
Cladding Diameter:	125.0 μm ± 1 μm	
Mode field concentricity error	≤ 0.6µm	
Cladding non-circularity	≤ 1%	
Cable Cut-off Wavelength λ_{cc}	≤ 1260 nm	
1550 nm loss performance	As per G.652 D	
Proof Test Level	≥ 0.69 Gpa	
Attenuation Coefficient:	$\begin{array}{llllllllllllllllllllllllllllllllllll$	
Point discontinuity @ 1310nm:	≤ 0.05 dB	
@ 1550nm:	≤ 0.05 dB	
Nominal Mode Field Diameter	8.6 to 9.5 μm (± 0.6 μm)	
Chromatic Dispersion; Maximum:	18 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) 1288-1339nm 5.3 ps/(nm x km) 1271-1360nm	
Zero Dispersion Wavelength: Zero Dispersion Slope:	1300 to 1324nm 0.092 ps/(nm²xkm) maximum	
Polarization mode dispersion coefficient	\leq 0.2 ps/km ¹ / ₂	
Temperature Dependence:	Induced attenuation $\leq 0.05 \text{ dB}$ (-60°C to +85°C)	
Bend Performance:	@ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise \leq 0.05 dB/km	
	@ 1550 nm (75±2 mm dia Mandrel), 100 turns;	
	Attenuation Rise \leq 0.10 dB/km @ 1550 nm (32±0.5 mm dia Mandrel, 1 turn; Attenuation Rise \leq 0.50 dB/km	
Short ckt current	≥ 5.6 kA for 1.0 second	
DC Resistance	<1.0Ohm per KM	
Central Fibre optic unit design	Al Tube	
Сгеер	The 25 year creep at 25% of UTS (creep test as per IEEE 1138) shall be such that the 25 year creep plus the cable strain at Max Allowable Tension (MAT) is less than or equal to the cable strain margin.	

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11.12 Schedule A.12

MATERIAL FOR TOWER GROUNDING

ITEM	DESCRIPTION	DATA
1.	Pipe Type Earthing	
1.1	Galvanized steel Flat	50 x 6mm steel 6 mtr long
1.2	Pipe	25NB heavy Duty GIMS Pipe-3 mtr long 6.5 dia holes 150mm apart
2.	Counter Poise earthing	
2.1	Galvanized steel wire	10.97mm Dia HTGS wire -30mtr @ 4 legs up to soil resistivity 1500ohm mtr, above 1500 Ohm meter 70 mtr @ 4 legs
3.	Connection of ground electrode with stub angle	
3.1	For connection:	Steel wire as above with GS Lugs



11.13 Schedule A.13

FOUNDATION APPLICATION SCHEDULE

FOUNDATION TYPE	APPLICATION	SOIL DESCRIPTION		
l. "Spread Footing"	For use with all 132kV lattice tower types QA QB	Soil capable of being excavated with vertical wall limit bearing capacity 2.5 kg/ sq.cm. Assume cone of earth 30 degrees.		
	QC QD	Dry Cohesive Material – Stiff clay. Some silt and sand. Not readily excavated by shovel alone. Cannot be molded by finger pressure and intended by thumb. Blow count 8 to 10.		
		Granular Material- Compacted sand. Some silt and gravel. Difficult to excavate by shovel alone. Relative density over 60%. Blow count 10 to 20.		
ll "Spread Footing"	For use with all 132kV lattice tower types	Soil capable of being excavated without appreciable sloughing. Limit Bearing Capacity 1.25 kg/sq. cm.		
looting		Assume cone of earth 15 degrees.		
		 a) Cohesive Material – Soft to medium clay. Some silt and sand. Can be excavated by shovel alone and molded by medium finger pressure. Blow count 4 to 8. 		
		Granular Material – Loose to medium sand and silt. Easily excavated by shovel alone and molded by medium finger pressure. Blow count 4 to 10, paddy fields.		
		When the top layer of soil upto 1.5m each black cotton/Loose Silty Sandy soil and followed by normal dry cohesive ordinary soil.		
		And where subsoil water table is met at 1.5m or below the ground level.		
		 b) For all the above soils and where subsoil water table is met less than 0.75m or below the ground level. 		
		Fully submerged soil consisting top layer of black cotton soil/Loose silty sandy soils followed by ordinary fine grained soil strata.		
		c) Wet fissured/disintegrated rock, hard gravel, Kankar and limestone, <mark>Later it.</mark>		
III "Spread Footing"	For use with all 132kV lattice tower types	Hard Rock/ordinary soil followed the hard rock.		



11.14 Schedule A.14

INSEPTION TESTS AT MANUFACTURE'S PLANT

ITEM	DESCRIPTION	DATA
1.	Rolled Steel Angles and Bolts	
1.1	Tensile strength test and chemical analysis, zinc coating test	Steel Mill Certificates
	Full scale tower load test to destruction	IEC 652
2.	Insulators	
2.1	Temperature cycle test, mechanical failing load test	IEC 383 & IEC 575
2.2	Porosity test, continuity of zinc coating	BS 137
2.3	Electrical test on complete insulator strings	ANSI C-29.1
3.	Insulator Fittings	
3.1	Routine and sample mechanical tests	BS 3288
3.2	Galvanizing tests	BS 729
4.	Clamps and joints	
4.1	Mechanical and electrical type tests, galvanizing and mechanical routine tests	BS 3288 BS 729 ISO
5.	Dampers	
5.1	Fatigue resistant tests	
5.2	Test of clamp slippage resistance	BS 729
5.3	Galvanizing tests	ISO
6.	Line Conductor and earth wire	
6.1	Mechanical test, galvanizing test and resistivity test, ultimate tensile stress of complete conductor	IEC 209 BS 2677



CHAPTER - 12 FORMS AND PROCEDURES



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Employer's Requirements

FORM OF COMPLETION CERTIFICATE

|--|

То: _____

Dear Ladies and/or Gentlemen,

Pursuant to GCC Clause 24 (Completion of the Facilities) of the General Conditions of the Contract entered into between yourselves and the Employer dated ______, relating to the ______, we hereby notify you that the following part(s) of the Facilities was (were) complete on the date specified below, and that, in accordance with the terms of the Contract, the Employer hereby takes over the said part(s) of the Facilities, together with the responsibility for care and custody and the risk of loss thereof on the date mentioned below.

1. Description of the Facilities or part thereof:

2. Date of Completion: _____

However, you are required to complete the outstanding items listed in the attachment hereto as soon as practicable.

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

Title (Project Manager)



FORM OF OPERATIONAL ACCEPTANCE CERTIFICATE

IFB No: _____

То:

Dear Ladies and/or Gentlemen,

Pursuant to GCC Sub-Clause 25.3 (Operational Acceptance) of the General Conditions of the Contract entered into between yourselves and the Employer dated ______, relating to the ______, we hereby notify you that the Functional Guarantees of the following part(s) of the Facilities were satisfactorily attained on the date specified below.

1. Description of the Facilities or part thereof:

2. Date of Operational Acceptance: _____

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

Title

(Project Manager)



CHANGE ORDER PROCEDURE AND FORMS

Date:			

IFB No: _____

CONTENTS

- 1. General
- 2. Change Order Log
- 3. References for Changes

ANNEXURES:

- Annex 1 Request for Change Proposal
- Annex 2 Estimates for Change Proposal
- Annex 3 Acceptance of Estimate
- Annex 4 Change Proposal
- Annex 5 Change Order
- Annex 6 Pending Agreement Change Order
- Annex 7 Application for Change Proposal



CHAPTER 12: FORMS & PROCEDURES

CHANGE ORDER PROCEDURE

1.1 General

This section provides samples of procedures and forms for implementing changes in the Facilities during the performance of the Contract in accordance with GCC Clause 39 (Change in the Facilities) of the General Conditions of the Contract.

1.2 Change Order Log

The Contractor shall keep an up-to-date Change Order Log to show the current status of Requests for Change and Changes authorized or pending. Entries of the Changes in the Change Order Log shall be made to ensure that the log is up to date. The Contractor shall attach a copy of the current Change Order Log in the monthly progress report to be submitted to the Employer.

1.3 References for Changes

- a. Request for Change as referred to in GCC Clause 39 shall be serially numbered CR-X-nnn.
- b. Estimate for Change Proposal as referred to in GCC Clause 39 shall be serially numbered CN-X-nnn.
- c. Acceptance of Estimate as referred to in GCC Clause 39 shall be serially numbered CA-X-nnn.
- d. Change Proposal as referred to in GCC Clause 39 shall be serially numbered CP-X-nnn.
- e. Change Order as referred to in GCC Clause 39 shall be serially numbered CO-X-nnn.

Note:

- (a) Requests for Change issued from the Employer's Home Office and the Site representatives of the Employer shall have the following respective references:
 - Home Office CR-H-nnn
 - Site CR-S-nnn
- (b) The above number "nnn" is the same for Request for Change, Estimate for Change Proposal, Acceptance of Estimate, Change Proposal and Change Order.





Date:

ANNEXURE – 1: REQUEST FOR CHANGE PROPOSAL

General

This section provides samples of procedures and forms for implementing changes in the Facilities during the performance of the Contract in accordance with GCC Clause 39 (Change in the Facilities) of the General Conditions of the Contract.

(Employer's Letterhead)

То: _____

Attention:

Contract Name: _____

Contract Number:	

Dear Ladies and/ or Gentlemen:

With reference to the captioned Contract, you are requested to prepare and submit a Change Proposal for the Change noted below in accordance with the following instructions within ______ days of the date of this letter

1.	Title of Change:
2.	Change Request No.
3.	Originator of Change: Employer: Contractor (by Application for Change Proposal No:
4.	Brief Description of Change:
5.	Facilities and/or Item No. of equipment related to the requested Change:
6.	Reference drawings and/or technical documents for the request of Change:
	Drawing No./Document No. Description
7.	Detailed conditions or special requirements on the requested Change:



- 8. General Terms and Conditions:
- (a) Please submit your estimate to us showing what effect the requested Change will have on the Contract Price.
- (b) Your estimate shall include your claim for the additional time, if any, for completion of the requested change.
- (c) If you have any opinion negative to the adoption of the requested Change in connection with the conformability to the other provisions of the Contract or the safety of the Plant or Facilities, please inform us of your opinion in your proposal of revised provisions.
- (d) Any increase or decrease in the work of the Contractor relating to the services of its personnel shall be calculated.
- (e) You shall not proceed with the execution of the work for the requested Change until we have accepted and confirmed the amount and nature in writing.

(Employer's Name)

(Signature)

(Name of signatory)

(Title of signatory)



Employer's Requirements

ANNEXURE – 2: ESTIMATE FOR CHANGE PROPOSAL

(NOT APPLICABLE)

(Contractor's Letterhead)

То: _____

Attention:

Contract Name: _____

Dear Ladies and/or Gentlemen:

With reference to your Request for Change Proposal, we are pleased to notify you of the approximate cost of preparing the below-referenced Change Proposal in accordance with GCC Sub-Clause 39.2.1 of the General Conditions of the Contract. We acknowledge that your agreement to the cost of preparing the Change Proposal, in accordance with GCC Sub-Clause 39.2.2, is required before estimating the cost for change work.

1.	Title c	of Change:	
2.	Chang	ge Request No./Rev.:	
3.	Brief I	Description of Change:	
4.	Scheo	duled Impact of Change:	
5.	Cost for Preparation of Change Proposal:		
(a)	Engin	eering	(Amount)
	(i) (ii)	Engineer hrs x rate/hr = Draftsperson hrs x rate/hr = Sub-total hrs	
Total	Enginee	ring Cost	



Date: _____

(b) Other Cost

Total Cost (a) + (b)

(Contractor's Name)

(Signature)

(Name of signatory)

(Title of signatory)



ANNEXURE – 3: ACCEPTANCE OF ESTIMATE

(NOT APPLICABLE)

(Employer's Letterhead)

То: _____

Attention: _____

Contract Name: _____

Contract Number: _____

Dear Ladies and/ or Gentlemen:

We hereby accept your Estimate for Change Proposal and agree that you should proceed with the preparation of the Change Proposal.

1. Title of Change: _____

2. Change Request No./Rev.: _____

3. Estimate for Change Proposal No./Rev.: _____

4. Acceptance of Estimate No./Rev.:

5. Brief Description of Change: _____

6. Other Terms and Conditions: In the event that we decide not to order the Change accepted, you shall be entitled to compensation for the cost of preparation of Change Proposal described in your Estimate for Change Proposal mentioned in para. 3 above in accordance with GC Clause 39 of the General Conditions.

(Employer's Name)

(Signature)

(Name and Title of signatory)



Date:

	ANNEXURE – 4: CHANGE PROPOS	AL .
	(Contractor's Letterhead)	
To: _		Date:
Attent	on:	
Contra	act Name:	
Contra		
Dear l	adies and/or Gentlemen:	
In resj submi	oonse to your Request for Change Proposal No t our proposal as follows:	, we hereby
1.	Title of Change:	
2.	Change Proposal No./Rev.:	
3.	Originator of Change: Employer: Contractor:	
4.	Brief Description of Change:	
5.	Reasons for Change:	
6.	Facilities and/ or Item No. of Equipment related to the requested	Change:
7.	Reference drawings and/or technical documents for the request	ed Change:
	Drawing/ Document No.	<u>Description</u>
8.	Estimate of increase/ decrease to the Contract Price resulting fro	m Change Proposal:1
		(Amount)
(a)	Direct material	
(b)	Major construction equipment	
(c)	Direct field labour (Total hrs)	
(d)	Subcontracts	

¹ Costs shall be in the currencies of the Contract.



	CHAPTER 12: FORMS & PROCEDURES	
(e)	Indirect material and labor	
(f)	Site supervision	
(g)	Head office technical staff salaries	
Proces	ss engineer hrs @ rate/hr	
Project	t engineer hrs @ rate/hr	
Equipm	nent engineer hrs @ rate/hr	
Procure	ementhrs @rate/hr	
Draftsp	personhrs @rate/hr	
Total	hrs	

- (h) Extraordinary costs (computer, travel, etc.)
- (i) Fee for general administration, % of Items
- (j) Taxes and customs duties

Total lump sum cost of Change Proposal

Hetauda-Parwanipur-Pokhariya 132 kV Transmission Line Project

(Sum of items (a) to (j))

Cost to prepare Estimate for Change Proposal (Amount payable if Change is not accepted)

- 9. Additional time for Completion required due to Change Proposal
- 10. Effect on the Functional Guarantees
- 11. Effect on the other terms and conditions of the Contract
- 12. Validity of this Proposal: within [Number] days after receipt of this Proposal by the Employer
- 13. Other terms and conditions of this Change Proposal:
- (a) You are requested to notify us of your acceptance, comments or rejection of this detailed Change Proposal within ______ days from your receipt of this Proposal.


- (b) The amount of any increase and/or decrease shall be taken into account in the adjustment of the Contract Price.
- (c) Contractor's cost for preparation of this Change Proposal:

(Contractor's Name)

(Signature)

(Name of signatory)

(Title of signatory)



	ANNEXURE – 5: CHANGE ORDER - 1	
	(Employer's Letterhead)	
To: _		Date:
Atten	tion:	
Contr	ract Name:	
Contr	act Number:	
Dear	Ladies and/ or Gentlemen:	
We a adjus GCC	pprove the Change Order for the work specified in the Change Proposal (No t the Contract Price, Time for Completion and/or other conditions of the Con Clause 39 of the General Conditions of the Contract.), and agree to tract in accordance with
1.	Title of Change:	
2.	Change Request No. /Rev.:	
3.	Change Order No. /Rev.:	
4.	Originator of Change: Employer: Contractor:	
5.	Authorized Price:	
	Ref. No.: Date:	
6.	Adjustment of Time for Completion	
	None Increase days Decrease days	
7.	Other effects, if any	



Authorized by:

Date:

(Employer)

Accepted by:

Date:

_____ (Contractor)



	ANNEXURE – 6: CHANGE ORDER - 2			
	(Employer's Letterhead)			
To: _		Date:		
Attent	on:			
Contra Contra	act Name:act Number: [
Dear l	adies and/or Gentlemen:			
We in: 39 of t	struct you to carry out the work in the Change Order detailed below in acco he General Conditions of the Contract.	ordance with GCC Clause		
1.	Title of Change:			
2.	Employer's Request for Change Proposal No./Rev.: dated:			
3.	Contractor's Change Proposal No./Rev.:dated:			
4.	Brief Description of Change:			
5.	Facilities and/or Item No. of equipment related to the requested Change:			
6.	Reference Drawings and/or technical documents for the requested Chang	ge:		
	Drawing/Document No.	Description		
7.	Adjustment of Time for Completion:			
8.	Other change in the Contract terms:			
9.	Other terms and conditions:			



(Employer's Name)

(Signature)

(Name of signatory)

(Title of signatory)



ANNEXURE – 7: PENDING AGREEMENT CHANGE ORDER



(Contractor's Letterhead) To:

Date: _____

PMD/PTDSSP/HPP/2080/81-01: Supply, Installation, Testing and Commissioning of Parwanipur-Pokhariya 132 kV Transmission Line. Page 187 of 193 Attention:

Contract Name:

Contract Number: _____

Dear Ladies and/or Gentlemen:

We hereby propose that the below-mentioned work be treated as a Change in the Facilities.

