NEPAL ELECTRICITY AUTHORITY

(An Undertaking of Government of Nepal)
Project Management Directorate

CHOVAR-PATAN-CHAPAGAUN 132kV UNDERGROUND TRANSMISSION LINE PROJECT

A component of
Electricity Grid Modernization Project-Additional Financing

BIDDING DOCUMENT
FOR

Procurement of Plant for
Design, Supply, Installation and Commissioning of 132kV underground line from Chobhar Substation to New Patan Substation(Package A1.1)

Single-Stage, Two-Envelope
Bidding Procedure

Issued on:	**May 08, 2023**
Invitation for Bids No.:	**PMD/EGMPAF/CPCUGTLP-079/80-02**
ICB No.:	**PMD/EGMPAF/CPCUGTLP-078/79-02**
Employer:	**Nepal Electricity Authority**
Country:	**Nepal**

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Chovar-Patan-Chapagaun 132kV Underground Transmission Line Project
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CHAPTER 1 – PROJECT SPECIFIC REQUIREMENT (PSR)

FOR

132kV Underground Line from Chobhar to New Patan Substation

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ANNEXURES

CHAPTER 1- Project Specific Requirement

1.0 GENERAL

Nepal Electricity Authority (NEA) intend to construct new 132kV underground transmission line from 132kV Chobhar substation(under construction) upto New Patan Substation.

This specification describes the requirements for construction of the 132kV underground transmission line from 132kV Chobhar substation(under construction) upto New Patan Substation on a turnkey basis.

Patan substation is existing 66kV substation(being upgraded to 132kV GIS substation) and Chobhar substation is under construction 132kV substation .

1.1.1 NEA is the Executive Agency for EGMP-AF (Electricity Grid Modernization Project – Additional Financing).

1.1.2 The Project will be supervised by the PSC Consultant, which has been appointed.

1.1 SAFETY MEASURES

The Contract Price shall include the cost for all necessary safety and health procedures to be taken by Contractor and Sub-Contractors under the Project, including following safety measures (not limited to): The Contractor shall submit to the Project Manager the work program including concrete safety plans to be done by Contractor (and Sub-Contractors) for protection of general public from accidents and for prevention of traffic accident in the project sites. - “Health & Safety (Accident Prevention) Officer” shall be continuously stationed in the project construction site throughout the construction period.
- In case power shutdown of existing facility of NEA is required for Contractor’s works, the Contractor shall submit a safety and work plan and request the power outage at an appropriate time, subject to approval of Chief of Relevant Department of NEA.
- The Contractor shall immediately notify to the Project Manager in case any fatal, major or other accident, which may involve serious injuries, occurs during the period throughout implementation of Project.
Before the excavation for trenches, the area must be properly barricaded with hording boards and secured from outside excess. Hording board used for barricading should be properly fastened to the ground. Further, to allow movement of commuters, backfilling shall be done as soon as necessary length of pipe are laid in trench for easy and quick accessibility of traffics.

1.2 COORDINATION AND COOPERATION WITH OTHER CONTRACTS

The Contractor shall cooperate with the Employer and other contractors to ensure the satisfactory completion of the Project. The Contractor shall be responsible for design on the Plant interfacing with any items of equipment which will be installed by other contractor(s), when needed.
The Project Manager may call a coordination meeting(s) with other contractors. The Contractor shall dispatch qualified engineer(s) and settle all design parameters, interface conditions and other matters by these coordination meetings. The necessary expenses such as round-trip international air ticket, accommodation, inland travel charge, etc shall be borne by the Contractor, and such a cost shall be deemed to be included in the Contract Price.

1.3 INTENT OF SPECIFICATION

1.3.1 This specification covers the execution of works for the subject package, by establishing

a. The scope include construction of new 4.5 km length or as indicated in the BPS 132kV underground double Circuit line from Chobhar Substation(Under Construction) to New Patan substation.

1.3.2 It is the intent of this specification to describe primary features, materials, and design & performance requirements and to establish minimum standards for the work. The specification is not intended to specify the complete details of various practices of manufactures/ bidders, but to specify the requirements with regard to performance, durability and satisfactory operation under the specified site conditions.

2.1 SCOPE (for Underground Transmission Line portion)

2.1.1 The broad scope of this specification covers the following substations and other equipment.

2.1.2 Basic Requirements

Civil Works	External electrical Works	Transformers	Switchgear	Design and Integration
Transmission line route cable laying in duct, joint pits, precasted RCC cover, cable bridge, restoration/upgradation of road as per department of road norms etc,.	All equipment necessary to construct underground T.L. of 132 kV supply			The underground cabling works with necessary cable bridge shall be designed by the contractor and shall follow NEA requirements.

2.1.3 Construction of a 132 kV double circuit 800 sq.mm XLPE cable transmission line from Chobhar Substation(Under Construction) to New Patan Substation, complete as per Diagram & as indicated in BPS:

The detailed scope of work is brought out in subsequent clauses of this chapter.

2.1.3.1 Design, engineering, manufacture, testing, supply including transportation & insurance, storage, erection, testing and commissioning of following equipment and items complete in all respect:

a) **145kV Termination:-**
At Chobhar Substation:

AIS cable termination with Surge Arrestor.

At Patan Substation:
GIS cable termination Arrangement (Male/Female Termination with accessories as required). GIS to be connected by 800 Sq mm Copper XLPE cable.

b) 145 kV grade XLPE Power cables, minimum Straight Through Joints, Insulation Joints, cross bonding, earthing, link boxes along with complete accessories, termination requirement at Chobhar and New Patan as necessary, suitable for GIS termination.

c) Underground Optical Fibre cables (48 core) along with all accessories, Testing of underground optic fibre and provision of the OTDR test results for the overall complete lines

d) HDPE Pipes/Flexible Corrugated Pipes/PLB HDPE and other necessary pipes along with all accessories.

e) Detail GPS/GPR survey and complete designing (Underground) lines including civil works.

f) Undergrounding and laying of EHV Power cables, Optical Fiber, DAS & DTS system (for cable monitoring & protection) using open excavation and Trenchless boring methodology(HDD) wherever applicable. Where open excavation is not possible/permitted, with Employers approval trenchless boring (Horizontal drilling) shall be used for undergrounding works.

g) The scope of work shall also include the design and laying of spare cable system with duct and it should be such that in case of failure of any one cable, there should be provision for easy replacement of faulty cable with the spare cable. The Contractor should provide justifiable design of spare cable with full functional guarantee without derating in performance. If the functional guarantee and design cannot be provided, the Contractor should give justifiable clarification with Alternatives in Design for quick replacement of faulty cable minimizing the breakdown time.

h) Installation, laying, splicing and termination of Optical Fibre Cables to establish communication network for SCADA communication system.

i) Installation of DAS & DTS system and necessary accessories, processor panels for cable monitoring, protection and fault detection and its integration to existing SCADA system of Substations.

j) Mandatory Spares, Training as per **BPS** (Bid Price Schedule).

k) Any other equipment/material required to complete the specified scope of work. Any minor electrical/communication equipment/items which are not mentioned in the bidding documents but are required for the successful completion of the project shall be in the scope of contractor for which no extra payment will be made.