- 1. Title of Change: _____
- 3. Brief Description of Change: _____
- 4. Reasons for Change:
- 5. Order of Magnitude Estimation (in the currencies of the Contract):
- 6. Scheduled Impact of Change:
- 7. Effect on Functional Guarantees, if any:
- 8. Appendix:

(Contractor's Name)

(Signature)

(Name of signatory)

(Title of signatory)



CHAPTER - 13 PAYMENT OF WORKS



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13 PAYMENT OF WORKS

This contract is a fixed price Turnkey Contract and the term of payment is set out in Volume I of Bidding Document.

Invoices of materials, supplied, freight and insurance and erection work shall be submitted separately for the purpose of accounting.

This section provides general guidelines for interim progress payment of different equipment and works covered under this contract.

Interim Certificates for site work shall be restricted in scope to the following items:

- a. Preliminary work
- b. Steel towers and accessories
- c. Concrete foundations
- d. All support earthing systems
- e. All line and earth conductors and their associated fittings and insulator set
- f. Protection of tower footings

The Contractor shall submit to the Employer for approval a draft blank printed Form of Measurement Certificate at an early stage in the Contract.

All measurements for the purpose of payments shall be made jointly between representatives of the Contractor and the Employer.

The measurement of conductor and OPGW stringing is to be made along the center line of the transmission lines without allowance for sag or scrap and will be based on the horizontal distance involved. Measurement for supply part of conductor and OPGW is to be made as per actual length supplied.

The rates in the Price Schedule for the standard towers, foundations and for excavation in any type of ground, concrete etc., shall include all work irrespective of access conditions, slope of the ground, nature of the subsoil and the presence of water.

No extra payments will be made for the followings, which are not mentioned in the price schedule and required for execution of the work:

- Design, Engineering and project management services.
- Supply of Construction power and water.
- Deployment of man powers required for construction, erection testing and commissioning.
- Providing tools & tackles, consumables, construction machinery, vehicles, testing equipment, spare parts required for construction, erection, testing and commissioning.
- Excavation necessary solely for the installation of stub setting templates.
- Tower erection methods employed.
- Additional costs of access and transport of personnel, materials and erection equipment to the structure or along the route.
- Pumping out of water and flooding conditions.
- Shuttering, planking and close timbering of excavations.



- Lean Concrete made in tower foundation.
- Scaffolding necessary for stringing of conductors over existing overhead line, telecommunication lines, building, waterways, roads or railways.
- Delays arising from the necessity to switch out and earth existing overhead lines which have to be crossed over or under.
- And other items specifically mentioned in the document.

Costs of all the above items are deemed to be included in the quoted price in price schedule. Payment

for various items as per the Price Schedule shall be as follows:

Table 13.1: Schedule for Interim Payment

S. No.	Description	Unit	Basis of Payment
1	Preliminary Work		
1.1	Check survey and Staking (Horizontal distance)	km	Based on km of line length
1.2	Detail Survey	km	Based on km of line length
1.3	Detail soil test	Location	Based on No. of Tower Locations
1.4	Measurement of Ground Electric resistance	Location	Based on No. of Tower Locations
1.5	Benching	Cu m	Based on Measured Value
2.	Galvanized steel tower		
2.1	Galvanized Steel Tower	No.	Based on no. of Tower
2.2	Galvanized Steel work for leg extension etc.	No.	Based on size and numbers supplied and erected
3	Tower accessories (Signs on tower)	Set / No.	Based on no. of Set / No.
4	Tower earthing (each set means one complete set for one tower footing)		
4.1	Ріре Туре	Set	Based on no. of sets
4.2	Counterpoise type	No.	based on the set with Galvanized (earthing) steel wire



S. No.	Description	Unit	Basis of Payment
			length used
5	Conductor and accessory		
5.1	Supply of ACSR conductor and OPGW	km	Based on length of supply
5.2	Stringing of ACSR conductor and OPGW	km	Based on both double circuit conductor km horizontal (all six wires) and OPGW distance
6	Foundations	No.	Based on no. and type of foundations
7	Protection of Tower Footing		
7.1	Stone masonry work	Cum	Based on measured value
7.2	Gabion Wall	Cum	Based on measured value
7.3	Back filling and leveling	Cu m	Based on measured value
7.4	R.C.C works	Cum	Based on measured value



Annex-A

Environmental Management Plan (EMP) Requirements to be Complied During Implementation



Торіс	Activity / Issue	Commitment	Applicable Project Standards / Guidelines	Implementation Responsibility (Budget Source and Timing)	Monitoring Responsibility
1. Siting and design of Project infrastructure	Detailed design	 Design and layouts to reflect the requirements of the EMP and international engineering best practices/good EHS practice, as well as the issues raised by the public and other stakeholders as documented in the consultation chapter of the IEE report Comply with all applicable national and state environment, health, and safety (EHS) regulatory requirements in addition to the mitigation measures set out in the EMP – if there is any conflict between national requirements and measures set out in the EMP the most stringent provisions will take precedence For all construction works undertake facilitated H&S risk assessment through a workshop during the design (and at other key stages) so it can inform both design and pre-construction preparations, considering both occupational and community H&S risks resulting from subsequent stages of the project. Facilitated workshop will involve the design and construction team of the contractors and NEA operational staff. 	 ADB SPS (2009)¹ IFC EHS General Guidelines² IFC EHS Electric Power T&D Guidelines ³ ILO Worker Accommodation⁴ GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before design approval for further implementation during construction phase	NEA PMU / PISC

Table 1: Design Phase EMP

⁴ 2https://www.ilo.org/media/340691/download



¹ Safeguard Policy Statement (June 2009) (https://www.adb.org/sites/default/files/institutional-document/32056/safeguard-policy-statement-june2009.pdf)

² Manual or Guideline Environmental, Health, and Safety Guidelines (https://www.ifc.org/en/insights-reports/2000/general-environmental-health-and-safety-guidelines)

³ Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution (https://www.ifc.org/content/dam/ifc/doc/2000/2007-electric-transmissiondistribution-ehs-guidelines-en.pdf)

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Table 1: Design Phase EMP

Торіс	Activity / Issue	Commitment	Applicable Project Standards / Guidelines	Implementation Responsibility (Budget Source and Timing)	Monitoring Responsibility
	<u>TL</u> Finalization of design and route alignments	 In undertaking design, contractor with NEA to consult with communities in 500m to get their views and input into the route alignment (records of consultations are to be kept) Ensure conductors and/or jumpers are fitted with "bird sensitive" design measures e.g. adequate separation between live and ground or and insultation. No towers will be located within rivers or their floodplain No school compounds, playgrounds or similar facilities shall be crossed River/stream crossings required will be single span. Minimize visual impacts/amount of visual clutter through sensitive route alignment of overhead lines and tower placement having cognizance of any above ground physical cultural resources adjacent. Barbed wire type anti-climbing device shall be provided and installed for all tower structures. The height of the anticlimbing device shall be approximately 3 m above ground level Ensure that ICNRP community EMF exposure levels (reference and peak values) will be achieved All transmission towers will feature written and visual warning signs that meet the IEEE standards to include the ISO 7010 "Hazard Type: Electrical Symbol" warning of the risk of electrocution 	 ADB SPS (2009) IFC EHS General Guidelines IFC EHS Electric Power T&D Guidelines ILO Worker Accommodation⁵ GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before design approval for further implementation during construction phase	NEA PMU / PISC



 ⁵ https://www.ilo.org/media/340691/download

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Table 1: Design Phase EMP

Торіс	Activity / Issue	Commitment	Applicable Project Standards / Guidelines	Implementation Responsibility (Budget Source and Timing)	Monitoring Responsibility
	<u>TL, SS</u> Geohazards, and climate hazards	 Select an appropriate design for all civil and structural components including foundations considering climate factors, seismic risk All buildings will be designed in accordance with national building safety codes and standards for earthquake resistance plus international good practice seismic design standards. Designs to be checked for seismic safety by design team and by an independent expert, separate to design team, to confirm international good practice seismic design standards are met. Identify presence of floodplain, drainage routes or depressions that get waterlogged in the rainy season and avoid these during detailed design. Conduct flood and drainage risk assessment and incorporate effective drainage design (at 1 in 100 years allowing for climate change) to prevent possible flooding or waterlogging of SS equipment during the wet season. Final surface level of towers will be at least 0.5 m above the existing ground level or highest flood level including an allowance for climate change based on the findings of the climate change assessment prepared for the Project (whichever is higher) Place electrical equipment above the flood level whilst ensuring that surface runoff from the project site is no more than the greenfield runoff rate through attenuation on site (retention ponds) to avoid exacerbating flooding of the adjacent land. All designs shall incorporate climate change adaptation measures per the climate risk assessment for the project. Construction activities must be planned not to limit the availability of or restrict access to water sources (e.g., groundwater) used by local communities 	 ADB SPS (2009) IFC EHS General Guidelines IFC EHS Electric Power T&D Guidelines GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before design approval for further implementation during construction phase	NEA PMU / PISC

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Торіс	Activity / Issue	Commitment	Applicable Project Standards / Guidelines	Implementation Responsibility (Budget Source and Timing)	Monitoring Responsibility
Electrocution and collision risk to birds	TL Electrocution and collision risk to notable bird species	 Further bird surveys during overwintering and breeding seasons will map presence of notable species, bird nests, communal roosts, carcass dumps and movements Detailed design will ensure the transmission lines are routed at least 1 km from nesting sites of notable species at risk of collision (for instance Lesser Adjutant), to minimize collision risks to fledglings which are more at risk than adults. If any endangered or critically endangered nesting birds are observed (none to date) then the set back of 2km is recommended Spacing between live and ground components will be large enough to avoid electrocution of notable species present Bird diverters will be installed on all crossings of waterbodies, and at other key locations Bird diverters must also be an internationally accepted robust design, rotates, of contrasting color, reflects UV light, glows in the dark, and is guaranteed. At minimum the bird divertors to be placed at 10m spacing along the earth wire. 	 ADB SPS (2009) APLIC guidelines⁶ 	EPC Contractor Include in EPC contract cost Before design approval for further implementation during construction phase	NEA PMU / PISC
Equipment specifications and design parameters	TL and SS Exposure to electromagnetic interference	 Designs to comply with the reference and peak levels of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) for EMF occupational and community exposure will be achieved within the substation and outside of the fence line respectively. Contractor to provide EMF calculations to the PISC for review and approval. Use of shielding equipment/materials to decrease electromagnetic field exposure included at any substation where calculations identify levels above ICNIRP reference levels at properties close to the substation. 	 ADB SPS (2009) IFC EHS General Guidelines IFC EHS Electric Power T&D Guidelines GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before design approval for further implementation during construction phase	NEA PMU PISC



 ⁶ https://www.aplic.org/documents

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Table 1: Design Phase EMP

Торіс	Activity / Issue	Commitment	Applicable Project Standards / Guidelines	Implementation Responsibility (Budget Source and Timing)	Monitoring Responsibility
	Hazardous Materials	 No asbestos containing materials of any type will be used in the design and construction of project facilities. 	 ADB SPS (2009) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before design approval for further implementation during construction phase	NEA PMU / PISC
Detailed designs	Community Consultations	 Contractors to undertake and document meaningful consultations with potentially affected persons and local communities within 500m of the TL, substations as well as other stakeholders including local authorities and public utilities during design in order that any concerns raised can be reflected in the choice of route, site layout and construction method. 	• ADB SPS (2009)	EPC Contractor Include in EPC contract cost Before design approval for further implementation during construction phase	NEA PMU / PISC
	TL, SS Review of documentation, update of the IEE	 Detailed designs will be reviewed by the contractor and NEA to confirm all measures required by the IEE/EMP have been adequately incorporated and that they reflect international engineering best practice/good EHS practice before they are approved. Prior to NEA approval of the designs and commencement of construction, ensure that NEA have updated the IEE as required to reflect the final design, seeking ADB clearance of any updated IEE before works start by contractor. 	• ADB SPS (2009)	EPC Contractor Include in EPC contract cost Before design approval for further implementation during construction phase	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards / Best Practice	Implementation Responsibility	Monitoring Responsibility
Management Planning	General, unanticipated impacts and corrective actions	 Comply with the definite version of the EMP which is the version disclosed on ADB's website. This includes any measures in an updated IEE following design or any updates in response to unanticipated impacts. Comply with all applicable national and state environment, health, and safety (EHS) regulatory requirements in addition to the mitigation measures set out in the EMP – if there is any conflict between national requirements and measures set out in the EMP the most stringent provisions will take precedence Comply with the EHS codes of practice (ECoP) and Labour Accommodation Requirements appended as Labor Camp Standards Comply with any corrective action plan required by NEA, contractor to cover the costs where corrective action is required due to non-compliance on behalf of the contractor, its subcontractors or third parties. Do not engage in any activities described on the ADB Prohibited Investment Activities List in Appendix 5 of ADB's SPS (2009) Ensure all subcontractors and third parties, irrespective of being formally or informally employed also comply with the EMP and any updates to it, as well as the CSEMP and that this responsibility is cascaded down any chain involved. Put in place appropriate incentives and/or penalties for (non-) compliance by workers related to use of PPE, and any violations of the Contractors Code of Conduct. 	ADB SPS (2009)	EPC Contractor Include in EPC contract cost Before the start of any related works including site establishment, preparation and clearance works then ongoing through project implementation	NEA PMU / PISC

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Торіс	Impact / Issue	Commitment	Applicable Project Standards / Best Practice	Implementation Responsibility	Monitoring Responsibility
	CSEMP	 Preparation for NEA approval and implementation of the CSEMP and its associated management sub-plans reflecting the EMP requirements and international engineering best practice/good EHS practices-CSEMP shall include subplans as indicated in the EMP main text, such as: Construction Method Statement Identifying all construction activities, schedule, access routes, anticipated traffic volumes, and construction methods to be used as well as temporary construction facilities needed and their location e.g., laydown areas, stores, worker rest areas, toilets/washrooms, worker overnight accommodation etc. Pollution Prevention Plan and Emergency Response Plan(s) Covering dust and emissions to air management, noise management, the protection of water resources and environmentally sound and safe storage, use, and disposal of all fuels, chemicals and oils used on site and an emergency preparedness and response plan in the event of any leaks or spills (e.g., of oil, etc.) or an incident such as flood. Particular attention to receptors in 500m and along access roads. Include clear schedule for damping of site and access roads, description of water resources requirement, and time and activity restraints. Include pollution monitoring procedures and pre-construction to deal with event of an accidental spill leak, including leakage of SF6 as a greenhouse gas. Occupational Health and Safety Plan including Risk Assessment and Emergency Response Plan(s) Outlining all the relevant measures in this EMP relating to community health and safety. Community Health and Safety Plan shall include flow chart and contact details to deal with situation should any community health and safety. Community Health and Safety Plan shall include flow chart and contact details to deal with situation should any community health and safety. Community Health and Safety Plan shall include flow chart and contact details to deal with s	 ADB SPS (2009) IFC EHS General Guideline T&D Guidelines ILO Safety and Health in Construction 	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works for NEA approval then implement throughout construction phase	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards / Best Practice	Implementation Responsibility	Monitoring Responsibility
		 Community Health and Safety Plan including Risk Assessment and Emergency Response Plan(s) Outlining all the relevant measures in this EMP relating to community health and safety. Community Health and Safety Plan shall include flow chart and contact details to deal with situation should any community member be impacted. Biodiversity Management: Invasive Species Control Procedures and Wildlife Encounter Protocol Including (i) prohibitions on hunting, poaching, collection of firewood, restricted areas etc. (ii) a wildlife incident reporting procedure and emergency fauna rescue and handling procedure including contractors of forest officials, nearest veterinary etc. (iii) measures to avoid the spread of invasive species, and (iv) a chance find procedure for routine findings of small animals encountered in work areas. For works in 500m of BZ, KBA, IBA and forest land additional ecological supervision will be put in situ. Solid and Hazardous Waste Management Plan Dealing 			
		with all solid and hazardous waste as well as wastewater generated in an environmentally sound and safe manner. Where possible it will ensure surplus materials will be reused or recycled, disposal will be the last resort. Plan shall also set out waste monitoring procedures.			
		7 Traffic Management Plan			
		areas, traffic controls e.g., speed limits, delivery timings, ensuring use of well-maintained vehicles, access road improvements, driver training and permits etc. Considering both the safety of pedestrians and vehicles and need to avoid traffic congestion; it is to be developed in consultation with relevant local authorities to ensure proper execution of traffic controls including where temporary blockage of a road or footpath is needed for installation. More Specific Action and Monitoring at sensitive sites such as Hospitals, Schools, Highway crossings etc.			
		Addressing employment of migrant workers, sanitation and welfare,			
		gender-based violence/sexual exploitation, abuse, and harassment prevention etc. Including details of construction camp site/overnight accommodation meeting the requirements of ILO for labor accommodation, see annex. Gender sensitization to be carried out prior to construction work begins.			



Торіс	Impact / Issue	Commitment	Applicable Project Standards / Best Practice	Implementation Responsibility	Monitoring Responsibility
Regulations, permits etc.	Permits and Licenses	 Code of Conduct Chance Find Procedure for physical cultural resources Measures for coming across unknown archaeology during works including stop works and reporting to the Department of Archaeology. Communication Plan Outlining stakeholder consultation for the construction period. Provides a schedule for regular meetings, includes different communication methods as identified in the IEE. Training and Induction Plan Describing the types of EHS training required during construction for staff, schedule of training to be included. CSEMP and its associated management sub-plans will be living documents, to be updated as required and reapproved by NEA as construction proceeds, if construction methods or site conditions change, in response to an incident, near miss etc. CSEMP will identify all temporary construction facilities needed e.g., laydown and storage areas, temporary workers facilities etc. Acquire all requisite environment, health, safety and labor permits and licenses for construction activities or construction plant as required by national laws and regulations, prior to the commencement of works and then maintain them. If the route or site has changed since the national IEE approval was granted then it must be confirmed in writing that no further update of the national IEE is required to assess the changes. Statutory H&S and labor requirements including permits, licenses, and insurances for all workers to be obtained and maintained. Medical insurance will be provided for all workers with sick leave allowance of at least 12 days to ensure symptomatic workers do not attend site due to no work-no pay policies. 	 ADB SPS (2009) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works then implement throughout construction phase	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards / Best Practice	Implementation Responsibility	Monitoring Responsibility
Temporary facility	Selection of temporary construction facilities	 Local communities within 500m to be consulted when selecting sites for temporary project facilities prior to finalization. Provide a central covered warehouse for storage of construction materials etc. Only volumes of material required for the day's work will be stored on-site No borrow pits or quarries will be established and only licensed off-site materials will be used. Due diligence will be undertaken before the contractor signs any contract with an existing borrow pit or quarry for fill material etc. This includes a review of the location, licensees etc. No concrete batching or hot mix will be established. All temporary facilities including material and waste storage areas and offices will be sited in agreement with NEA Contractor to seek to locate all temporary construction facilities required including laydown and storage areas within the boundaries of NEA land (substations) except for overnight accommodation that could be provided in existing properties offsite. If other public or private land is required for temporary construction facilities noisy and dusty facilities or those that may generate sediment laden runoff or wastewater (e.g., refueling areas, maintenance yards, storage areas, temporary worker camps) must be sited 500m from residential property and other sensitive receptors (houses, schools, clinics, temples, etc.) and 100m from surface water or groundwater resource. Laydown and storage areas that are not potential pollution sources may be located 50m distant but must not block accesses or road use. No temporary facilities will be established in forest or other natural habitat. No public or private land requiring clearance of vegetation or supporting forest habitat or having waterbodies is to be used. No cutting of trees or mature vegetation clearance will be allowed for temporary facilities. Temporary land use to be negotiated with private landowner and compensated by the Contractor in	 ADB SPS (2009) Project LARP GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works then implement throughout construction phase	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 matrix, submit land ownership papers and copy of agreement for temporary land use with a photographic record of preproject condition. A photographic record will be made of the preconstruction condition of land used for temporary facilities before construction to inform the reinstatement works. After completion of the construction work the temporary structures shall be completely removed and the land will be restored to its earlier condition. 			
Staffing	Inadequate staff to provide supervision and oversight	 NEA, PISC and contractor are to appoint a suitably qualified and experienced, dedicated environment, health and safety staff as per the EMP requirements Ensure each active construction site and subcontractor has adequate health and safety supervision to ensure the H&S of all workers and local communities Do not discriminate and proactively encourage the employment of (i) suitably skilled women, and (ii) local employment for unskilled roles whilst ensuring suitably qualified and experienced workers for skilled roles; noting that all workers must be appropriately skilled given the hazardous nature of works. No child will be employed, and no under 18 will be engaged on construction site (hazardous work). Provide medical/accident insurance for all workers (formal and informal) for the duration of their contracts as well as at least 12 days of sick leave for all construction workers. 	ADB SPS (2009)	EPC Contractor Include in EPC contract cost with BOQ line for staff Staff in place prior to the start of construction and ongoing through project Implementation	NEA PMU / PISC
	Induction and Orientation	 NEA to prepare a detailed training plan upon loan effectiveness detailed how training and awareness raising activities required by the EMP will be conducted. 	ADB SPS (2009)	EPC Contractor Include in EPC contract cost	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 NEA to conduct training with support of PISC. Ensure all members of contractor's safeguards team, design team, and construction management team attend NEA EMP trainings. Contractor to conduct their own trainings for their construction management and provide all workers and visitors on site, irrespective of them being formally or informally employed by the contractor, subcontractor or third party with an EHS induction before being allowed on site – induction to cover orientation on EHS requirements and roles and responsibilities in relation to EMP implementation, dos and don'ts in relation to the construction site, employer provided staff accommodation, code of conduct and interaction with local communities etc. Ensure topics covered by training and induction include, but are not limited to, good housekeeping at all times; environmentally safe and sound waste management practices; hygiene and communicable disease prevention including HIV/AIDS; gender-based violence and sexual exploitation, abuse and harassment prevention; code of conduct, interaction with local communities and culturally acceptable practices; prohibition on trapping, hunting, fishing, or poaching by workers; chance find procedures; H&S including use of PPE; etc. Contractors to carry out awareness raising for all construction workers about the GRM at the start of their employment on site including disseminating GRM contact details on noticeboards at construction site offices and at employer provided staff accommodation. Prepare with guidance of health experts HIV/AIDS and communicable disease information video/brochures/leaflets for distribution to all workers 		Before the start of any works including construction site establishment then on an ongoing basis	



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 during induction, covering factual health issues as well as behavior change issues around the transmission and infection of HIV/AIDS and other communicable diseases including improved sanitation. Prepare with guidance of labor experts a worker Code of Conduct and information video/brochure/leaflet for distribution to all workers during induction addressing culturally acceptable practices etc. Code must be informed by the CSEMP and address the following aspects: Zero tolerance in respect of health and safety Requirement on always wearing PPE on site o Zero tolerance of bribery or corruption o Respect for local community and customs, avoiding community conflict situations especially for vulnerable groups Zero tolerance of illegal and unacceptable activities/behavior, including but not limited to engagement in: prostitution; gender based violence/sexual exploitation, abuse, and harassment; illegal sale or purchase of alcohol; sale, purchase, or consumption of drugs; gambling; fighting Alcohol and drugs policy and testing regime o Role of workers in good housekeeping o Role of workers in maintaining good hygiene o Respect of wildlife and the environment o Description of disciplinary measures for infringement of the code of conduct and other employer rules (e.g., immediate removal from site, fine etc.) 			
Communications	Advance Notice and Consultation on Works Schedule	 No works will start until NEA has locally disclosed the IEE and any update to it with executive summary translated into Nepali and any other relevant local languages via the NEA website, NEA offices, existing substations, and construction site offices. Brochures and posters on the main findings of the IEE and where the full version can be accessed, as well as a translation of the executive summary of the IEE, will be printed in local language and made available/displayed for public scrutiny at places easily accessible to affected persons. 	ADB SPS (2009)	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works then implement throughout construction phase	NEA PMU / PISC

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Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 Directly liaise one-on-one with receptors immediately adjacent to site boundary and access roads to specifically notify them about the commencement of work etc. 			
		• Undertake face-to-face consultations with all communities, residents, schools, clinics, temples in 500m of the site and along access roads to notify them one month prior to the commencement of works of the intended start date and schedule			
		• Prior to the commencement of works all activities will be announced in local papers and on site and local community notice boards at least once month prior to works			
		• Provide information to the general public about the scope and schedule of construction activities and expected disruptions and access restrictions at least 72 hours before they occur.			
		 Local communities as well as individual property owners within 500m are to be consulted when selecting sites for temporary construction facilities outside of substations prior to finalization of their location. 			
		• Road authorities will be notified when oversize heavy loads need to be transported and they will be escorted by the police			
		In relation to cumulative impact contractors to liaise with other utilities regarding the timing and extent of other construction works in the project area of influence and ensure plans for construction works are coordinated so emissions/disruption/ disturbance are minimized.			



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	GRM	 NEA with support of contractor to inform all potentially affected persons and local communities within 500m of TL, substations and directly affected with other components as well as the GRM process and means of submitting project grievance to Inform all residents and businesses of the GRM in advance of works (at least one month). Community awareness raising of the GRM will be undertaken verbally, through community meetings, one-on-one consultations with landowners; through the distribution of notices/pamphlets/posters; and through other media outlets. Provide notice boards at all substations, construction site offices and active work sites including details of the GRM including the name, designation, contact numbers including phone/SMS/What's App, address of both the NEA and contractor's GRM focal persons plus the timeline and process of redressal together with a suggestion box that will be regularly checked for any grievances received. 	ADB SPS (2009) Project GRM	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works then implement throughout construction phase	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
Hydrology	<u>TL, SS</u> Water Use	 Any piling, drilling or excavation works within 50m of boreholes and wells used as a drinking water source by local communities will require pre-construction and post construction water quality monitoring against GoN drinking water standards to ensure there is no contamination of the supply. Construction water to ideally be sourced from an existing licensed commercial supplier (preferred option especially for potable water supplies) where available or rainwater harvesting. If using an existing surface water or an existing borewell for construction water, permissions to be obtained from authorities together with the agreement of local communities. Prior agreement is required from local community users to use any existing surface water/borewell or local piped water either temporarily during construction or permanently for substations; in cases where use of local water source is not agreed contractor to import tanked water to the project area. No groundwater will be used in districts groundwater will not be used only after it has been confirmed through assessment there will be no additional stress on groundwater resources as a result. 	 ADB SPS (2009) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works then implement throughout construction phase	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	<u>TL, SS</u> Water Pollution	 If any surface waterbodies or groundwater sources are within 500m, undertake a baseline water quality sampling as per the EMoP to confirm their current water quality status at least one week prior to the commencement of any activity onsite. Plan for designated impermeable fuel/oil/chemical hazardous materials/waste storage areas bunded to 110% capacity and located at least 50m from surface water and groundwater sources. Storage areas should be capable of storing all the hazardous materials used and waste materials generated. Storage areas shall be well ventilated. Fuel and diesel storage tanks will be sited in suitably sized and constructed bunded areas that are designed to be impervious to water and fuel. The bund volume will be designed to no less than 110% of the tank volume. Loading and off-loading connections will be located over secondary containment. All health and safety provisions will be made for fire hazard etc. Refuelling procedure will be developed, which will include a reas with impermeable surface will be assigned for refuelling to minimize spillage to soil. 	 ADB SPS (2009) IFC EHS Guidelines: wastewater and ambient water quality GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, Preparation and clearance works then implement throughout construction phase	NEA PMU / PISC
Utilities & Infrastructure	<u>TL.SS</u> Disruption to supply	 Check with relevant local authorities (electric, water, telecoms) whether there are known pipes, cables, or other utility lines and carry out a scan using cable avoidance tool to identify any unknown underground utilities prior to excavation. Contractors to identify in consultation with service providers appropriate measures to minimize period of disruption to utilities and reduce health and safety risks during installation. If services must be disrupted contractors (via service providers if appropriate) to notify affected communities well in advance of any power outage etc. Should utilities need relocating or required to be removed consult with the relevant utilities and local community to ensure that there is no change in supply because of these changes. 	 ADB SPS (2009) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, Preparation and clearance works then implement throughout construction phase	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		Obtain necessary clearances consistent with the regulatory requirements from other utilities that could be affected by the Project (municipality for street furniture, electric, water, sewerage, telecommunications, road etc.)			
		• All electricity and gas supply networks in the Project area will be kept operational, particularly during the winter months. Liaise with the relevant utilities operators to ensure they remain operational.			
		• In relation to cumulative impact liaise with other utilities regarding the timing and extent of other construction works in the same location and ensure plans for construction works are coordinated so emissions/disruption/ disturbance are minimized.			
		For private property or public utilities/street furniture that may be damaged during construction, including from potential breaking/drilling vibration damage (buildings, roads, drains etc.) photographic and/or structural pre-condition surveys are to be completed and agreed with NEA prior to any works, including site establishment. To be documented in a pre-project condition report, which will serve as baseline in case any inadvertent damage or vibration impact to property occurs. If risk of structural damage to adjacent properties from vibration identified due to current condition, consider alternative construction methods or temporary relocation of occupants during works if at risk.			