2.1.3.2 **Civil Works** - The scope of work shall include but shall not be limited to the following based on design and drawings to be developed by the contractor:- (where applicable as per the BPS)

a) All civil works for minimum trench excavation with required protective measures for cable laying including RCC precast cover, laying of warning tape, foundations associated with equipment support structure and cable joint pit and earthing.

b) Pile foundation, Foundation for Cable Bridge (structure) to cross the rivers, streams, wherever if required.

c) Supply of structure for Cable Bridge, and other structure.

d) Cable trenches inside substation compound.

e) Soil investigation.

f) Restoration/upgradation work of roads, sidewalks/footpath (all type) (when and as required) as per specification of relevant road department

g) Any minor electrical/communication equipment/items which are not mentioned in the bidding documents but are required for the successful completion of the project shall be in the scope of contractor for which no extra payment will be made.

h) Charges if any be paid to the Road, Sewage or any other Government bodies as per the requirement of the works under the scope of the Contractor will be borne by the NEA on actual cost basis. Initially the requisite charges are to be deposited by the Contractor with the concerned department. The same shall be reimbursed to the Contractor on production receipt of such deposited amount after completing the work for which the amount is paid. However, any damages to the existing facilities of NEA and

other utilities incurred by the Contractor during the construction process shall be borne by the contractor.

i) The contractor will manufacture/lay the underground power cable in such a fashion that no straight through joints are required and only end terminations joints are required. However, in exceptional circumstances straight through joints may be allowed with justifiable clarification from the Contractor. The number of straight through joints and Joint Pit shall be minimized in considering optimum design. Similarly, proposed Straight Through Joints number, Cable length schedule, joint pit number and its location should be approved from the Employer taking consent of relevant authorities such as Road Department, Municipality etc,. The Contractor should lay extra cable at terminations and Joints in joint bay through snake laying with clamping accessories considering easy maintenance when there is fault at joints and terminations.

j) The General information for laying of XLPE Cable, optical fibre cable is as specified. However, the methodology of laying shall be documented in details and shall be submitted along with inception report for approval.

k) The cable route markers, at a maximum distance of 50 meters, and danger boards/warning tapes shall be provided for the information of all concerned and for their safety. Any additional requirement in terms of safety perspective shall be provided by the contractor without any extra cost. The cable route marker shall also be visible during night.

l) It is the responsibility of the contractor to maintain the required statutory clearances from other utility services. Any damage caused to any utility services/ human life / public property etc. shall be the sole responsibility of the contractor.

m) The methodology of laying shall be documented in details and shall be submitted along with inception report for approval.

Preferable methodology for cable trench:

S.N	Cable Route Methodology	Preference
1	Along the Road/Along the road with charged line	Excavation/Manual Excavation
2	Road crossing	Excavation/HDD Excavation
3	Highway Crossing	HDD
4	Canal/river crossing	Cable bridge/HDD
5	Along the Canal	Cable bridge/HDD
6	Inside substation	Concrete cable trench

N.B. For Road crossing excavation will be preferred and for Canal/river crossing cable bridge will be preferred. However, if it is not allowed by the respective authority then HDD methodology shall be used with approval from the Employer. Quantity of HDD work for any double circuit cable line section shall be measured from one pit to another pit horizontally.

n) Contractor shall work during day and night as instructed by the Employer. Contractor shall not leave any trenches or pits open for more than 24 hours from the time of excavation. For critical working site, employer may instruct to the contractor to complete particular section of the work within 6 hours so that there will not be any hindrances for vehicle and pedestrians. The trench or pits are to be covered with rubber mat such that dust pollution is minimal. The cost of rubber mat (on returnable basis) shall be borne by Contractor. The traffic management activities shall be responsibility of the Contractor and its associated cost shall be loaded in the BPS.

o) The Contractor shall not start the work of excavation/drilling/boring without having permission/consultation from the Employer. Each and Every excavation/drilling/boring work shall be restored to its original state (along with the black top wherever required) within 10 (ten) days of excavation.

p) Any property belongs to public or government (e.g. water pipe, tele communication cable, power cable, sewerage pipe, road, footpaths etc:) damaged during the excavation/drilling/boring or during construction shall immediately be restored by the Contractor without any cost to Employer.

2.1.3.2.1 Restoration/upgradation of Road:

i. The laying of the power and optical cables and other works may require digging alongside/ across the roads/ streets/ pavements/ or any other public/private area. The contractor has to restore the dugout area by back filling and suitable compacting and upgrade the road as per the requirement. The top layer (hexagonal blocks, bricks, stones, kerb-stones etc.) has to be restored in the same fashion and condition to give it the original look. All above works shall be as per the norms and standards of Department of Road, GoN (http://dor.gov.np/home/publication/standard-specification-of-roads-and-bridges/standard-specifications-for-road-and-bridge-works-2-73) / norms and standard of associated municipality in the earliest possible time. The inspection of the restoration/upgradation works shall be carried out as per the norms of the road department in presence of representative nominated by the relevant road department.

ii. The cost associated with restoration/upgradation work except as indicated in BPS shall be loaded in the respective bill of quantity (BOQ) items of the bid price schedule. No payment towards any additional material, other than that provided in the Price Schedules, approved drawing incurred on labour / erection/ services etc. required for,

a) All other requirement to complete Work like fixing of danger plate, phase plate, number-plate, anti-climbing device (if applicable) etc. are properly installed.

b) The electrical and communication systems are tested satisfactorily before commissioning.

2.3 The bidders are advised to visit the transmission line routes and acquaint themselves with the topography, infrastructure and also the design philosophy. Before proceeding with the construction work of the line, the Contractor shall fully familiarize himself with the site conditions and General arrangements & scheme etc. Though the Employer shall endeavor to provide the information, it shall not be binding for the Employer to provide the same. The bidder shall be fully responsible for providing all equipment, materials, system and services specified or otherwise which are required to complete the construction and successful commissioning, operation & maintenance of the underground transmission line in all respects. All materials required for the Civil and construction / installation work shall be supplied by the Contractor. The cement and steel shall also be supplied by the Contractor.

The complete design **(unless specified otherwise in specification elsewhere)** and detailed engineering shall be done by the Contractor based on conceptual tender drawings. Drawings for civil works enclosed with tender drawings are for information only. However civil drawings shall be developed by the contractor as per his design.