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
Occupational Health and Safety	General	 Strictly implement all the OHS measures outlined in the annex and all the measures outlined below. Informed by risk assessment prepare H&S plan for approval by NEA in accordance with the IFC EHS General Guidelines on OHS, considering occupational and community H&S and including adherence to electrical safety standards and emergency preparedness and response plan with communication systems and protocols to report an emergency. For all pre-construction and construction works comply with GoN rules and regulations for the protection of workers. During construction works, ensure qualified first aider and trained fire marshal is always available on-site with an appropriately equipped first aid kit and appropriate fire extinguisher and other firefighting equipment immediately available for use. Contractors will set up an accident reporting system for any health and safety incidents (near miss, minor, lost time, fatal) involving workers or community to be reported to NEA within 24 hours of occurrence will be avoided within 48 hours. Record of all incidents and response plan detailing the incident and how its reoccurrence will be avoided within 48 hours. Record of all incidents and response taken should include date, time, details of incident, treatment given and outcome, and lessons learnt for the future. Contractors will ensure all workers are covered by insurance to pay out in the event of a disability or fatality. Emergency contact number and details for medical, fire, etc. are to be displayed in all construction sites. Plan to include emergency drills to be held to ensure prompt response to medical incident or natural hazard that did occur. If working under live lines then a safety scaffold will be installed so that the workers cannot come in contact with the OHL, with warning signs provided – all works under lines must have an activity specific risk assessment and management plan given the high risk	 ADB SPS (2009) Project GRM IFC EHS Guidelines: Electrical Power and Distribution (2007) • IFC General EHS Guidelines: Occupational Health and Safety IFC General EHS Guidelines: Community Health and Safety ILO safety and health in construction GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works then implement throughout construction phase	



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	Labour and accommodation	 Design of temporary worker camps/overnight accommodation to conform to national requirements and international good practice. Contractors to provide all basic requirements (beds and beddings, mosquito nets, artificial lights, natural light, windows and ventilation, fans, emergency exits, firefighting equipment, kitchen and dining halls, mobile charging points, toilets and washing facilities, potable drinking water, recreational space etc. The contractor shall ensure the camps established for providing accommodation to laborers engaged in construction activities meet the requirements. CSEMP to include camp management plan. No temporary worker camps/overnight accommodation will be established in forest or other natural habitat. Shaded rest area that is accessible and can accommodate the number of workers at the active works site Tents may be used for day rest areas but all overnight accommodation for workers must be provided in a structurally sound built structure providing adequate shelter from rain, wind etc. 		EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works then implement throughout construction phase	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	Sub-contractors	 All subcontractors and third parties irrespective of being formally or informally employed will comply with the EMP and updates to it, as well as this CSEMP, and this responsibility must be cascaded down any chain involved through their subcontract All sub-contractors will be supplied with copies of the EMP and CSEMP. Provisions will be incorporated into all works subcontracts to ensure compliance with the CSEMP at all tiers of the subcontracting. All works subcontractors in the chain will be required to appoint an EHS representative who will be available on each work site at all times when their workers or their subcontractor in providing oversight of the subcontracted activities. Use of work gangs and daily labor is highly discouraged due to less control over health and safety if used by any subcontractor in the chain the contractor will be required to provide additional environment, health and safety supervision. 		EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works then implement throughout construction phase	NEA PMU / PISC
	Grievance	Establish a formal Grievance Mechanism for workers. Carry out awareness raising amongst formally and informally employed workers including those of subcontractors about the GRM at the start of their employment, including details of how to submit a grievance to the PMU/PISC and/or to the Contractor.		EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works for NEA approval then implement throughout construction phase	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
Community Health and Safety	TL, SS Dust, noise and vibration	 Contractor to undertake baseline noise and air quality monitoring per the EMoP to confirm current background levels in the project area at least one week prior to the commencement of any actively on-site. Contractor will be required to measure and confirm the distance from their construction works to sensitive receptors to confirm if the noise standards can be met based on their construction methods or if temporary acoustic barriers are required. Contractor to avoid soil compaction, piling, blasting and other vibration inducing activities as much as possible If piling, blasting or other vibration inducing activities are to be undertaken for construction a detailed construction noise/vibration assessment is to be undertaken by the contractor to demonstrate how construction noise and vibration levels/guidelines can be achieved at the site boundary and nearest receptors and a piling/blasting management plan is to be prepared for approval. In locations where this is unavoidable Contractor to identify properties within the zone of influence and undertake preconstruction structural surveys to identify level of risk. If risk of structural damage to properties identified due to current condition, consider alternative construction method or temporary relocation of occupants during works if at risk. Consider need to install monitors during construction to monitor structural movement. Structural or cosmetic damage to be repaired by Contractor to at least pre-project condition at their own cost. 	 ADB SPS (2009) IFC EHS General Guidelines/Electric Power T&D Guidelines GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works for NEA approval then implement throughout construction phase	NEA PMU / PISC

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Торіс	Impact / Issue	Commitment	Applicable Project	Implementation	Monitoring
			Standards /Best Practice	Responsibility	Responsibility
	22 17	 In conjunction with the local municipality or village head 	• ADB SPS (2009)	EPC Contractor	Include in EPC
	<u>11,00</u>	in rural areas plus the media organize health and safety			contract cost
	Community Safety	campaigns including the distribution of posters. leaflets.	General		00111201 0031
	Awareness	and safety booklets to all households in Nepali or local	Guidelines/Electric		Before the start
		language with strong use of graphics for construction and	Power T&D Guidelines		of any works
		electrical safety community awareness raising activities	GoN laws and		including site
		in local communities and schools within 500 m of the TL	regulations		establishment,
		and substations prior to construction and then again prior			preparation and
		electrical incidents having greater emphasis on			clearance works
		operational hazard and risks, etc. Materials will be written			for NEA
		in non-technical language and will provide illustrations			approval then
		where practical.			implement
		Deliver face-to-face electrical safety awareness training			throughout
		to local children including their parents and/or their			construction
		teachers at all educational facilities within at least 500m.			pnase
		Provide construction work site safety awareness sessions at all educational facilities within 500m of any			
		work zone and along access roads used by construction			
		traffic.			
		Provide EMF awareness sessions at villages within 500m			
		of TL and substations. The awareness sessions should			
		provide information regarding the findings of the IEE on			
		EMF and specifically discuss best practice reference			
		Imits for EMF and how they have been applied to the			
		Project.			
		• Develop and distribute leatlets/pamphiets/posters to the			
		construction camps covering (i) health awareness			
		including HIV/AIDS/STDs and other communicable			
		diseases, and (ii) the conduct of construction workers that			
		can be expected. Materials will be written in nontechnical			
		language and will provide illustrations where practical.			
		Keep a record of the number of leaflets distributed and their			
		locations.			



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
Physical, Cultural Resources	<u>TL, SS</u> Chance Finds	 In consultation with the local community contractor will maintain an inventory of above ground physical cultural resources adjacent to the site and along the access roads checking against the findings of the IEE, including any trees where prayers/rituals are performed, and take measures to protect them during construction. For physical cultural resources that shall be impacted receptor-specific management plan will be developed in consultation with the local community to ensure significant adverse impacts can be avoided. Demarcation of the working area by the contractor and avoidance of encroachment outside the agreed corridor of impact. Also, demarcation of physical cultural resources (such as shrines, trees) to be avoided and retained. Ensure workers do not loiter outside of temples etc. A chance find procedure will be developed for implementation in the event physical cultural resources are found, to include the following procedures: If suspected physical cultural resources are encountered, all works at the find site should be immediately halted; The find should be assessed by a competent local official managing cultural issues, and procedures to avoid, minimize or mitigate impacts to such physical cultural resources have been agreed and implemented in full. 	 ADB SPS (2009) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works for NEA approval then implement throughout construction phase	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		If avoidance is not feasible, and no alternatives to removal exist, and the project benefits outweigh the anticipated cultural heritage loss from removal which is unlikely unless in case of resource of local value, following clearance of Department of Archaeology and ADB the physical cultural resources should be removed and preserved using the best available technique in accordance with relevant provisions of national heritage protection laws and decrees. o Records should be maintained of all finds, including chain of custody instructions for movable finds. • All construction workers to be made aware of the chance-find procedure and types of finds to be reported.			
Procurement	Material Sourcing	 Considering relevant technical and commercial considerations, the Project will seek to purchase goods and services from within Nepal. Environmental considerations will be included in the procurement process. Contractors will use locally sourced materials as far as practical to reduce transportation, but all raw materials will be sourced only from existing licensed sources. Only already existing state licensed borrow pits for land raising will be allowed for use. Provide copies of the borrow pit operator's license and permit before any materials from the borrow pit are delivered to site. Materials will not be sourced from quarries in the beds or rivers or other permanent watercourses even if they are licensed. 	 ADB SPS (2009) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works then implement throughout construction phase	NEA PMU / PISC



 Construction water to be sourced from an existing licensed commercial supplier (preferred option especially for potable water supplies), where available, or rainwater harvesting. If using an existing surface water or an existing borewell for construction water, permissions to be obtained from the relevant authorities together with the agreement of local communities. Prior agreement is required from local community users to use any existing surface water/borewell or local piped water temporarily during construction; in cases where use of local water source is not agreed, contractor to import tanked water to the project area. 	Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
 No groundwater will be used in locations without additional groundwater capacity – in other locations groundwater will only be used after it has been confirmed through assessment that there will be no additional stress on groundwater resources as a result. Construction water to be sourced from an existing licensed commercial supplier (preferred option especially for potable water supplies), where available, or rainwater harvesting. If using an existing surface water or an existing borewell for construction water, permissions to be obtained from the relevant authorities together with the agreement of local communities. Prior agreement is required from local community users to use any existing surface water/lorewell or local piped water temporarily during construction; in cases where use of local water source is not agreed, contractor to import tanked water to the project area. Records to be kept of all the materials used and source with copies of licenses etc. Procedures will be established to determine the acceptability of material storage conditions and to promote the minimization of storage volumes on-site. 			 Construction water to be sourced from an existing licensed commercial supplier (preferred option especially for potable water supplies), where available, or rainwater harvesting. If using an existing surface water or an existing borewell for construction water, permissions to be obtained from the relevant authorities together with the agreement of local communities. Prior agreement is required from local community users to use any existing surface water/borewell or local piped water temporarily during construction; in cases where use of local water source is not agreed, contractor to import tanked water to the project area. No groundwater will be used in locations without additional groundwater capacity – in other locations groundwater will only be used after it has been confirmed through assessment that there will be no additional stress on groundwater resources as a result. Construction water to be sourced from an existing licensed commercial supplies), where available, or rainwater harvesting. If using an existing surface water or an existing borewell for construction water, permissions to be obtained from the relevant authorities together with the agreement of local communities. Prior agreement is required from local community users to use any existing surface water/borewell or local piped water temporarily during construction; in cases where use of local communities. Prior agreement is required from local community users to use any existing surface water/borewell or local piped water temporarily during construction; in cases where use of local communities. Prior agreement is required from local community users to use any existing surface water/borewell or local piped water temporarily during construction; in cases where use of local communities. Prior agreement is required from local community users to use any existing surface water/borewell or local piped water temporarily during construction; in cases			



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
Economy and Employment Livelihoods	Employment	 Targets for local recruitment from the local communities will be agreed with NEA based on initial assessment of the labor market for unskilled and semiskilled work force. Seek to manage employment expectations by explaining the number and type of opportunities in advance to local communities. Applications for employment will only be considered if submitted via the official application procedure. Recruitment procedures will be transparent, public, and non- discriminatory and open with respect to ethnicity, religion, sexuality, disability or gender. Clear job descriptions will be provided in advance of recruitment and will explain the skills required for each post. Job vacancies will be advertised in the local communities through appropriate and accessible media. For unskilled use a 'ballot' system to ensure that employment is fair and not weighted to connected people for unskilled roles. 	 ADB SPS (2009) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works then implement throughout construction phase	NEA PMU / PISC



Table 2: Pre-construction Phase EMP

Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	Workers' Rights	 Contractor to allow collective bargaining and ensure that ILO core labor standards to which Nepal is a signatory are upheld. All employees will receive at least the minimum wage as defined by national legislation. All workers will have contracts describing their job description and conditions of work and will have the contents explained to them. Employee Code of Conduct will prohibit the workforce from participating in illegal activities, including use of illegal drugs, bribery and corruption or requesting or receiving gifts from communities. Policy limiting alcohol consumption in construction camps will be applied Workforce training will include a briefing on camp rules and awareness of local social issues and sensitivities. No unauthorized access to, or use of, any camp facilities will be allowed. Review measures to mitigate community health and safety impacts regularly, and consult community leaders every six months, informing them on the status of implementation and results, and discussing any changes needed to the Pollution Prevention Plan or the Community Health and Safety Plan in advance of proposed changes. 	 ADB SPS (2009) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Before the start of any works including site establishment, preparation and clearance works then implement throughout construction phase	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
Training	<u>TL, SS</u> Pollution Prevention	 Conduct bi-monthly training of workers on pollution prevention control including good housekeeping and how to clean up oil/fuel spills and dispose of contaminated sorbent material which would be treated as a hazardous waste. Include emergency preparedness and response procedures (drills) in case of spill. To include training for subcontractors before commencement of works. Information will also be incorporated into the site induction process and will outline the role of personnel in the management of waste and emissions from site and spill response procedures. Site induction training will be supplemented by regular toolbox talks with relevant personnel if inspections or audits highlight failings in waste management. 	 ADB SPS (2009) IFC EHS General Guidelines/Electric Power T&D Guidelines GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
	OHS	 Conduct daily toolbox talks on pertinent topics related to the day's work and weekly training on occupational health and safety for all construction workers including refreshers. To include training for subcontractors before commencement of works. Ensure workers with a specific role have attended specialized health and safety trainings related that role e.g., health and safety stewards, first aiders, fire safety officers, as well as ensuring workers have received task-specific trainings for working at height, demolition, working with electricity, etc. Only allow suitably trained and qualified workers to work on electrical equipment and at height, these workers must have training record of attending suitable training course on electrical safety and working at height and be provided with and wear the appropriate PPE for their role. No workers shall be allowed to work at height unless they have passed a vertigo test Untrained workers must not be permitted to work with live electricity or to work at height. 	 ADB SPS (2009) IFC EHS General Guidelines/Electric Power T&D Guidelines ILO safety and health in construction GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	Emergency Response	 Conduct monthly training involving all workers on emergency preparedness and response procedures (drills) in case of an occupational or community health and safety incident during construction works including fire, natural disaster, disease outbreak etc. To include training for subcontractors before commencement of works. Emergency preparedness and response training for construction management will include modules on first aid and fire safety including include training on how to use first aid and firefighting equipment provided on-site, and scenario of potential or confirmed infection. 	 ADB SPS (2009) IFC EHS General Guidelines/Electric Power T&D Guidelines ILO safety and health in construction GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
	<u>TL, SS</u> Driver Training	 Driver training, monthly, to include advice on behaviours to reduce the potential for disturbance, including use of horn, loud radios with windows open, switching engines off when not in use, strictly observing speed limits and not accelerating or braking aggressively. 	 ADB SPS (2009) IFC EHS General Guidelines/Electric Power T&D Guidelines ILO safety and health in construction GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
	GRM	 Contractor's safeguards team will act as site GRM Focal and keep affected persons and local communities informed of the status of work and be readily available onsite to receive, document and deal with grievances at site level. Encourage use of the GRM and clarify that this does not prevent affected persons from pursuing any legal action, if they feel it is needed, and inform communities about the ADB Accountability Mechanism and their possibility to resort to it if any grievance is not resolved by the project level GRM. 	 ADB SPS (2009) Project GRM GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	Emergency Response	 Conduct monthly training involving all workers on emergency preparedness and response procedures (drills) in case of an occupational or community health and safety incident during construction works including fire, natural disaster, disease outbreak etc. To include training for subcontractors before commencement of works. Emergency preparedness and response training for construction management will include modules on first aid and fire safety including include training on how to use first aid and firefighting equipment provided on-site, and scenario of potential or confirmed infection. 	 ADB SPS (2009) IFC EHS General Guidelines/Electric Power T&D Guidelines ILO safety and health in construction GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
	<u>TL, SS</u> Driver Training	 Driver training, monthly, to include advice on behaviours to reduce the potential for disturbance, including use of horn, loud radios with windows open, switching engines off when not in use, strictly observing speed limits and not accelerating or braking aggressively. 	 ADB SPS (2009) IFC EHS General Guidelines/Electric Power T&D Guidelines ILO safety and health in construction GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
Communications	GRM	 Contractor's safeguards team will act as site GRM Focal and keep affected persons and local communities informed of the status of work and be readily available onsite to receive, document and deal with grievances at site level. Encourage use of the GRM and clarify that this does not prevent affected persons from pursuing any legal action, if they feel it is needed, and inform communities about the ADB Accountability Mechanism and their possibility to resort to it if any grievance is not resolved by the project level GRM. 	 ADB SPS (2009) Project GRM GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC

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Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	Worker GRM	 GRM will be available to all workers for receiving and handling complaints about unfair treatment or unsafe living or working conditions, ensuring no coercion nor reprisal. Construction workers will be given access to register any grievances with the contractors or direct access to the NEA GRM Focal 	 ADB SPS (2009) Project GRM GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
Air Quality	<u>TL, SS</u> Release of Exhaust Gases and Fugitive Emissions	 Emission sources (vehicles such as excavators) shall be positioned as far as is practical from sensitive receptors. Equipment and vehicles will be regularly maintained in accordance with the manufacturer's recommendations to maximize fuel efficiency and help minimize emissions; keep log of maintenance records. Use diesel fuel that has a low sulfur content, less than 0.1% Construction equipment and vehicles will meet national emissions standards. Hold valid emission certificates of all construction vehicles Belching of black smoke is prohibited. Limit engine idling to maximum 5 minutes. The open burning of wastes generated by project-related activities is strictly prohibited. Avoid the use of diesel- or petrol-powered generators and use mains electricity or battery-powered equipment where practicable. Stack emissions of temporary diesel generator set or hot mix to comply with national emission standards with the stack height designed according to both national requirements and IFC EHS General Guidelines. 	 ADB SPS (2009) IFC EHS Guidelines: Air Emissions and Ambient Air Quality (2007) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
	<u>TL, SS</u> Siting of Equipment	Stationary emission sources (e.g., portable diesel generators, compressors, etc.) shall be positioned as far as is practical from sensitive receptors.			