2.4 The Contractor shall also be responsible for the overall co-ordination with internal / external agencies, project management, training of Employer's manpower, loading, unloading, handling, moving to final destination, testing and commissioning of the underground transmission line.

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

3.0 SPECIFIC EXCLUSIONS

The following items of work are specifically excluded from the scope of the specifications for all substations:

(a) Employer's site office

4.0 PHYSICAL AND OTHER PARAMETERS

4.1 Location of the Underground cable –

New Patan substation is 66 kV AIS substation undergoing upgradation to 132 kV GIS Substation located in Lalitpur district and Chobhar substation is 132 kV GIS substation which is under construction and located in Kathmandu District within Kathmandu Valley.

4.2 Meteorological data :-

a) Altitude above sea level :

1420m from MSL

b) Ambient Air Temperature :

45ºC(max)/ 0 ºC(min)

c) Average Humidity (in %) :

95 (max), 40(min)

d) The substation locations are lying in the wind speed Zone 4 i.e. 47m/s.

However, for design purposes, ambient temperature should be considered as 50 degree centigrade and Relative humidity 100% for all the substation.

4.3 The fault level of all equipment to be supplied under present scope shall be as indicated below:

S.NO.	Voltage Level	Fault Level
1	220kV	40kA for 1 Sec
2	132kV	31.5kA for 1 Sec
3.	66kV	31.5kA for 1 Sec
3	33kV / 11kV	25kA for 1 Sec

5.0 SCHEDULE OF QUANTITIES

The requirement of various items/equipments and civil works are indicated in Bid price Schedules.

All equipments/items and civil works for which bill of quantity has been indicated in BPS (Bid price Schedules) shall be payable on unit rate basis/quoted rate basis. During actual execution, any variation in such quantities shall be payable as per relevant clauses incorporated in Letter of award.

Wherever the quantities of items/works are indicated in LS/Lot/Set, the bidder is required to estimate the quantity required for entire execution and completion of works and incorporate their price in respective Bid price schedules. For erection hardware items, Bidders shall estimate the total requirement of the works and indicate module-wise lump sum price bay wise and include the same in relevant Bid price schedules. For module identification, Bidder may refer typical drawings enclosed with the specifications. Any material/works for the modules not specifically mentioned in the description in BPS, as may be required shall be deemed to be included in the module itself.

The detailed bill of quantities of the mandatory spares is as per BPS.

Bidder should include all such items in the bid proposal sheets, which are not specifically mentioned but are essential for the execution of the contract. Item which explicitly may not appear in various schedules and required for successful commissioning of substation shall be included in the bid price and shall be provided at no extra cost to Employer.

6.0 BASIC REFERENCE DRAWINGS

6.1 Single line diagram and general arrangements are enclosed with the bid documents for reference, which shall be further engineered by the bidder.

6.2 The reference drawings, which form a part of the specifications, are given at **Annexure-I.** The bidder shall maintain the overall dimensions of the substation, phase to earth clearance, phase to phase clearance and sectional clearances.

The enclosed drawings give the basic scheme, layout of substations, cable trench section at road etc. In case of any discrepancy between the drawings and text of specification, the requirements of text shall prevail in general. However, the Bidder is advised to get these clarified from Employer.

7.0 ORDER OF PRECEDENCE OF DIFFERENT PARTS OF TECHNICAL SPECIFICATION

For the purpose of present scope of work, technical specification shall consist of following parts and they should be read in conjunction with each other.

1.	Chapter 1 : Project Specific Requirement	
2.	Chapter 2: General Technical Requirement (GTR)	
3.	Chapter 3 : Switchgear,Surge Arrestor	
4.	Chapter 4: Power and Control Cable	
5.	Chapter 5: EHV XLPE Power Cable	
6.	Chapter 6: Structure	
7.	Chapter 7: Civil Works	
8.	Chapter 8 : Technical Specification for HDPE Pipe and Flexible Pipe	

9.	Chapter 9: Technical Specification for Fiber Optic Cable and PLB Duct	
10.	Chapter 10: Switchyard Erection	
11.	Chapter 11: Technical Data Sheet	

In case of any discrepancy between Chapter 1-PSR, Chapter 2-GTR and other technical specifications on scope of works, Chapter 1 - PSR shall prevail over all other chapters.

In case of any discrepancy between Chapter 2-GTR and individual chapters for various equipments, requirement of individual equipment chapter shall prevail.

8.0 SPARES

Mandatory Spares

The Mandatory Spares shall be included in the bid proposal by the bidder. The prices of these spares shall be given by the Bidder in the relevant schedule of BPS and shall be considered for evaluation of bid. It shall not be binding on the Employer to procure all of these mandatory spares.

The bidder is clarified that no mandatory spares shall be used during the commissioning of the equipment. Any spares required for commissioning purpose shall be arranged by the Contractor. The unutilized spares if any brought for commissioning purpose shall be taken back by the contractor.

9.0 SPECIAL TOOLS AND TACKLES

The bidder shall include in his proposal the supply of all special tools and tackles required for operation and maintenance of equipment. The special tools and tackles shall only cover items which are specifically required for the equipment offered and are proprietary in nature. However a list of all such devices should be indicated in the relevant schedule provided in the BPS. In addition to this the Contractor shall also furnish a list of special tools and tackles for the various equipment in a manner to be referred by the Employer during the operation of these equipment. The scope of special tools and tackles are to be decided during detail engineering and the list of special tools and tackles, if any shall be finalized.

10.0 FACILITIES TO BE PROVIDED BY THE EMPLOYER

10.1 Employer may available the auxiliary HT power supply from NEA on chargeable basis at a single point in the Sub-station. The prevailing energy rates of the state shall be applicable. All further distribution from the same for construction and permanent auxiliary supply shall be made by the contractor. However, in case of failure of power due to any unavoidable circumstances, the contractor shall make his own necessary arrangements like diesel generator sets etc. at his own cost so that progress of work is not affected and Employer shall in no case be responsible for any delay in works because of non-availability of power.

10.2 Employer may available construction water supply at a single point in the site. All further distribution for the same shall be made by the Contractor. In case of non-availability or inadequate availability of water for construction work, the contractor shall make his own arrangement at his own cost and the Employer shall in no case be responsible for any delay in works because of non-availability or inadequate availability of water.

10.3 If minor repair & restoration of the approach roads and strengthening of bridges are required for transportation of materials and equipment, the contractor shall include such cost in the price schedule for respective items.

11.0 SPECIFIC REQUIREMENT

11.1 The Bidders are advised to visit site and acquaint themselves with existing facilities, the topography, infrastructure, etc.

11.2 The bidder shall be responsible for safety of human 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 Employer.

The Contractor shall arrange all T&P (such as necessary supports, cranes, ladders, platforms etc.) for erection, testing & commissioning of the system at his own cost. Further, all consumables, wastage and damages shall be to the account of contractor.

11.5 Erection, testing and commissioning of equipment's, Cable Termination, Surge Arrestor, Cables, Cable monitoring and Protection System, required Panels, shall be done by the contractors under the supervision of respective equipment manufacturers. Charges for the above supervision shall be included by the bidder in the erection charges for the respective equipment in the BPS.

11.6 The Contractor shall impart the necessary training to Employer's Personnel as per following details:-

- **Training at Manufacturer's works**. The Contractor shall include in the training charges (i) Accommodation Charges (ii) payment of per Diem allowance to NEA trainees @ as per NEA Financial Regulation per day per trainee for the duration of training abroad towards accommodation, meals and other incidental expenses and (iii) to and fro economy class air ticket from Nepal to place of training. The duration of training shall be excluding travelling period.

  The training shall be provided in the field of design, testing and maintenance at Manufacturer's works for 04 (four) persons as per following:-

S. No.	Description of training	No of days	No. of Trainees
1	Cable Termination	5 Days	4
2	Cable Jointing	5 Days	4

- **On Job Training in Nepal:** The traveling and living expenses of Employer's personnel for the training programme conducted in Nepal shall be borne by the Employer. The Contractor shall provide per diem expense of NRs 1000 per day for the training days per Employer's personnel involved in training.

  The training shall be provided to Employer's personnel in the field of erection, testing, operation and maintenance at each substation site as per following:-

S.No.	Description of training	No of days
3	Power Cable Termination and jointing	5 Days
4	DTS, DAS system	5 Days

The cost of training for jointing and termination in both abroad and Nepal shall include necessary jointing kits and termination kits for effective technology transfer to the trainees.

11.7 The reference of IS standard (i.e. Indian Standard) mentioned in the technical specification shall be read as equivalent IEC or BS or equivalent International Standard.

11.8 LIST OF PREFERED SHORTLISTED MAKE/MANUFACTURER:

"It is preferred that the equipment be supplied from the manufacturers listed in **ANNEXURE-II** for mentioned equipments/items.
The bidders may offer equipment/brands other than those listed in **ANNEXURE-II**, that are better or equivalent with regard to quality and performance substantiated with appropriate documents.

11.9 In specification all parameters mentioned are corresponding to less than 1000 Mts MSL. However for all equipments (including transformer), all design parameters including air clearances, external insulation etc,. shall be corresponding to altitude of 1420 Mtr from MSL in (accordance to IEC) considering altitude correction factor.

12.0 PRECOMMISSIONING, COMMISSIONING, TRIAL-RUN & COMPLETION

As soon as the Facilities covered by these specifications are physically completed in all respects, the Pre commissioning, Commissioning, Trial-run and Completion of the Facilities, as mentioned below, shall be attained in accordance with the procedure given in the Conditions of Contract, Vol.-I of the Bidding Documents.

(i) Pre commissioning **:** As per relevant Chapters

(ii) Commissioning : Charging of the Facilities at rated voltage

Further, wherever appearing in these specifications, the words – 'commissioning checks', 'installation checks', 'site tests', 'performance guarantee tests for fire protection system', are to be considered as 'pre commissioning checks'.

(iii) Trial-run : Operation of the Facilities or any part thereof by the Contractor immediately after the Commissioning for a continuous period of 72(Seventy two) hours continuously. In case of interruption due to problem / failure in the respective equipment, the contractor shall rectify the problem and after rectification, continuous 72(Seventy two) hours period start after such rectification.

(iv) Completion : Upon successful completion of Trial-run.

'Guarantee Test(s)' and/or 'Functional Guarantees' are applicable only for Substation Automation System as specified in Chapter-'Substation Automation System.'

Note: The Contractor shall do the necessary calculations for relay setting required for Pre-commissioning, Commissioning, Trial-run and Completion for the substations under the scope of this Contract. All the relay setting calculations required for the substations (in this scope) with related to Integrated Nepal Power System (INPS) shall be done by the Contractor.

13. Social Safeguard and Environment Management Activities

The Contractor shall prepare Social Safeguard and Environment Management Plan and the same shall be implemented during execution of the Project. The following major activities shall be considered:

Demarcation, signing and closing of worksites: Setting up warning signs at worksites to limit the access of persons, machinery and equipment into construction areas and confine the works related to the construction process to the allocated areas.

Disruption of pedestrian and automobile traffic: Traffic management is the responsibility of the Contractor without any cost to the Employer. Further,when trenches are opened along the road, they should be barricaded, fenced off and warning signs placed at the worksites to ensure the safety of pedestrians, motorists and the staff carrying out the works.

There must be continued access to land and buildings located along trenches through installation of secure and clearly signalled temporary structures. This also applies to trenches that cut across the roadways.

Upon completion of the underground cable installation, the trenches should be resealed and the pavement repaired as soon as possible, to ensure its durability and the absence of irregularities that may present a traffic hazard.

Regular sprinkling of water shall be done to avoid dust pollution till the roads/sidewalks are reinstated.

Restoration of sites: After the infrastructure has been put in place and the construction sites and equipment depots cleared, the sites should be rehabilitated without undue delay in the original condition or better, unless there are plans for future use requiring that such sites be left in their current state.

Access to private property: Contractor shall coordinate with the Employer for the access of private property, if required. Crossing of private property shall be subject to prior notification to the owners and conducted in such a manner as to minimize damage to crops or other property on the land.

Restoration or damage compensation: If the works on private property cause damage to crops or other property, the Contractor must proceed with the repair of such damage or, where this solution is not sustainable, with the fair and timely compensation to the owners.

Management of material from digging trenches: Uncontaminated soil from excavations will be reused to backfill the trenches of underground lines. Any such soil that cannot be reused is deemed to be waste and must be conveyed to its final destination. Its uncontrolled spread is prohibited in places where it could cause damage. Minimum dust on ground policy is to be used to prevent dust associated pollution after the construction.

Public information on electrical hazards, behaviour and preventive measures: Before switching on the infrastructure installed as part of the project, the neighbouring populations should be informed in good time, through public meetings and/or distribution of information leaflets. The information provided to them should focus on the electrical hazards associated with the infrastructure and the behaviour that would allow them to avert such hazards. The population of these areas should be particularly targeted.

Labour recruitment: The Contractor shall give preference to the use of local and regional labour provided that it is consistent with the requirement of good workmanship based on the need of the project.

Staff training and sensitization: At the beginning of works the Contractor shall organize training and awareness-raising workshops intended for his teams to improve their understanding to prevent or minimize the impact of their activities on the environmental and social aspects to promote good relations with the local people.