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	<u>TL, SS</u> Dust	 Construction entrance/exit wash bays shall be provided to control sediment, dust, invasive species spread and avoid scattering of mud on the access roads Ensure an adequate supply of bowsers and carry out watering for dust control at least twice a day on the work site, more if needed, and within 500m of work sites in dry weather with temperatures of over 25C, or in windy weather. Dust control measures will also be implemented on all access roads within 50m of receptors. Avoid overwatering as this may make the surrounding area muddy. Vehicle movements will be restricted to defined access routes and demarcated working areas (unless in the event of an emergency). All internal roads and access roads to substations off the highway will be asphalt or concrete surfaced. A strict speed limit of at most 20 km/hr will be enforced for construction vehicles. A solid temporary fencing shall be installed around the boundary/works area to minimize the dispersion of dust, it will also function as a temporary acoustic noise fence to minimize the noise and visual impact. Keep stockpiles of soil, aggregate and waste materials covered with canvas or tarpaulin when spoil heaps are not active to avoid suspension or dispersal of fine soil particles during windy days and to prevent disturbance by stray animals. Earthwork operation will be suspended when the wind speed exceeds 20 km/h in areas within 500 m of any community. Only use cutting, grinding, or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g., suitable local exhaust ventilation systems. 	 ADB SPS (2009) IFC EHS Guidelines: Air Emissions and Ambient Air Quality (2007) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 Undertake sequenced construction method and revegetate areas immediately construction activities are completed in one area rather than undertaking earthworks on all parts of the site to minimize the area of bare ground exposed at any one time. Undertake weekly dust soiling checks of surfaces of adjacent properties during earthworks and help with cleaning of external surfaces of property if dust is evident. If there is an increase in existing background air pollution or complaints are received contractor will be required to implement additional dust or noise mitigation e.g., barricading/isolating sources of dust, use of wheel wash etc. Provide workers with N95 dust masks to be worn when ambient conditions are dusty or when dust generating activities take place. 	 ADB SPS (2009) IFC EHS Guidelines: Air Emissions and Ambient Air Quality (2007) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
Hydrology	<u>TL</u> Water resources	 Construction activities must not limit the availability of or restrict access to water sources (e.g., wells) used by local communities. Natural flow of waterbodies must not be obstructed or diverted to another direction. No works to be undertaken within 20m of the banks of waterbodies to avoid bank slippage and loss of soil that would increase the turbidity of water. Ensure that no construction materials or construction waste block existing drainage channels. Channels shall be kept open at all times to avoid disruption. 	 ADB SPS (2009) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	

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Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 Undertake sequenced construction method and revegetate areas immediately construction activities are completed in one area rather than undertaking earthworks on all parts of the site to minimize the area of bare ground exposed at any one time. Undertake weekly dust soiling checks of surfaces of adjacent properties during earthworks and help with cleaning of external surfaces of property if dust is evident. If there is an increase in existing background air pollution or complaints are received contractor will be required to implement additional dust or noise mitigation e.g., barricading/isolating sources of dust, use of wheel wash etc. Provide workers with N95 dust masks to be worn when ambient conditions are dusty or when dust generating activities take place. 			
	<u>TL</u> Water pollution	 Follow liquid management and storage requirements listed below under 'soils' No untreated wastewater will be discharged direct to surface waterbodies or groundwater. All wastewater to be connected to existing sewerage system or septic tank with soak away, septic tank/soakaway effluent to meet national general wastewater standards or IFC wastewater discharge limits, whatever is the most stringent given the receiving source. Self-enclosed portable toilets may be used where the wastewater generated is enclosed in a container and will later be taken offsite to a municipal sewage treatment plant for wastewater treatment and disposal. Use of pit latrines is prohibited as is open defecation and urination and uncivil use of roads or private premises by construction workers. Treated wastewater will be used for damping down earthworks and road surfaces to mitigate dust generation. Construction site camps will be located at least 50m from water courses. 	 ADB SPS (2009) IFC EHS Guidelines: Hazardous Materials Management (2007) IFC EHS Guidelines: Wastewater and ambient water quality GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 Ensure no hazardous materials are placed where there could be spill or leak into surface water. Locate mobile generators and site construction equipment at least 50m from groundwater resources and surface waters. Discharge of sediment laden surface water runoff directly into surface water forbidden. Construction of sedimentation ponds is required to allow sediment to settle out of surface water runoff before release of water into the downstream environment. Sedimentation ponds for treating surface water runoff to be adequately sized for the volume of runoff, contractor to provide design calculations for approval. Dumping of construction waste including excess spoil and concrete sludge into streams and drains will be prohibited to minimize siltation. Provide spill prevent kits (sorbent pads, loose sorbent material etc.) at storage areas and other at-risk locations within clearly labelled containers. 	 ADB SPS (2009) IFC EHS Guidelines: Hazardous Materials Management (2007) IFC EHS Guidelines: Wastewater and ambient water quality GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 water courses. Ensure no hazardous materials are placed where there could be spill or leak into surface water. Locate mobile generators and site construction equipment at least 50m from groundwater resources and surface waters. Discharge of sediment laden surface water runoff directly into surface water forbidden. Construction of sedimentation ponds is required to allow sediment to settle out of surface water runoff before release of water into the downstream environment. Sedimentation ponds for treating surface water runoff to be adequately sized for the volume of runoff, contractor to provide design calculations for approval. Dumping of construction waste including excess spoil and concrete sludge into streams and drains will be prohibited to minimize siltation. Provide spill prevent kits (sorbent pads, loose sorbent material etc.) at storage areas and other at-risk locations within clearly labelled containers. 	 ADB SPS (2009) IFC EHS Guidelines: Hazardous Materials Management (2007) IFC EHS Guidelines: Wastewater and ambient water quality GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
Soils	<u>TL</u> Soil compaction, topsoil and excavated materials	 Avoid compaction impacts outside the cleared areas i.e., vehicle movements will be restricted to working areas. In wet conditions minimize use of heavy machinery and consider temporary installation of removable steel plates to protect soil and vegetation. Minimize removal of topsoil. Topsoil disturbed will be separately stored and used to restore the surface of the excavated area. On completion of works, stockpiled topsoil will be spread over the surface of disturbed areas (if not under hard surfaces) and used in the restoration of temporary construction facilities. Once the topsoil has been replaced it will be store picked to remove any large stones which are not in keeping with the surrounding soil texture. 	 ADB SPS (2009) IFC EHS General Guidelines GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC



Standards /Best Responsibility Responsibility	itoring ponsibility
 Revegetation of the solis will follow using native seed mixes to Nepal and the project area. Records of excavated soil, generated waste, and transfer records will be kept. If topsoil is stored for more than six months, the stacks will be monitored for anaerobic conditions and manual aeration will be undertaken if they develop. Stored subsoil and topsoil will be segregated in a manner that avoids mixing. Topsoil stacks will be free draining. Topsoil will be stored outside the running track used by construction plant, equipment and vehicles. Soil storage areas will be protected from vehicle movements to avoid soil compaction. Excavation will be limited to within the agreed corridor of impact. Infertile and rocky material will where possible be reused as fill material around foundations. If it needs to be taken off site, it will be disposed of by licensed waste management operator at designated disposal area suitable for accepting inert wastes. No spoil shall be removed from site until the disposal locations have been approved by NEA. Under no circumstances will excess materials be dumped on private lands, dumped or pushed into any river, irrigation canal, stream or drain at any location. Upon completion of subsoil and topsoil reinstatement, disturbed areas will be inspected jointly for signs of topographic diversity, surface water drainage capacity and function, and compaction with the contractor implementing remedial measures where required. 	(PMU / C



Торіс	Impact / Issue	Commitment	Applicable Project	Implementation	Monitoring
			Standards /Best	Responsibility	Responsibility
			Practice		
	TL, Soil Pollution	• Fuel, oil, and chemicals used to be kept under lock and key and		EPC Contractor	NEA PMU / PISC
		stored in labelled, sealed containers on drip trays to provide			
		secondary containment. They will be located on an impermeable		Include in EPC	
		any surface water course or seasonal water channel.		contract cost	
		• Mount plant containing oil and diesel on drip trays to catch leaks.		Throughout	
		• Refueling operations, equipment servicing and washdown to take		construction	
		place on an impermeable surface at least 50m from watercourses,			
		interceptors before being discharged into a settling pond prior to			
		discharge offsite.			
		• Regular inspections and maintenance will be carried out of			
		secondary containment areas to confirm that they are functioning effectively.			
		• Provide sufficient absorbent materials (e.g., sorbents, dry sand,			
		sandbags) on-site for soaking up fuel, oil or chemical leaks/spills.			
		Spill response equipment (absorbents etc.) will be available in hazardous materials storage areas.			
		• All material safety data sheets (MSDS) are kept on site with the relevant materials.			
		• Materials that can potentially react with each other will be segregated during storage.			
		Hazardous chemicals will be securely stored on site in a designated storage area.			
		• Relevant personnel will be trained in safe use and handling of			
		hazardous materials.			
		Relevant construction personnel will be trained in use of spill kits and disposal practices.			
		• Vehicles delivering fuel or hazardous liquids will carry appropriate spill kits to allow an initial response to any spill to be deployed.			
		All mobile plant (excluding vehicles) will be integrally bunded or will			
		be equipped with a bund or drip tray which will be regularly inspected			
		and emptied to prevent rainwater accumulating.			
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Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	Existing SS Contaminated Land and asbestos	 Soil exposed to oil leakage from transformer equipment is to be removed from site for disposal as a hazardous waste. Any soils within work sites that appear to be contaminated by leaked oil or fuel shall be removed and disposed of as hazardous waste, similarly asbestos will be managed per the Asbestos Management Plan. 		EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
Biodiversity	<u>TL, SS</u> Project footprint	 Demarcation of the working areas and avoid encroachment outside these areas. All unanticipated damage to vegetation will be restored to preproject condition and/or compensated at the cost of the contractor in line with the entitlement matrix. 	 ADB SPS (2009) IFC EHS General Guidelines GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
	<u>TL, SS</u> Fauna	 Trees and vegetation to be cleared outside the breeding bird season, unless access to the substation site is limited due to seasonal weather conditions Before cutting or trimming trees ecologist to check for presence of nesting birds or roosting bats. On-site check for ground nesting birds by experienced ecologist prior to vegetation clearance if conducted during the bird breeding season. If nesting birds are found present, work will not take place until the adult birds and young have left the nest. Meanwhile a suitably sized protection zone will be clearly marked around the nest site by the ecologist to prevent any accidental disturbance or damage. Prior to earthworks, area will be checked by an ecologist for any signs of burrows etc. If occupied work will not take place in that area during the breeding season. Meanwhile a suitably sized protection zone will be clearly marked around the nest site by the ecologist to prevent any accidental disturbance or damage. Outside the breeding season only manual digging under close supervision of the ecologist permitted. 	 ADB SPS (2009) IFC EHS General Guidelines GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 No works from 1 hour before sunset to 1 hour after sunrise to avoid disturbance to fauna. No fauna to be injured by work, conduct walkover at start of each day to give fauna the chance to move on. Direct intervention by ecologist if need to relocate fauna outside the works area before start of work. Excavated pits will be robustly fenced or covered to prevent fauna accidentally falling in, further an escape ramp will be provided to allow their escape. Keep written record, supported by photographs of any animal relocations or casualties, including a cause of death if known. 	 ADB SPS (2009) IFC EHS General Guidelines GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
	<u>TL, SS</u> Disturbance	 Works at all sites within 500m of areas of high biodiversity value (BZ/KBA/IBA) and in or within 500m of areas supporting community forest or natural habitat will only be carried out under ecological supervision to minimize disturbance. Use existing access roads to access work sites, in areas where access is restricted use manual labor to transport, install and string the TL to minimize the need to construct new access tracks Demarcate the working area and avoid encroachment outside the working area. Provide a good standard of worker accommodation with heating and meals to help discourage breaches of prohibition by workers. Contractor to provide alternative fuel source (LPG) which will be stored in safe conditions in communal kitchen and for heating of accommodation. 	 ADB SPS (2009) IFC EHS General Guidelines GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC

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Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	<u>TL, SS</u> Invasive species	 Removal and disposal of identified plant species in an ecologically sound manner. Use wash stations at site entrance to pressure wash vehicles, plant and equipment before import to site and as needed on leaving site to minimize accidental spread. Imported materials must be free of invasive plant species. 	 ADB SPS (2009) IFC EHS General Guidelines GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
	TL, SS Pesticides	Use of herbicides or burning to clear vegetation is strictly prohibited.			
Land Use	<u>TL, SS</u> Damage to Property or cause detriment or inconvenience	 Condition surveys of access roads and adjacent properties to be completed before project commences. Construction work will make effort to cause as little damage to property or cause detriment and inconvenience. If caused, NEA shall make full compensation. All unanticipated damage to existing public and private property outside the site boundary shall be restored to preproject condition and/or compensated at the cost of the contractor in line with the LARP entitlement matrix. 	 ADB SPS (2009) Project LARP 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
Waste Management	<u>General Impacts</u>	 Excess fill from excavation works across the site to be balanced with fill. Provide adequate facilities for handling and storage of construction materials to reduce the amount of waste that is caused by damage or exposure to the elements and a system for the collection/storage of wastes generated. Any plant or equipment that is rejected during the installation and commissioning due to damage or failure to immediately be removed from the site and returned to the supplier. 	 ADB SPS (2009) IFC EHS Guidelines: Waste Management (2007) IFC EHS Guidelines: Contaminated Land (2007) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 be removed from the site and returned to the supplier. Ensure that the waste hierarchy is followed including prevention, minimization, reuse and recycling maximum reuse and recycling of waste and timely removal of unusable waste according to national waste management regulations. Restrict use of plastics and polyethene and use recyclable/biodegradable materials during construction to the extent possible. In locations where waste is dumped (existing site conditions) the contractor will clean the site and collect the waste for onward disposal before they commence their works. Ensure sufficiently sized facilities are provided for the environmentally safe and sound collection, segregation and storage of waste (including from overnight accommodation) onsite, maximum reuse and recycling of waste by reputable, legitimate, licensed third parties and timely removal and safe transportation of unusable waste to a suitably licensed and engineered waste management facility with all waste transfer records retained. Keep copies of the waste management company's licenses on file. Document all volumes and types of wastes generated and removed off site (inert, solid, hazardous) using transfer Leaving or disposing of construction wastes by burying them onsite or disposing of them at unlicensed waste management facilities is strictly prohibited. Unsanitary open dumps are not to be used by the contractor or their third parties. Municipal waste collection systems must not be used as this is likely to mean that the waste is open dumped, arrangements should be made for direct disposal to a suitably licensed and engineered waste management facility with all waste transfer records retained. No construction material or waste to be poured or thrown into drains Provide regular training of staff in waste management issues. 	 ADB SPS (2009) IFC EHS Guidelines: Waste Management (2007) IFC EHS Guidelines: Contaminated Land (2007) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	All <u>Components</u> Recycling	All recyclable waste (plastic, metal, paper, etc.) will be sorted on source and sent for recycling where facilities for recycling of these materials exist.		EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
	Domestic and Inert Waste	 No domestic waste shall be left at work sites. Any spoil material from tower or substation foundations will be removed from the site and sent to an appropriate state licensed waste management facility. Ensure that wastes are not haphazardly dumped within the work sites and adjacent areas 		EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
	Hazardous Waste	 Use containers suitable for each type of waste. Mark containers adequately specifying the waste types. Do not mix various waste streams. Remove waste at the completion of the work day and return it for storage at the appropriate Contractor facility before final disposal via a licensed contractor for hazardous waste removal and keep agreements with hazardous waste management company's active. 		EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
	Waste Tracking	 Keep copies of waste manifests on site. Keep a record of waste on-site and waste removed. 		EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC

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Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
Noise and Vibration	<u>TL, SS</u> Elevated noise levels and vibration	 Equipment and vehicles will be regularly maintained in accordance with the manufacturer's recommendations to help minimize noise emissions. Only well-maintained modern equipment conforming with noise standards will be used at site. Contractor to use suitably designed mufflers or sound reduction equipment on breakers/drills and ensure all leaks in the air line are sealed on them. Work will be undertaken in daytime hours only – in accordance with IFC EHS definitions (7am – 10pm). Unless in remote locations away from population installation works in the public domain and interacting with public roads or footpaths during 7am -10am as children are going to school and 3pm-5pm as they return back are to be avoided, especially near narrow roads where no safe alternative/diversion route is available for them. If the works need to be undertaken during this time then a safe and signed pedestrian diversion route must be put in place with a pedestrian marshal to ensure that children do not go near the working area and a flag man to control traffic if required to ensure children are not put at increased risk. Noisy construction activity at substations (especially earthworks) only between the hours of 8 am - 6 pm except where no receptors in 500m. No works on Sundays, holidays or festival days within 500m receptors. Sensitive receptors within 500m to be consulted with any other special days when they would wish noise levels to be minimized. 	 ADB SPS (2009) IFC EHS Guidelines – Noise Management (2007) IFC EHS Guidelines: Electrical Power and Distribution (2007) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout project implementation	NEA PMU / PISC



Topic Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	 Loud construction noise, breaking and drilling activities, must be limited to very short periods of activity adjacent to receptors to minimize disturbance. On the boundary of the substation construction noise will be limited to 1- hour LAeq 70 dB(A). Construction noise experienced at rural residences must be limited to 45dB(A), other residences to 55dB(A), commercial buildings 65dB(A), and quiet areas 50dB(A) as 1hour LAeq – if nighttime work is permitted it must be limited to 40dBA in rural residences and quiet areas, 45dBA at other residences and 55dB(A) at commercial buildings as 1hour LAeq If these noise levels are exceeded, or background levels >3dBA were already exceeded, the contractor will be required to implement additional noise mitigation measures such as adjusting working methods or placing of temporary noise barriers to ensure the noise standard is met. No piling or blasting is to be undertaken for construction unless a piling/blasting management plan has been agreed. Any rock removal will be undertaken using pneumatic hammer (handheld or excavator mounted). Use low noise generating equipment e.g., less than 55dBA sound pressure level at 1m. The use of horns in areas where sensitive receptors are located (houses, schools, clinics, temples, etc.) will be prohibited. Residents within 500m of substations will be forewarned of planned activities that are considered by the Project to be noisy (e.g., trench excavation / drilling). 	 ADB SPS (2009) IFC EHS Guidelines – Noise Management (2007) IFC EHS Guidelines: Electrical Power and Distribution (2007) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout project implementation	NEA PMU / PISC

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Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 If complaints are received from the local population regarding elevated noise levels, temporary noise screens shall be installed around the work site, shielding the identified receptors from the source of noise. In the event of a grievance being received carry out an investigation of noise levels to determine whether they will comply with permitted maximum levels using a hand held noise monitor mounted on a tripod to measure IEC A-weighting dB(A) LAeq. Construction workers exposure to noise should not exceed the levels set out in the General EHS Guidelines on Occupational Health and Safety otherwise the hearing protection is to be provided e.g., 85 dB(A) during continuation of 8 working hours without wearing PPE. 	 ADB SPS (2009) IFC EHS Guidelines – Noise Management (2007) IFC EHS Guidelines: Electrical Power and Distribution (2007) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout project implementation	NEA PMU / PISC
Physical & Cultural Heritage	<u>TL, SS</u> Chance Finds	 Implement the chance find procedure, if required. 	 ADB SPS (2009) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
Utilities & Infrastucture	<u>TL, SS</u> Outages, damage to utilities and private property	 All unanticipated damage to existing public utilities shall be restored immediately to pre-project condition and/or compensated at the cost of the contractor. If existing structures (e.g., buildings) and roads, tracks, crops, or, canals, or drains are damaged by works, the Contractor will be required to rehabilitate them to at least their condition prior to construction works to the satisfaction of the property owner having reference to pre-condition surveys. 	 ADB SPS (2009) GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
Occupational Health & Safety	General	 For all construction works comply with GoN rules and regulations for the protection of workers. Strictly implement all the measures outlined in annexes and all the measures outlined below. Emergency contact number and details for medical, fire, etc. are to be displayed in all construction sites. No unaccompanied members of the public shall be allowed on the construction site. 	ADB SPS (2009) IFC EHS Guidelines General IFC EHS Guidelines: Electrical Power	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
	Fatalities	 In the event of any fatality occurring during the construction phase at any work site, provide NEA with the details of the fatality within one day (24 hours) of the event occurring in a Fatality Report (for onward reporting to ADB within 48 hours) and provide within 48 hours an incident report with corrective action detailing how reoccurrence will be prevented. 	Power Transmission & Distribution (2007) • ILO safety and health in		
	Work Site	 Contractor is responsible for ensuring H&S of everyone on construction site including visitors and sub-contractor workers regardless they have been formally or informally employed. Ensure adequate health and safety supervision is always on site (if staff temporarily off sick or on short term leave of less than a fortnight contractor to provide a named alternate in advance; if safeguard staff are on longer term leave, are posted elsewhere, or resign, contractor to ensure replacement CV is submitted to NEA in seven days of the contractor becoming aware with the staff joining the site within one month). Construction plant and equipment used will be modern and fitted with appropriate safety devices. Temporary safety fences shall be erected around each work site. 	GoN laws & regulations		

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Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 Require workers to confirm they have seen and understood the requirements of the OHS plan before proceeding with the work. Warning signs will be displayed around work sites to warn workers and members of the local community of potential risks in Nepali and other languages of the workers found on site. MSDS are to be readily available to any exposed workers and the first-aid personnel. All crews shall have a competent person responsible for first aid. Only allow suitably trained and qualified workers to be allowed to work on electrical equipment and at height, these workers must have training record of attending suitable training course on electrical safety and working at height and have a recent medical checkup to confirm they are fit for work. Require other workers to observe the minimum approach distances for excavations, tools, vehicles, pruning, and other activities when working around power lines. Provide personal protective equipment (PPEs) for workers in accordance with national OHS regulations and good international industry practice. Handwashing facilities with clean running water supply and soap as well as hand sanitizers and closed bins for disposal of hygiene related wastes to be provided on-site during works. Display posters to promote handwashing and respiratory hygiene etc. Sanitation and welfare facilities used by construction workers to be regularly cleaned and disinfected by the contractor. Enforce disciplinary system (e.g., immediate removal from site) for non-compliance with PPE requirements. 	 ADB SPS (2009) IFC EHS Guidelines General IFC EHS Guidelines: Electrical Power Transmission & Distribution (2007) ILO safety and health in construction GoN laws & regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 Ensure proper grounding and deactivation of live power lines during construction /decommissioning work or before any work near the lines and this will be checked and certified by Health and Safety Officer in advance. Require workers to observe IFC EHS Guideline on T&D requirements for working at height. During construction works ensure qualified first aider and trained fire marshal is always available on-site with an appropriately equipped first aid kit and appropriate fire extinguisher and other firefighting equipment immediately available for use. Every crew under one H&S supervisor shall have a first aid box at the worksite. Since fuel, oil and chemicals will be handled on site provide emergency eye wash facilities adjacent to the storage facilities. Arrange with nearest Health Center and/or Hospital for emergency cares of workers with an ambulance transport available on site or on immediate call. Provide workers with access to an existing functional toilet facility (toilets and hand washing area) or provide a self-contained portable toilet with hand washing facilities (open defecation and use of pit latrines to be prohibited) generated wastewater to be disposed of to wastewater treatment plant. Toilet facilities to be provided with adequate supplies of hot and cold running water, soap, and hand drying device. Sufficient toilet facilities should be provided for the number of workers, and there should be an indication of whether the toilet facility is "in use" or "vacant" if not segregated. Each transient work gang will always have with them on site canned drinking water - 4 liter per person per day, first aid kit and fire extinguisher (in case of forest fires) Equipment used on or around the site will be modern and fitted with appropriate safety devices. 	 ADB SPS (2009) IFC EHS Guidelines General IFC EHS Guidelines: Electrical Power Transmission & Distribution (2007) ILO safety and health in construction GoN laws & regulations 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		 Ensure good housekeeping at construction site, storage areas, staff accommodation, etc to be kept neat and tidy, e.g., no materials, equipment, trash laying around, clean-up worksites so that they are free of debris on daily basis. Use good means of communication during works in lines and checklists with triple signatories to confirm the deenergizing/energizing is completed. 	 ADB SPS (2009) IFC EHS Guidelines General IFC EHS Guidelines: Electrical 	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC
	<u>TL, SS</u> Working at height	There must be a competent person present to supervise work at height and ensure that safety measures are being followed. If working under live lines (HV or LV) then a safety scaffold will be installed so that the workers cannot come in contact with the OHL, with warning signs provided. There must be a competent person present to supervise work at height and ensure that safety measures are being followed. Workers must be provided with adequate rest periods to avoid fatigue and must not be required to work at height during adverse weather conditions. First aid kit to include adequate ORS fluid/power packets.	Power Transmission & Distribution (2007) ILO safety and health in construction GoN laws & regulations		
	<u>TL and SS</u> EMF	 Measure exposure levels to electromagnetic fields (EMF) and provide workers working in zones where EMF levels are above reference levels with personal EMF monitoring device to be attached onto their PPE. 			
	Food and drink	 Provide workers with access to clean eating area with supply of drinking water. Adequate supplies of potable drinking water (at least 4 liters per person per day) meeting national standards should be provided to workers. 			

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Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
	Forced and Child Labour	 No forced or child labor to be employed in construction with the minimum age for employment on construction site to be 18 given hazardous nature of works involved. Verifiable proof of age documentation is maintained for every worker. Workers operate within the legal working hours and additional work hours are adequately compensated. All overtime hours are voluntary; coercion, threats or penalties not used to pressure the workers into overtime. Wages being paid to workers confirms to the minimum wage rated specified under applicable laws. All wages including overtime are paid within legally defined time limits. Pay statements shows earned wages, regular and overtime pay, bonuses and all relevant deductions No unreasonable restraints on the worker's freedom of movement. Terms of employment outlined at the time of recruitment do not differ from the terms offered during the course of employment. 	 ADB SPS (2009) ILO Convention-Minimum Age Convention (1973) ILO Convention-Worst Forms of Child Labour Convention (1999) ILO Convention-Forced Labour ILO Safety and health in construction GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	
	Labour and Accommodation Camps	• Ensure the camps established for providing accommodation to labors engaged in construction activities meet the requirements specified in the ILO safety and health in construction/worker accommodation guidelines and the requirements of the annex.	 ADB SPS (2009) World Bank Guidance Note on Managing Labor Influx, 2016 ILO safety & health in construction /worker accommodation guidelines GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout construction	



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
Community Health and Safety	Grievances Record Keeping	 Implement the GRM procedures to provide opportunity for residents to raise concerns. Provide 72 hours advance notice of any works (not including emergency works) to the local community. Keep a specific record of any community incidents that occur during the construction phase. Report the numbers to NEA monthly. 	 ADB SPS (2009) Project GRM IFC EHS Guidelines: Community Health and Safety (2007) Voluntary Principles on Security and Human Rights⁷ GoN laws and regulations 	EPC Contractor Include in EPC contract cost Throughout	NEA PMU / PISC
	Conflict with Security Personnel	 The project will implement the 'Voluntary Principles on Security and Human Rights' During construction, due diligence will be applied to selection of security providers, rules of engagement will be devised, and training provided to all personnel. Performance will be monitored and audited periodically. 		 Voluntary construction Principles on Security and Human Rights⁷ GoN laws and regulations 	
Traffic Management	Traffic and Pedestrian Safety	 Implement agreed traffic management plan. Safe access to property and roads should be maintained and alternative routes and access provided where there are temporary diversions or blockages. Diversion works to be immediately dismantled on completion of works and the footpath and roads restored to their original condition. Transport equipment only during non-rush hours i.e., avoid the hours of 9am to 11 am and 4pm to 6 pm to minimize traffic congestion. Stockpiling of spoil and any new equipment (conductor reels, etc.) shall be away from properties and only in designated 	• ADB SPS (2009)	EPC Contractor Include in EPC contract cost Throughout construction	NEA PMU / PISC



² https://www.voluntaryprinciples.org

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Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		Allow for adequate traffic flow around construction areas via diversions or temporary access roads.	• ADB SPS (2009)	EPC Contractor	NEA PMU / PISC
		• Provide adequate traffic signs, appropriate lighting, well- designed traffic safety signs, barriers, and flag persons for traffic control.		Include in EPC contract cost	
		• Ensure that safe access ways to public and private amenities (including schools) are maintained, safe alternative routes provided and clearly signed where there are temporary diversions or blockages.		Throughout construction	
		• Traffic management will need to be done in consultation with the affected communities to ensure they are aware of likely disruption.			
		• Implement traffic management controls during construction works with advance warning signs or flag persons to ensure health and safety of construction workers and road users.			
		 Construction traffic warning signs will be positioned at road crossings and other appropriate locations as determined by the project, for example, along access routes before they are used by construction traffic. 			
		• Road safety and warning signs must be posted at 500m, 100m, and immediately in advance of the site entrance at least two days prior to the works commencing to inform the public of the temporary hazard of turning traffic.			
		For site entrances flagmen should be utilized to warn road users of the situation.			



Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
Training	<u>TL, SS</u> Pollution Prevention	• Conduct bi-monthly training of workers on pollution prevent control including good housekeeping and how to clean up oil/fuel spills and dispose of contaminated sorbent material which would be treated as a hazardous waste.	• ADB SPS (2009)	EPC Contractor	NEA PMU / PISC
	OHS	• Conduct weekly training on occupational health and safety for all construction workers including refreshers. To include training for subcontractors before commencement of works.	• ADB SPS (2009)	EPC Contractor	NEA PMU / PISC
	Emergency Response	• Conduct monthly training of workers on emergency preparedness and response procedures in case of an occupational or community health and safety incident during construction works. To include training for subcontractors before commencement of works.	• ADB SPS (2009)	EPC Contractor	NEA PMU / PISC
	<u>TL, SS</u> Driver Training	• Driver training, monthly, to include advice on behaviors to reduce the potential for disturbance, including use of horn, loud radios with windows open, switching engines off when not in use, strictly observing speed limits and not accelerating or braking aggressively.	• ADB SPS (2009)	EPC Contractor	NEA PMU / PISC
GRM	GRM Communication and Implementation	 Disseminate GRM contact details and arrangements to the community through the distribution of pamphlets, prominently posted notices at work sites, community centers etc. Ensure that throughout construction highly visible signage providing their and GRM Focals names and contact details are prominently displayed at all construction sites, storage areas, temporary worker camps, subproject site offices, road crossing points etc. To facilitate liaison with the local community the environment safeguards team will need to be supported by a member of staff who can speak the local language. 	ADB SPS (2009) Project GRM	EPC Contractor	NEA PMU / PISC

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Торіс	Impact / Issue	Commitment	Applicable Project Standards /Best Practice	Implementation Responsibility	Monitoring Responsibility
		• Encourage affected persons to make use of the GRM yet clarify that this does not prevent them from pursuing legal action, if they feel that it is needed	ADB SPS (2009) Project GRM	EPC Contractor / NEA PMU	NEA PMU / PISC
		• Keep a record of all grievances received and their resolution and to report on them.		EPC Contractor	NEA PMU / PISC

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Торіс	Activity / Issue	Commitment	Applicable Project Standards / Guidelines	Implementation Responsibility (Budget Source and Timing)	Monitoring Responsibility
Substations	General EHS impacts during O&M	 During the operational phase NEA will be responsible for ensuring that all required corrective actions for existing substations continue to be complied with per the Corrective Action Plan. NEA to develop SOP for pollution control and health and safety management of substation operation and maintenance including inspections schedules etc. SOP to cover pollution control, solid and hazardous waste management, health and safety risk assessments and management plans addressing both occupational and community risks and including permit to work system of critical activities such as electrical or work at height and emergency preparedness and response provisions. Implementation of SOP environment, health and safety measures, provision of regular EHS trainings to O&M workers on SOP implementation and good housekeeping practices including how to clean up oil/fuel spills and dispose of contaminated sorbent material which would be treated as hazardous waste etc. Continually improve compliance with national requirements and good international practice for EHS including health and safety and solid and hazardous materials and waste management in particular: Undertake regular visual and technical inspection of condition of substation equipment and carry out maintenance as required, if SF6 or an oil leak encountered these are to be immediately addressed. Provide at least one-month advance notice to local community about the schedule of and details of planned major maintenance works. Mitigation measures applicable to the construction stage are also applicable to the O&M activities and workers. 	 ADB SPS (2009) IFC EHS General Guidelines IFC EHS Electric Power T&D Guidelines GoN laws and regulations 	NEA O&M team Throughout O&M phase	NEA PMU / PISC



Торіс	Activity / Issue	Commitment	Applicable Project Standards / Guidelines	Implementation Responsibility (Budget Source and Timing)	Monitoring Responsibility
Training/all components	OHS	 Ensure workers with a specific role have attended specialized health and safety trainings related that role e.g., health and safety stewards, first aiders, fire safety officers, as well as ensuring workers have received task-specific trainings for working with electricity, etc. Only allow suitably trained and qualified workers to work on electrical equipment these workers must have training record of attending suitable training course on electrical safety and working at height and be provided with and wear the appropriate PPE for their role. Untrained workers must not be permitted to work with live electricity. 	• ADB SPS (2009)	NEA O&M team Throughout O&M phase	NEA PMU / PISC
	Emergency Response	 Conduct monthly training involving all workers on emergency preparedness and response procedures (drills) in case of an occupational or community health and safety incident during O&M including fire, natural disaster, disease outbreak etc. Emergency preparedness and response training for operational management will include modules on first aid and fire safety including include training on how to use first aid and firefighting equipment provided onsite, and scenario of potential or confirmed infection. 			
	Pollution Prevention	• Conduct bi-monthly training of workers on pollution prevent control including good housekeeping and how to clean up oil/fuel spills and dispose of contaminated sorbent material which would be treated as a hazardous waste.			

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Table 4: O & M EMP

Торіс	Activity / Issue	Commitment	Applicable Project Standards / Guidelines	Implementation Responsibility (Budget Source and Timing)	Monitoring Responsibility
Waste Management/ substations	General impacts	 Collect and segregate all O&M wastes including scrap metal, oil, and solid waste; ensure all workers are familiar with this segregation. Store all the wastes produced in an environmentally sound manner in designated, labelled area with separate waste containers (drums, bins, skips) for each type of waste with solid waste in enclosed bins to contain leachate and avoid vermin. Ensure that the waste hierarchy is followed including prevention, minimization, reuse and recycling – maximum reuse and recycling of waste and timely removal of unusable waste according to national waste management regulations. Ensure sufficiently sized facilities are provided for the environmentally safe and sound collection, segregation and storage of waste (including from overnight accommodation) on-site, maximum reuse and recycling of waste by reputable, legitimate, licensed third parties and timely removal and safe transportation of unusable waste to a suitably licensed and engineered waste management facility with all waste transfer records retained. Keep copies of the waste management company's licenses on file. Document all volumes and types of wastes generated and removed off site (inert, solid, hazardous) using transfer 	 ADB (2009) IFC Guidelines Waste Management (2007) IFC Guidelines: SPS EHS Contaminated Land (2007) GoN laws and regulations 	NEA Throughout O&M phase	NEA PMU / PISC
		 Municipal waste collection systems must not be used as this is likely to mean that the waste is open dumped, arrangements should be made for direct disposal to a suitably licensed and engineered waste management facility with all waste transfer records retained. Since it is unlikely any will be available locally use waste management facilities (e.g. compost, incineration) included on-site during the design stage. Burning of waste on-site is also strictly prohibited, including vegetation. Removal and disposal of identified invasive plant species in an ecologically sound manner. 			



Торіс	Activity / Issue	Commitment	Applicable Project Standards / Guidelines	Implementation Responsibility (Budget Source and Timing)	Monitoring Responsibility
substations	General Impacts	 Conect and segregate an Oxim wastes including scrap metal, oil, and solid waste; ensure all workers are familiar with this segregation. Store all the wastes produced in an environmentally sound manner in designated, labelled area with separate waste containers (drums, bins, skips) for each type of waste with solid waste in enclosed bins to contain leachate and avoid vermin. Ensure that the waste hierarchy is followed including prevention, minimization, reuse and recycling – maximum reuse and recycling of waste and timely removal of unusable waste according to national waste management regulations. Ensure sufficiently sized facilities are provided for the environmentally safe and sound collection, segregation and storage of waste (including from overnight accommodation) on-site, maximum reuse and recycling of waste by reputable, legitimate, licensed third parties and timely removal and safe transportation of unusable waste to a suitably licensed and engineered waste generated and removed off site (inert, solid, hazardous) using transfer Municipal waste collection systems must not be used as this is likely to mean that the waste is open dumped, arrangements should be made for direct disposal to a suitably licensed and engineered waste management facility with all waste transfer records retained. Since it is unlikely any will be available locally use waste management facilities (e.g. compost, incineration) included on-site during the design stage. Burning of waste on-site is also strictly prohibited, including vegetation. 	 ADB (2009) IFC Guidelines Waste Management (2007) IFC Guidelines: SPS EHS Contaminated Land (2007) GoN laws and regulations IFC Guidelines: SPS EHS 		



Table 4: O & M EMP

Торіс	Activity / Issue	Commitment	Applicable Project Standards / Guidelines	Implementation Responsibility (Budget Source and Timing)	Monitoring Responsibility
Health and Safety/all components	General	 NEA is responsible for ensuring H&S of everyone on construction site including visitors and sub-contractor workers regardless they have been formally or informally employed. Strictly implement SOP and all health and safety measures in annex. Warning signs will be displayed around work sites to warn workers and members of the local community of potential risks. Maintain warning / advisory signs in good and visible condition. Emergency contact number and details for medical fire, etc. are to be displayed at the site. For all maintenance works undertake risk assessment and prepare H&S plan in accordance with EHS Guidelines, considering occupational and community H&S and including adherence emergency preparedness and response plan with communication systems and protocols to report an emergency situation. Mitigation measures applicable to the construction stage are also applicable to O&M activities. Enforce disciplinary system (e.g., immediate removal from site) for non-compliance with PPE requirements. 	 ADB SPS (2009) IFC EHS Guidelines General IFC EHS Guidelines: Electrical Power Transmission and Distribution (2007) GoN laws and regulations 	NEA Throughout O&M phase	NEA PMU / PISC



Table 4: O & M EMP

OHS Adequate supplies of potable drinking water meeting mational standards should be provided to workers. Sanitation and welfare facilities to be regularly cleaned and disinfected. Handwashing facilities with clean running water supply and soap as well as hand sanitizers and closed bins for disposed of hygiene-related wastes to be provided on- site during works. Display posters to promote handwashing and respiratory hygiene etc. Arrange with nearest Health Center and/or Hospital for emergency cares of workers. Maintain incident logbook and medical tests / health check-up of staff Provide everyone who enters the substation with an OHS induction Ohy allow suitably trained and qualified workers to be allowed to work on electrical equipment and at height, these workers must have training record of attending suitable training courd of attending suitable training curved. Require other workers to observe the minimum approach distances. Provide personal protective equipment (PPEs) for workers in accordance with national OHS regulations and GIIP. Keep vents/windows unblocked and replace defunct bulbs/lights immediately. Ensure all substation workers receive basic first aid 	Торіс	Activity / Issue	Commitment	Applicable Project Standards / Guidelines	Implementation Responsibility (Budget Source and Timing)	Monitoring Responsibility
and firefighting training with annual refreshers.		OHS	 Adequate supplies of potable drinking water meeting national standards should be provided to workers. Sanitation and welfare facilities to be regularly cleaned and disinfected. Handwashing facilities with clean running water supply and soap as well as hand sanitizers and closed bins for disposal of hygiene-related wastes to be provided onsite during works. Display posters to promote handwashing and respiratory hygiene etc. Arrange with nearest Health Center and/or Hospital for emergency cares of workers. Maintain incident logbook and medical tests / health check-up of staff Provide everyone who enters the substation with an OHS induction Only allow suitably trained and qualified workers to be allowed to work on electrical equipment and at height, these workers must have training record of attending suitable training course on electrical safety and working at height and have a recent medical check-up to confirm they are fit for work. Require other workers to observe the minimum approach distances. Provide personal protective equipment (PPEs) for workers in accordance with national OHS regulations and GIIP. Keep vents/windows unblocked and replace defunct bulbs/lights immediately. Ensure all substation workers receive basic first aid and firefighting training with annual refreshers. 		NEA Throughout O&M phase	NEA PMU / PISC

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Торіс	Activity / Issue	Commitment	Applicable Project Standards / Guidelines	Implementation Responsibility (Budget Source and Timing)	Monitoring Responsibility
		 Ensure that at least one staff at substation is fully trained as a first aider and fire marshal During O&M works ensure qualified first aider and trained fire marshal is always available on-site with an appropriately equipped first aid kit and appropriate fire extinguisher and other firefighting equipment immediately available for use. 		NEA Throughout O&M phase	NEA PMU / PISC
		 Maintain fully stocked, in-date first aid kit, keep first aid posters and emergency contact lists that are posted up to date 			
		 Maintain firefighting systems including in-date fire extinguishers and full sand buckets and keep fire safety posters up 			
		 Carry out regular inspections and periodic maintenance to ensure electrical standards are being upheld 			
		 Display clear emergency exits signs (in working order, if light signs, ensure they work) and keep exits clear of any blockages. Remove any trip hazards on the ground, e.g., materials, equipment, trash laying around. 			
		 Undertake regular pest control using integrated pest management approach 			
		 Maintain vegetation at the substation that poses a health and safety hazard 			
		 Cleaning of toilets on daily basis, use of disinfectant and floor cleaners; keep toilets/septic tank/soakaway maintained Massure exposure levels to electromagnetic fields 			
		(EMF) and provide workers working in zones where EMF levels are above reference levels with personal EMF monitoring device to be attached onto their PPE.			

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Торіс	Activity / Issue	Commitment	Applicable Project Standards / Guidelines	Implementation Responsibility (Budget Source and Timing)	Monitoring Responsibility
		 Periodic spot monitoring using mobile phone app of noise levels and ambient EMF for substations at the boundary fence/near transformers to ensure they are below the occupational/community noise levels and ICNRP occupational/community EMF exposure levels Maintain security and prevent entry by the local community and livestock by maintaining adequate boundary fencing or wall, always keeping control room doors and gates shut, and having security persons present 24x7 to prevent unauthorized public access and trespass. NEA in conjunction with local municipalities, village heads, and the media with the support of CSOs to continue to organize health and safety campaigns on electrical safety community awareness raising activities in local communities and schools within 500 m of the substations. 		NEA Throughout O&M phase	NEA PMU / PISC
	Fatalities	 In the event of any fatality occurring during the O&M phase at any work site, provide PMU with the details of the fatality within one day (24 hours) of the event occurring in a Fatality Report (for onward reporting to ADB within 48 hours) and provide within 48 hours an incident report with corrective action detailing how reoccurrence will be prevented. 		NEA Throughout O&M phase	NEA PMU / PISC

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Project Activity or		Method of								
Environment Impacts/ Risks	Monitoring Parameters	Monitoring including Standards/ Guidelines	Frequency and Timing	Location/ Components	Performance Indicator	Implementation	Supervision (NEA PMU)			
	Pre-construction									
Statutory Clearances	Licenses / Permits and Insurances	Review of all applicable clearances, licenses, permits and insurances before the start of construction	One time prior to the start of construction	In general, for all project components	All relevant permits, licenses and insurances outlined in the IEE are obtained prior to the start of works.	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly reports with copies attached.	Review all clearances, licenses, permits and insurances and document compliance in EMR			
Staffing	Contractors environmental, social, health and safety staff	Review of staff contracts, timesheets and payslips	Prior to the start of \construction then periodically throughout construction	In general, for all project components	All staff outlined in the IEE are in place at the start of construction and are on site for the allotted periods specified in the EMP	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly progress reports with evidence attached.	Review contracts, timesheets and payslips and document compliance in EMR.			
Training and Inductions	Training records	Review of all induction training records, including training materials, attendance sheets and photographs. Attendance at sample of sessions and randomized sample of people on site to assess if they have received training and induction.	One time prior to the start of construction. Then periodically through construction to ensure new staff have received induction training and refreshers are being delivered.	In general, for all project components	All people on-site whether formally or informally employed have received the required training and induction.	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly progress reports with evidence attached.	Review all training and induction records, attendance at sample of sessions, sample of people on site and document compliance in EMR.			

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Project Activity or Environment Impacts/ Risks	Monitoring Parameters	Method of Monitoring including Standards/ Guidelines	Frequency and Timing	Location/ Components	Performance Indicator	Implementation	Supervision (NEA PMU)
Community Awareness	Pre-construction and pre-operation awareness documents	Review documents prepared for community awareness activities, attendance sheets and photographs of meetings held to deliver them. Randomized sample of residents to assess if they have received any awareness materials.	One time prior to the start of construction and again during commissioning prior to operation.	In general, for all project components.	Awareness documents completed and distributed to adjacent villages within 500m.	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly progress reports with evidence attached.	Review awareness documents, attendance at sample of sessions held, conduct sample of residents and document compliance in EMR.
Environmental management	Incident reporting system including GRM and environmental management provisions	Review of incident reporting system including GRM, inspection audit of environmental management provisions by environment safeguard staff	Prior to the start of construction then periodically throughout construction	All construction areas and related facilities, labour camps and overnight accommodation areas etc.	System established and contract is fully compliance with EMP requirements, GON legislation and IFC EHS Guidelines	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly progress reports with evidence attached including environment officer's checklists etc.	Review of contractor's system and audit, inspection audit by PISC environment expert and document compliance in EMR
Labor Camps and Overnight Accommodation, Sanitation and Welfare Facilities	GON legislation, ILO Safety and Health in construction and guidance on worker accommodation, and IOM migrant workers accommodation checklist	Inspection audit of labor camps and overnight accommodation by labor staff.	Prior to the start of construction then periodically throughout construction	For all labor camps and overnight accommodation areas as well as day rest areas	Labor camps and overnight accommodation are compliant with EMP requirements, GON legislation, ILO guidance and IOM checklist	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly progress reports with their labor officer's inspection audit and other evidence attached.	Review of contractor's audit, inspection audit by PISC labor expert, and document compliance in EMR