Among others topics addressed should also include the following:

Likely environmental impact of works, good practices, preventive and corrective measures to be adopted; Rules and procedures for waste management at construction sites; Safety risks associated with the works, and preventive attitude to adopt; First aid and what to do in case of accident; General standards concerning relations with the local people; Risks and prevention of sexually transmitted diseases. The training and awareness sessions should be organized whenever new workers are recruited. Feedback and training during the works and after the monitoring and control exercise, additional training and awareness activities may be necessary if it happens that the previous sessions had failed to achieve the desired effects.

Discovery of relics of historical and archaeological importance: In the unlikely event of discovery of historical relics, the works will be interrupted temporarily and the discovery notified to the local authority responsible for cultural heritage in order to determine the appropriate course of action.

Storage and handling of hazardous substances: Hazardous substances such as oils, lubricants or other hazardous substances likely to contaminate surface or ground water and soil should be stored or handled in premises specially designed for this purpose, in order to protect the environment and human health. If the handling of oils and fuels is necessary, demarcated and waterproofed areas must be provided.

Maintenance of equipment: Maintenance of equipment should not be performed immediately at the work site as far as practicable.

Air quality and noise pollution: Care must be taken to ensure that all equipment, machinery and vehicles used for works and equipped with a combustion engine are in good working conditions to limit undesired emission of air pollutants and noise nuisance.

Construction works that could cause noise should be performed only outside normal rest hours near residential areas. When noisy works must be carried out close to schools or other noise-sensitive receptors, working hours should be so scheduled as to limit the nuisance caused.

It is forbidden to burn in the open any kind of household, industrial and toxic or hazardous waste, project induced waste and all types of scrap metal.

Transportation of equipment: Equipment for overhead lines will be transported by existing roads up to the point nearest to the installation site. Thereafter, it will be transported manually to the site without opening up any access paths. When crossing the land between roads and installation sites, care should be taken not to damage vegetation, agricultural land or any other property on the land.

Erection and installation of Poles/Equipment: Vegetation should be removed only in so far as strictly necessary for opening foundations for poles/equipment and for such other operations as may be performed at each spot.

When erecting and installing the poles/equipment, necessary precaution should be taken to minimize the impact on adjacent areas.

Unrolling of cables: When cables are being unrolled, necessary precaution should be taken to prevent impact on tree vegetation, crops and other property on the land crossed by the cables. If necessary, temporary gantry-like structures should be used to facilitate crossings.

Restoration or damage compensation: If the works on private property cause damage to crops or other property, the Contractor must proceed with the repair of such damage or, where this solution is not sustainable, with the fair and timely compensation of the owners. Management of material from digging trenches: Uncontaminated soil from excavations will be reused to backfill the trenches of underground lines. Any such soil that cannot be reused is deemed to be waste and must be conveyed to its final destination. Its uncontrolled spread is prohibited in places where it could cause damage. Minimum dust on ground policy is to be used to prevent dust associated pollution after the construction.

Disruption of pedestrian and automobile traffic: When trenches are opened along the road, they should be barricaded, fenced off and warning signs placed at the worksites to ensure the safety of pedestrians, motorists and the staff carrying out the works.

There must be continued access to land and buildings located along trenches through installation of secure and clearly signalled temporary structures. This also applies to trenches that cut across the roadways. Upon completion of the underground cable installation, the trenches should be resealed and the pavement repaired as soon as possible, to ensure its durability and the absence of irregularities that may present a traffic hazard. Regular sprinkling of water shall be done to avoid dust pollution till the roads/sidewalks are reinstated.

Public information on electrical hazards, behaviour and preventive measures: Before switching on the infrastructure installed as part of the project, the neighbouring population should be informed in good time, through public meetings and/or distribution of information leaflets. The information provided to them should focus on the electrical hazards associated with the infrastructure and the behaviour that would allow them to avert such hazards. The population of these areas should be particularly targeted. Unanticipated Impacts identified during the construction should be mitigated in coordination with environmental and social monitors employed by Contractor, Consultant and Government separately.

Sensitive Areas: From an environmental point of view, wetlands, swamps, and bogs should be avoided when planning underground cable as these habitats may suffer severe or even irreparable harm. Also sensitive water flows and archaeological sites should factor in route planning process.

Unanticipated Impacts identified during the construction should be mitigated in coordination with environmental and social monitors employed by Contractor, Consultant and Government separately.

All cost related to SSEMP,EMP activities shall be borne by the Contractor, the cost shall be included in the bid price (BoQ)

Additional EMP and required activities for its compliance that will be considered necessary by ADB to be implemented during the project preconstruction and construction stages are attached in ANNEXURE III.

14. Safety of Personnel

The maximum safety consistent with good erection practices in the case of work above ground must be afforded to personnel directly engaged under this contract. Reasonable measures shall be taken to afford adequate protection against material falling from a higher level onto personnel below.

15. Guarantee/Warranty

The Contractor shall correct, without any delay and at its own expense, at any portion of the Work during defect liability period and extended defect liability period including any required correction in defective design, errors, omissions, or changes in documentation, or by providing a non-defective replacement within 3 days of notification of the problem.

The costs of replacement shall be at the Contractor's expense and shall include all shipping costs, duties, fees, and taxes, both to and from the Contractor's facility, and the appropriate technical advice and direction for removal of the defect and installation of the corrected Work including On-Site Services as required. In the event the System or any portion thereof, is down, the Contractor will begin the dispatch process of appropriate personnel as specified.

The Contractor's liability shall be limited to adjusting, repairing, or replacing the defective article(s) and providing technical support and direction in the correction of the Work. In case of replacement of the equipment on or after 2 year a new warranty period shall apply, such new warranty period shall expire on the date 12 months from the date of such replacement, repair, or modification.

If the Contractor shall fail to correct any defect within a reasonable time, Employer shall have the right to employ others to do so. The Supplier shall be liable for all costs and expenses thereby incurred by Employer.

The Contractor shall furnish Employer with a Deficiency incident report upon completion of each visit by such Staff and upon resolution of each inquiry.

The Contractor shall provide to Employer, within 15 Days of the end of each calendar quarter, a list and description of all potential or actual problems.

16. Consultant for the Project

NEA has appointed TRACTEBEL, India as the post contract supervision consultant for this Project. The consultant shall be responsible for all work related to the supervision of the project including billing of the project.

ANNEXURE I

List of Drawings
(Refer Volume II)

ANNEXURE- II

LIST OF PREFERED (SHORTLISTED) MAKE

It is preferred that the following equipment be supplied from the manufacturers listed Here under:

(i) Main Protection Relays, Control &Relay panel, Substation Automation System from: ABB, AREVA / ALSTOM, SIEMENS, Fuji, Reyrolle, Toshiba, Mitsubishi, GE or equivalent.

(ii) Energy Meters from: ELSTER (ABB), ACTARIS (Schlumburger), EDMI, SIEMENS or equivalent.

(iii) *Temperature Indicators*: shall be from AB Khilstrom, Sweden or equivalent

(iv) Cable termination and joints: ABB, Raychem, Hitachi, Brugg, Pfisterer or Equivalent

The bidders may offer equipment/brands other than those listed above that are better or equivalent with regard to quality and performance substantiated with appropriate documents. The bidder is required to submit all technical information, brochures, test reports of the proposed equipment for assessing equivalence with the shortlisted vendor during the bid submission.

Annexure III - EMP Mitigation and Monitoring Plans

Table 1 Environmental Mitigation Plan

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
Project-wide EMP							
Detailed design and pre-construction preparations							
General							
Compliance with national regulations and international good practice guidelines.	Environment, health, and safety impacts and risks of the project in general	• NEA and Contractor to ensure compliance with national and international regulatory framework as set out in Section II of the IEE, including ADB Safeguard Policy Statement (2009), IFC EHS General Guidelines (April 2007), and IFC EHS Guidelines for Electric Power Transmission and Distribution (April 2007) plus other applicable environment, health and safety laws and regulations in force during project implementation, in addition to any further mitigation measures set out in this EMP.	No breaches of national regulations and/or international good practice guidelines.	PMD to comply with requirements throughout project implementation. PMD supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout contract implementation.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line
Grievance Redress Mechanism (GRM).	Environment, health, and safety impacts and risks of the project on affected persons; including construction workers and affected local communities	• NEA with support of Contractor to establish multi-level GRM as per Section VII of IEE, including identification of GRM Officers at all GRM levels and Grievance Redress Committee members. • NEA and Contractor to carry out community awareness raising during community meetings and one-to-one discussions about the GRM with directly affected persons before the commencement of works including details of how to submit a grievance to either NEA and/or the Contractor, consultations are to be documented. • NEA and Contractor to disseminate GRM contact details verbally and by SMS as well as through distribution of leaflets, and prominently posting GRM arrangements on noticeboards located at the project sites and at local NEA offices, project substations, community centers etc. • Contractor to carry out awareness raising amongst workers about the GRM at the start of their	GRM operationalized upon loan effectiveness, affected persons are aware of its existence and are actively using GRM to raise their grievances. 100% of grievances received are resolved in a timely manner by NEA and Contractor. Details of GRM operationalization including photos of awareness raising activities to be submitted in first	PMD to comply with requirements throughout project implementation. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout contract implementation.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing GRM as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		employment on-site, including details of how to submit a grievance to either NEA and/or the Contractor. Disseminate GRM contact details verbally and by SMS as well as through noticeboards located at temporary construction workers camps and construction site offices. • Contractor to ensure that throughout construction, signage is prominently visible detailing site and office contacts in case of grievance. • NEA and Contractor to encourage affected persons to make use of the GRM yet clarify that this does not prevent them from pursuing any legal action, if they feel that it is needed. • NEA and Contractor to inform communities about the ADB Accountability Mechanism and their possibility to resort to it if any of their grievance is not resolved by the project's GRM. • NEA and Contractor to keep record of grievances received and their resolution as report on these, as per Section VII of the IEE.	monitoring report, records and grievances and their resolution specified in subsequent monitoring reports.				
Environment safeguards staffing – see also site-specific measures for additional staffing requirements	Environment, health, and safety impacts and risks of the project in general	**PMD:** • NEA to operationalize the formal, fully functional environment and social safeguard safeguards unit within PMD and provide requisite facilities and equipment to enable its operation. • NEA to assign / start appointing suitably qualified and experienced environmental safeguards team, under the direction of the safeguards unit, to support EMP implementation and be responsible for undertaking regular on-site supervision and monitoring of the project. The environmental safeguards team for the project will comprise: (i) a full-time Senior Environment Officer, (ii) a full-time Senior Health and Safety Officer, (iii) a full-time Senior Biodiversity Officer, (iii) 2 full-time Junior EHS Field Officers, who are to be based on-site during the construction period, and (v) a full-time Community Engagement/GRM Officer. • PMD and environment safeguards team to oversee EMP implementation, providing guidance on corrective action as required, and recording	PMD environment and social safeguard safeguards unit has been operationalized. 100% of required staffing has been recruited to oversee EMP implementation during detailed design, pre-construction, construction, and operation & maintenance. PMD environment safeguards team and PSC shall be ready and on-board upon loan effectiveness.	PMD to comply with requirements by establishing environment and social safeguard safeguards unit within PMD and appointing required staff for the duration of the project. PMD to supervise and monitor contractor to ensure their compliance with these requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements and appoint required staff for the duration of their contract.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of safeguards staffing as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		construction activities and environment, health, and safety conditions on-site through photos and notes. • PMD senior officers to undertake at least monthly supervision visits as well as periodic "spot check" site visits to all contract packages whilst directing supervision efforts towards the most environmentally sensitive components of the project. **PSC:** • NEA to recruit PSC, including international environment safeguard specialist, international health and safety specialist, international biodiversity specialist, international heritage specialist as well as national equivalents in accordance with TOR agreed with ADB. • PSC to assist PMD to oversee EMP implementation, providing NEA and Contractor with guidance on corrective action as required, and recording construction activities and environment, health, and safety conditions on-site through photos and notes. • PSC to visit all contract packages at least semiannually during ongoing construction works whilst directing their supervision efforts towards the most environmentally sensitive components. **Contractor:** • Contractor to employ as part of the team delivering each package at least one suitably qualified and experienced, dedicated, environment officer and at least one suitably qualified and experienced, dedicated, health and safety officer responsible to be based on-site and monitor and supervise safeguards implementation on a day-to-day basis for the duration of the works. • Contractor to nominate a community engagement/GRM officer as part of the team delivering each package/lot to be based on-site and keep affected persons informed of the status of works and be available to receive and deal with any	Contractor environment safeguards team appointed upon commencement of contract, CVs for approval of environment safeguard team submitted as part of bid or subsequently for approval of NEA before field mobilization. List of staff and copies of CVs to be submitted in first monitoring report, any updates/changes in staffing specified in subsequent monitoring reports.				