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Project Activity or Environment Impacts/ Risks	Monitoring Parameters	Method of Monitoring including Standards/ Guidelines	Frequency and Timing	Location/ Components	Performance Indicator	Implementation	Supervision (NEA PMU)				
Health and Safety	Health and Safety Risk Assessment, Incident Reporting System including labor GRM and H&S provisions	Review of risk assessment and incident reporting system including GRM, inspection audit of H&S provisions by H&S safeguard staff	Prior to the start of construction then periodically throughout construction	For all project components, all construction areas and related facilities, labour camps & overnight accommodation areas etc.	Risk assessment completed, system established, and contract is fully compliance with EMP requirements, GON legislation, IFC EHS Guidelines and ILO Safety & Health in Construction	EPC contractor to undertake monitoring & report to NEA in monthly & quarterly progress reports with evidence attached including H&S officer's checklists etc.	Review of contractor's system and audit, inspection audit by PISC environment expert and document compliance in EMR				
C	Construction including Site Establishment, Preparation and Clearance Works and Commissioning Activities.										
Health and Safety – incidents	Records of health and safety incidents	Keep records of near miss, minor, lost time, and fatal health and safety incidents related to the project, compile records from construction sites into a database for tracking. Carry out randomized interviews with workers and the community to identify if any unrecorded incidents occurred.	Ongoing with Monthly Compilation of Records	For all project components, all construction areas and related facilities, labour camps and overnight accommodation areas etc. Offsite traffic incidents related to contractor's vehicles or the condition of access roads to site	Zero lost time incidents or fatalities (among workers & community) For 100% lost time incidents or fatalities immediate action taken to avoid repeat or escalation of situation All incidents including minor and near miss dealt with in accordance with EMP/CSEMP with lessons learnt for future 100% lost time & fatalities reported to NEA within 24 hours and ADB within 48 hours with incident report submitted within 48 hours with root cause analysis & corrective action taken	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly progress reports with records and reports attached.	Check monitoring being undertaken, review records and reports, conduct interviews with workers and the community and document compliance in EMR				



Project Activity or Environment Impacts/ Risks	Monitoring Parameters	Method of Monitoring including Standards/ Guidelines	Frequency and Timing	Location/ Components	Performance Indicator	Implementation	Supervision (NEA PMU)
Water resources	Water volume used and source	Keep records of all water used (volume in m ³) and source. Carry out randomized interviews with the community to identify if any unrecorded grievances occurred.	Ongoing with Monthly of Compilation Records	For TL, SS, DC and DRC, all construction areas & related facilities, labour camps & overnight accommodation areas etc.	Water use documented. No grievance received during construction or operation regarding conflict with other water users	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly progress reports with records and evidence provided.	Check monitoring being undertaken, review records, conduct interviews with the community and document compliance in EMR
Soil (earthworks)	Volume of soil disturbed during construction	Keep records of earthworks involved, including total volume in m ³ of soil excavated and reused (any disposed of as spoil off site to licensed waste disposal facilities recorded as per waste generation) Carry out visual inspection and randomized interviews with community to identify if any unrecorded grievances occurred	Ongoing Monthly Compilation Records	For construction sites involving earthworks/cut and fill activities	Earthworks documented, & all excavated & cut and fill volumes accounted for, either reused on- site or disposed of off-site to licensed waste disposal facilities with no grievance received related to spoil disposal unresolved.	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly progress reports with records &evidence provided.	Check monitoring being undertaken, review records, conduct Inspection and interviews with the community and document compliance in EMR
Hazardous materials– incidents	Pollution incidents	Records of pollution incidents (e.g., type of material spilled, amount in kg or m ³ & action taken to clean up) Carry out visual inspection and interviews with workers & the community to identify if any unrecorded incidents occurred	Ongoing Monthly Compilation Records	For all construction areas and related facilities, labour camps and overnight accommodation areas etc.	Zero major incidents occurred. Minor incidents responded to in accordance with EMP/CSEMP with lessons learnt for future.	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly progress reports with records and reports attached.	Check monitoring being undertaken, review records and reports, conduct Inspection & interviews with the workers & community & document compliance in EMR

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Project Activity or Environment Impacts/ Risks	Monitoring Parameters	Method of Monitoring including Standards/ Guidelines	Frequency and Timing	Location/ Components	Performance Indicator	Implementation	Supervision (NEA PMU)
Natural Resource Use (Construction Materials) and Waste Generation	Volume of construction materials used, and waste generated, and disposal route	Keep records of all types of materials used and wastes produced by type, volume/ weight. Document waste disposal through transfer notes including type, volume/ weight, transport provider, intermediaries if any & final treatment or disposal facility (with its license and capacity) Carry out visual inspection & randomized interviews with community to identify if any unrecorded grievances occurred	Ongoing Monthly Compilation Records	For all project components, all construction areas and related facilities, labour camps and overnight accommodation areas etc.	Transfer of 100% of construction wastes documented, and all wastes disposed of in an environmentally safe and sound manner in accordance with the EMP/CSEMP and IFC General EHS Guidelines with no grievance received related to waste disposal unresolved	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly progress reports with records and other evidence provided.	Check monitoring being undertaken, review records, conduct Inspection and interviews with the community and document compliance in EMR
Wildlife	Animal casualties	Keep written record, supported by photographs, of any animal conflicts or casualties, including a cause of death if known Carry out visual inspection and randomized interviews with workers and community to identify if any unrecorded grievances occurred	Ongoing Monthly Compilation Records	For TL, SS, DC and DRC, construction site, including temporary construction facilities. Offsite traffic incidents related to the contractor's vehicles or the condition of village roads used for access	Zero fatal animal casualties occurred For 100% incidents immediate action taken per wildlife encounter protocol and GON legislation & to avoid repeat or escalation of situation All incidents including minor & near miss dealt with in accordance with EMP/CSEMP with lessons learnt for future	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly progress reports with records and reports attached.	Check monitoring being undertaken, review records and reports, conduct inspections and interviews with the community and document compliance in EMR



Project Activity or Environment Impacts/ Risks	Monitoring Parameters	Method of Monitoring including Standards/ Guidelines	Frequency and Timing	Location/ Components	Performance Indicator	Implementation	Supervision (NEA PMU)
Employment	Records of all construction workers including subcontractor workers whether formally or informally employed and including any daily labor	Keep records of employment generated, age/gender/sex- disaggregated employment data, home locations, medical checks, if labor accommodation provided, and trainings and inductions received Carry out visual inspection and randomized interviews with workers to identify if any unrecorded grievances occurred	Ongoing with Monthly compilation Records	For all project components, construction site	Employment in accordance with EMP/CSEMP plus GON legislation; no grievance received related to employment of workers unresolved	EPC contractor to undertake Monitoring and report to NEA in monthly and quarterly progress reports with records and other evidence provided.	Check monitoring being undertaken, review records, conduct Inspections and interviews with workers and document compliance in EMR
Climate change emissions	SF6 used and leakage rates	Keep records of SF6 total volume used in SS installation and leakage rates	Ongoing Monthly Compilation Records	Substations	EMP compliance: significantly less than 0.1% leakage rate	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly progress reports with records attached	Check monitoring being undertaken, review records, conduct Inspections and interviews with workers and document compliance in EMR
Drinking Water supplies	GON drinking water standards	Drinking water tests from supplier Carry out visual inspection and randomized interviews with workers to identify any unrecorded grievances	Ongoing Monthly Compilation Records	For all project components, sources of drinking water for construction for which supplier can provide copies of drinking water tests to confirm compliance.	GON drinking water parameters	EPC contractor to undertake monitoring and report to NEA in monthly and quarterly progress reports with records and test reports attached.	Check monitoring being undertaken, review records, conduct inspections and interviews with workers and document compliance in EMR

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Project Activity or Environment Impacts/ Risks	Monitoring Parameters	Method of Monitoring including Standards/ Guidelines	Frequency and Timing	Location/ Components	Performance Indicator	Implementation	Supervision (NEA PMU)		
	O&M								
Climate change emissions	SF6 used and leakage rates	Keep records of SF6 total volume used and leakage rates	Ongoing Monthly Compilation Records	Substations	EMP compliance: significantly less than 0.1% leakage rate	NEA O&M team to undertake monitoring and report to PMU in monthly and quarterly progress reports with records attached	Check monitoring being undertaken, review records, and document compliance in EMR		
Health and Safety – incidents	Records of health and safety incidents	Keep records of near miss, minor, lost time, and fatal health and safety incidents, compile incident records into database for tracking Carry out randomized interviews with workers and the community to identify if any unrecorded incidents occurred.	Ongoing Monthly Compilation Records	Substations	Zero lost time incidents or fatalities (among workers & community) For 100% lost time incidents or fatalities immediate action taken to avoid repeat or escalation of situation All incidents including minor and near miss dealt with in accordance with EMP with lessons learnt for future 100% lost time & fatalities reported within NEA in 24 hours & ADB within 48 hours with incident report submitted within 48 hours with root cause analysis & corrective action taken.	NEA O&M team to undertake monitoring & report to PMU in monthly and quarterly progress reports with records & reports attached	Check monitoring being undertaken, review records and reports, conduct interviews with workers and the community and document compliance in EMR		



Project Activity or Environment Impacts/ Risks	Monitoring Parameters	Method of Monitoring including Standards/ Guidelines	Frequency and Timing	Location/ Components	Performance Indicator	Implementation	Supervision (NEA PMU)
Water resources	Water volume used and source	Keep records of all water used (volume in m ³) and source. Carry out randomized interviews with community to identify if any unrecorded grievances occurred.	Ongoing Monthly Compilation Records	Substations, DC and DRC	Water use documented. No grievance received during construction or operation regarding conflict with other water users	NEA O&M team to undertake monitoring and report to PMU in monthly and quarterly progress reports with records provided.	Check monitoring being undertaken, review records, conduct interviews with the community & document compliance in EMR
Hazardous materials– incidents	Pollution incidents	Records of pollution incidents (e.g., type of material spilled, amount in kg or m ^{3,} and action taken to clean up) Carry out visual inspection and interviews with workers and the community to identify if any unrecorded incidents occurred	Ongoing Monthly Compilation Records	Substations	Zero major incidents occurred. Minor incidents responded to in accordance with EMP with lessons learnt for future.	NEA O&M team to undertake monitoring and report to PMU in monthly and quarterly progress reports with records and reports attached.	Check monitoring being undertaken, review records and reports, conduct Inspection and interviews with the workers and community and document compliance in EMR
Solid Hazardous Generation and Waste	Solid and hazardous waste generated, and disposal route	Keep records of all types of wastes produced by type, volume/ weight. Document waste disposal through transfer notes including type, volume/ weight, transport provider, intermediaries if any and final treatment or disposal facility (with its license and capacity) Carry out visual inspection & randomized interviews with community to identify if any unrecorded grievances occurred	Ongoing Monthly Compilation Records	Substations	Transfer of 100% of O&M wastes documented, and all wastes disposed of in an environmentally safe and sound manner in accordance with the EMP and IFC General EHS Guidelines with no grievance received related to waste disposal unresolved	NEA O&M team to undertake monitoring and report to PMU in monthly and quarterly progress reports with records provided	Check monitoring being undertaken, review records, conduct Inspection and interviews with the community and document compliance in EMR



Environmental Monitoring Plan

Project Activity or Environment Impacts/ Risks	Monitoring Parameters	Method of Monitoring including Standards/ Guidelines	Frequency and Timing	Location/ Components	Performance Indicator	Implementation	Supervision (NEA PMU)
Drinking Water Supply	GON drinking water standards	Drinking water tests from supplier Carry out visual inspection	Ongoing Monthly Compilation	SS, DC and DRC sources of drinking water for operation for which supplier can provide copies of drinking water tests to confirm compliance.	GON drinking water parameters	NEA O&M team to undertake monitoring and report to PMU in monthly and quarterly progress reports with test reports attached	Check monitoring being undertaken, review records, inspections and interviews with workers and document compliance in EMR conduct



Labor Camp Standards to be Complied by The Contractor During Implementation

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Annex-B

The following sample of construction and labor camp standards should be attached with bidding document, contract agreement, and SEMP approved by Engineer.

1. General

- SEMP shall include a "Camp Management Plan" with a Camp In-charge for maintaining clean and safe area free of garbage and waste and enforce workers Code of Conduct;
- Camp shall be located at an area with less than 30 degree slope and 300 ft away from waterbodies, water sources, historical areas, forest, and other sensitive areas;
- Camp shall be fenced with barbed wire or colored iron sheet, gated and guarded;
- Campsite shall be leveled, well drained with drainage around the perimeter; courtyard and pathways paved; area well-lit, and easily accessible by motorable road;
- Camp shall be on a stable foundation above flood level and shall not pollute waterbodies;
- Supply clean water at >10 liter per person per day for consumptive and 80 liters per person per day for non-consumptive purposes ensuring 48 hour reserve at all time;
- Supply electricity with circuit breaker, fuse protection, and double insulated electric wire;
- Keep oil, fuel, chemicals, and workshop away from living, cooking and dining area;
- Keep portable fire extinguishers or fire buckets in the camp ready to use during emergency;
- Provide recreational and sport facilities in the camp for the workers;
- Prohibit use of alcohol, smoking, gambling inside the camp;
- Remove camp, clean the area and leave in original condition after work completion.

2. Camp Structure

- Use preferably prefabricated camp structure on proper iron frame or brick/stone/concrete blocks, new colored iron sheet on iron frame. Restrict use of plain and old/rusted CGI sheet, tarpaulin and wooden or bamboo frame to construct camps;
- Use of readymade canvas tents could be conditionally approved by Engineer for temporary workers camp for linear work or for quarantine/isolation purpose;
- Ceiling height of cabins shall not be less than 7 ft., doors 6 ft. high and 3 ft. wide, and minimum 20 sq. ft. window/ventilation opening for a room of 12 ft. x 10 ft. size;
- Cabins shall have raised plinth above flood level, paved impervious floor;
- Roof should be of waterproof colored iron or PVC sheet or RCC structure;
- All doors and windows shall have locking system and are fitted with mosquito net.

3. Rooms/Cabins

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- Provide not less than 30 sq. ft. area per person and not more than 8 person in a room;
- Provide separate cot (no double-deck beds) with mosquito net for each worker with bedding suitable to local weather. Sleeping on floor shall be strictly prohibited;
- Beds shall be spaced at least 3 ft. apart and elevated at least 3 ft. from the floor;
- Arrange separate room for female workers and workers with spouse;
- Room will have facility of electricity and fan.

4. Kitchen and Dining

- Arrange well ventilated kitchen in the camp equipped with LPG burner on elevated cooking platform, clean store, and paved floor (PCC or tiled);
- Cooking gas cylinders should be kept at safe distance (at least 10 feet away) from cooking stove and preferably in an enclosed space outside of kitchen structure.
- Arrange minimum 10 sq. ft. per person dining area in a separate room or open shed on impervious floor with sufficient dining tables and chairs (restrict eating on floor);
- Arrange a hand washing basin, dish cleaning and drying area;
- Arrange kitchen waste disposal and wastewater discharge system with sump well;
- Prohibit cooking and eating meals in the cabins;
- Arrange proper garbage bins with lid and keep at least 100 ft. away from the cabins, dining and kitchen area. Use organic waste to recycle as compost for using in gardens, and arrange municipal waste collection service to collect remaining waste.

5. Sanitation

- Arrange toilets and bathing facility at minimum 1 toilet for 15 people of a size larger than 5 ft. x 3 ft. at 100 ft. away from cabins, kitchen and dining, and waterbody;
- Separate toilet and bath shall be provided for female workers away from men's toilet;
- Toilets shall be of rigid material on elevated impervious floor (at least 1.5 feet from ground level) with lock. Restrict use of plain CGI sheet, tarpaulin, sacks, bitumen drums. Restrict open bathing;
- Toilets shall use pan (not commode), have septic tanks before discharging (sewer or rivers);
- Toilet and bathing rooms shall have sufficient light and ventilation;
- Handwash facilities with soap and water shall be arranged at shelter, dinning and work sites;
- If a tubewell is used, the area shall be clean and have a paved platform with drain.

6. Medical Facility

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- Establish a medical facility in the camp with emergency supplies & medications
- Arrange a full-time medical staff to operate the medical facility;
- Keep first aid box at labor camp and key work areas with sufficient supplies;
- Train workers group leaders on application of first aid in case of injury and emergency;
- An emergency protocol shall be established with name and number of immediate person to contact, address of nearest medical facility in local language, and standby ambulance;
- Mandatory screening of health of workers before induction and periodically during work;
- Aware workers and staff on communicable and sexually transmitted diseases;
- Prepare emergency evacuation plan and evacuation/assembly points, make all staff and workers aware about it, and conduct periodic drills;
- Keep sufficient informative and safety signboards suitable to type of work (electricity, carpentry, mason, welding, fabrication etc.) in the camp and work site to keep workers aware of safety requirements to follow during work.



ANNEX C Drawings (for tender purpose only)













E







A





















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SCALE

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