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		grievances at the project site level, for all new transmission lines this will be a dedicated officer. • Contractor's environment safeguard team to oversee EMP implementation, providing guidance on corrective action as required, and recording construction activities and environment, health, and safety conditions on-site through photos and notes. • Contractor's environment safeguard team will be based on-site. • Contractor to ensure each active construction site or team has a project manager based on-site full-time who is nominated to the role of EHS Supervisor with responsibility for ensuring EMP implementation by their site/team, acting on the advice of, and reporting to the environment safeguards team on compliance. Project manager will be supported by full time OHS steward(s) for each construction site/team who will supervise all works. • NEA and Contractor should not discriminate and should proactively encourage the employment of suitably skilled women on the project.					
Biodiversity management – see also site-specific EMP	Impacts on biodiversity including biodiversity of Chure Conservation Area	• NEA will ensure that except for Dumkibas Substation and Chobar-Lagankhel Underground Transmission Line all other project components will be situated outside the boundaries and buffer zones of current or proposed protected areas and/or key biodiversity areas. • NEA will ensure that none of the project components including temporary construction facilities is situated within forest area. • Contractor's detailed designs and CEMP will be reviewed by the PSC International Biodiversity Specialist to confirm biodiversity impacts have been minimized before approval of detailed designs.	Project meets the SPS requirements for legally protected areas before issue of related bidding documents. Final IEE/EMP documents consultations and reflects the mitigation measures required by and support for promotion/enhancement measures agreed with the protected area management Detailed designs minimize biodiversity impacts, reflect	PMD to comply with requirements prior to issue of bidding documents, approval of detailed design and before the commencement of works. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor. PSC to help develop capacity of NEA and be responsible for reviews of Contractor's documentation.	Contractor to comply with requirements prior to approval of detailed design and before the commencement of works.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
			international good practice for "bird sensitive" design and respond to any concerns raised by Bird Conservation Nepal.				
Protected area management consultation and physical cultural resources management – see also site-specific EMP for Chobar-Lagankhel UG Line in Kathmandu Valley	Impacts on physical cultural resources of Kathmandu Valley Cultural, Religious and Archeological Sites from construction of Chobar-Lagankhel UG transmission line	• NEA will ensure that all project components are sited and designed to avoid significant damage to physical cultural resources. • NEA will ensure that none of the project components are situated within the boundaries or buffer zones of current or proposed World Heritage Sites or any other area of national archeological or cultural significance. • Contractor will confirm during detailed route surveys that no physical cultural resources of local importance fall in the footprint or right of way of the transmission lines.	Detailed designs minimize impacts on identified physical cultural resources and respond to concerns raised by their users.	PMD to comply with requirements prior to issue of bidding documents, approval of detailed design and before the commencement of works. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor. International Heritage Expert of PSC to help develop capacity of NEA and be responsible for reviews of Contractor's documentation.	Contractor to comply with requirements prior to approval of detailed design and before the commencement of works.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line
Meaningful consultations with affected people and other concerned stakeholders.	Environment, health, and safety impacts and risks of the project in general, community could be disrupted and disturbed by works hence they need to be consulted and kept well informed about the project and its progress	• NEA with the support of the PSC to prepare detailed communication/consultation plan upon loan effectiveness. • NEA will not award any contract for project components until meaningful consultation requirements are confirmed as met by ADB. • NEA to undertake additional meaningful consultations covering all project components with affected people and other concerned stakeholders such as Rural	Detailed communication/ consultation plan reflecting final EMP requirements developed upon loan effectiveness.	PMD to comply with requirements prior to issue of bidding documents and before the commencement of works.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and	Contractor to comply with requirements prior to the commencement of works, and then continue to remain actively involved with the	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		Municipalities as detailed in Section VI prior to the issue of bidding documents utilizing the agreed questionnaires. In particular, ensure all local affected communities within 500m of substations and the overhead transmission line and 100m of the underground transmission line have been informed of the project through NEA local offices and contact with village heads or equivalent, have had the opportunity to be actively involved in the design process and that any concerns raised have been duly addressed. For Kathmandu Valley component (Chobar-Lagankhel UG transmission line) assistance through the Kathmandu Valley Development Authority may be sought to keep affected communities informed of the project works. • For all new substations requiring permanent water supply etc. NEA to consult with and seek the agreement of local communities to use any community resources (e.g., water supplies, village ponds) to identify any potential conflict. If additional demand may place stress on community resources plan for alternative sourcing for these resources for project needs. • NEA to ensure the final IEE/EMP documents the consultations undertaken and demonstrates how concerns raised have been responded to. • During detailed route surveys, Contractor to consult one-on-one with all affected persons within ROW of transmission lines as well as all persons occupying properties in close proximity to the substations up to 500m and within the ROW up to 50m of the transmission line alignment, to seek their views and respond to individual environment, health, and safety concerns about alignment. Obtain no objection from private landowners. • Contractor to consult with and seek the agreement of local communities on their proposed locations for any temporary construction workers camps, site offices, storage areas, and areas for waste management, etc. • Contractor to consult with and seek the agreement of local communities to temporarily use any community resources (e.g., water supplies, village ponds) during	Meaningful consultations for all project components undertaken, documented, and reported on in final IEE. Local communities and other concerned stakeholders kept informed throughout project implementation. Details of ongoing consultations, including photos and records of participants (including gender) documented and included in monitoring reports.	PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	monitoring of the contractor. International Environment Expert to help develop capacity of NEA and prepare detailed communication /consultation plan.	local communities through ongoing consultations throughout contract duration. .	

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		construction to identify any potential conflict, if additional demand may place stress on community resources plan for alternative sourcing for these resources for project needs. • Contractor to communicate at least four weeks (one month) prior to the commencement of works, advance notice to local communities within 500m of substations and transmission lines verbally through NEA local offices and contact with village heads and through notices, pamphlets or similar in Nepali about the agreed schedule of and details of planned construction works in their area to help manage any disruption and disturbance and potential conflicts with local communities. • Contractor to continue to undertake one-on-one consultation with affected persons, especially those within ROW of transmission lines and whose properties are within 100m of new substations who will be most impacted to keep them fully informed of the nature of works and latest schedule, notifying them at least four weeks (one month) prior to the commencement of works of intended start date and schedule. • NEA and Contractor to ensure, in the context of the COVID-19 pandemic, that all consultations are carried out following latest national COVID-19 requirements and WHO social distancing and hygiene guidelines as detailed in Appendix 8 of the IEE. • Consultations undertaken during project implementation will be documented as reported in either final/updated IEE or attached to periodic monitoring reports.					
Obtain national EIA/IEE approvals, and other EHS permits and licenses	Environment, health, and safety impacts and risks of the project in general	• NEA to ensure all national EIA/IEE required are approved by the responsible authority prior to the start of any bidding process. • Contractor to comply with the conditions of the national EIA/IEE, if there is any conflict between the measures set out in this EMP and the national EIA/IEE	National EIA/IEE clearances obtained prior to the issue of bidding documents.	PMD to comply with requirements prior to issue of bidding documents and start of any works.	PSC to supervise, monitor, and assist PMD in ensuring their own	Contractor to comply with requirements prior to the commencement of works, and to	NEA counterpart funds Part of PSC budget

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		conditions most stringent provision will take precedence. • Contractor to acquire all other national EHS permits and licenses required by national laws and regulations, ensuring that these are all obtained before start of related works, including enabling works.	100% of applicable clearances, permits and licenses obtained prior to the start of works. Copies of clearances, permits and licenses to be submitted with monitoring reports.	PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	compliance and assist with supervision and monitoring of the contractor.	comply with any conditions imposed throughout contract duration. .	Part of contract cost, include costs of implementing EMP as BOQ line
Update and disclose IEE prior to contract award, update as required to reflect detailed designs.	Environment, health, and safety impacts and risks of the project in general	• NEA to update the IEE to reflect additional meaningful consultation and national environmental clearance conditions for ADB clearance and disclosure prior to contract award. • NEA to review the final IEE following the completion of the detailed designs and update it, as required, to reflect the detailed design for all project components, and obtain ADB's clearance before the commencement of any works, including enabling works. • If a change in project scope or design occurs during project implementation or if unanticipated impacts are identified at any point during project implementation NEA to inform ADB and, if deemed appropriate, NEA will update the IEE for clearance and disclosure by ADB. Project components having associated facility unable to avoid significant irreversible impacts post-mitigation on protected areas, natural and critical habitat do not qualify for financing under this project. NEA will ensure all associated facility of the project comply with national laws and regulations, and are consistent with SPS requirements by requiring them to comply with this EMP. • NEA to locally disclose in a timely manner the final IEE, any subsequent updates to it, and other environmental safeguards documentation by posting them on the NEA website and ensuring full copies of the latest IEE and its executive summary translated into Nepali are available at all local NEA offices and	Updated IEE cleared and disclosed by ADB prior to contract award. IEE updated, as required, to reflect the detailed design for all project components prior to the start of any works. Final IEE, any subsequent updates to it, and other environmental safeguards documentation are locally disclosed.	PMD to comply with requirements prior to issue of bidding documents and before the commencement of works. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance. PSC to support PMD in finalizing and updating IEE/EMP documentation.	Contractor to immediately inform NEA if any unanticipated impacts are identified at any point and make a copy of the latest IEE available at the project sites.	NEA counterpart funds, including costs of printing Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		project substations. Notices will also be placed on noticeboards at the project sites and local NEA offices and pamphlets should be distributed in the project areas in Nepali, informing of the main findings of the IEE and the availability of the IEE and reports with notice given that help with their translation into Nepali and affected persons' dialects will be extended free of charge on request.					
Bidding and contract documentation, contractor, and subcontractor management.	Environment, health, and safety impacts and risks of the project in general	• NEA to ensure the final EMP cleared by ADB is included prior to the issue of bidding documents and contract award. • NEA will ensure the requirement to comply with the final EMP forms an integral and binding part of the contract, including appropriate incentives and/or penalties for (non-)compliance related to their environment, health, and safety management. • Contractor will preferably have in place corporate environment, health and safety policies and corporate environment, health, and safety management system certifications, such as, ISO 14001 for environment, ISO 45001 for health and safety, or equivalents. • Contractor will comply with all relevant provisions of the final EMP and any updates to it following detailed designs or in response to any unanticipated impacts, they will be responsible for implementing and budgeting for all the measures required. • Contractor will comply with any corrective action plan required and cover the costs where corrective action is required due to non-compliance on behalf of the contractor, its subcontractors or third parties. • Contractor will ensure all its subcontractors and third parties, irrespective of being formally or informally employed, also comply with the final EMP and any updates to it, as well as their own CEMP and H&S Plan, and that this responsibility is cascaded down any chain involved.	Final EMP cleared by ADB and related provisions included in all bidding and signed contract documentation. No breaches of final EMP by contractor, subcontractor or third parties with prompt corrective action taken if it is required.	PMD to comply with requirements prior to issue of bidding documents and during procurement process.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance, reviewing bidding and contract documents to ensure they reflect requirements.	Contractor to comply with requirements throughout contract implementation, ensuring adequate budget for implementing final EMP is included in their contract cost.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Contractor will not engage in any activities described on the ADB Prohibited Investment Activities List in Appendix 5 of ADB's SPS (2009) • Contractor to ensure no persons under 18 are employed on the project. • Contractor will put in place appropriate incentives and/or penalties for (non-)compliance by workers related to PPE, prohibition on firewood and NTFPs collection and fishing, hunting, or poaching by workers. • Contractor to ensure project adopting strict anti-hunting and poaching protocols for workers, undertaking conservation awareness raising activities etc. Particular care will need to be taken by workers at K-N and Dumkibas in relation to avoidance of snake bite.					
Trainings and awareness raising activities.	Environment, health, and safety impacts and risks of the project in general.	• NEA with the support of the PSC to prepare detailed training plan upon loan effectiveness elaborating how training and awareness raising activities required by the final EMP will be conducted. **<u>EHS management:</u>** • NEA with support of the PSC to conduct training sessions on EMP implementation for all those with management responsibilities under it to clarify national and ADB SPS (2009) requirements, requirements at each stage of the project, roles and responsibilities, and, record keeping and reporting requirements. • NEA with support PSC to conduct training sessions on GRM operationalization for all those with responsibilities under it, including the nominated PMD Community Engagement/GRM Officer, and all members of the grievance redress committee. • Contractor to ensure all members of its project management team, environment safeguards team, design team, construction management team, and community engagement/GRM officers attend NEA trainings.	Detailed training plan reflecting final EMP requirements developed upon loan effectiveness. Trainings and awareness raising delivered in accordance with the plan. Contractor and construction workers fully aware of their responsibilities under EMP through training. Details of training and awareness raising sessions, including photos and records of participants (including gender) documented	PMD to comply with requirements throughout project implementation, including conducting training sessions and ensuring relevant staff attendance. PMD supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor. PSC to develop training materials for NEA, act as resource person to deliver them, and ensure relevant specialists' attendance.	Contractor to comply with requirements throughout contract implementation, including conducting training sessions and ensuring relevant staff attendance.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line Indicative costs for trainings and awareness raising are included in the EMP budget table

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Training of all PMD and O&M staff on the climate change impact of SF6, alternatives, H&S risks during O&M due to presence of toxic byproducts, leakage minimization, and environmentally sound and safe disposal of old equipment with SF6 **<u>Construction workers:</u>** • Contractor to conduct training for construction management and provide all workers and visitors on-site, irrespective of them being formally or informally employed by contractor, subcontractor or third-party with an environmental, health and safety induction before being allowed on-site including do's and don'ts in relation to construction site, temporary workers camps, local communities, protected areas, etc. • Contractor to ensure topics covered by training and induction will include but not be limited to: good housekeeping at all times; environmentally sound waste management practices; hygiene and communicable disease prevention including COVID-19 and HIV/AIDS; snake and rodent bites and precautionary measures for avoidance i.e. avoid work after rain, flood, and in the crop ripening seasons, caution while putting hands in holes; sexual exploitation, abuse and harassment prevention; culturally acceptable practices; biodiversity conservation awareness; fire safety prevention; prohibition on firewood and NTFPs collection by workers; prohibition on fishing, hunting, or poaching by workers; heritage conservation awareness; chance find procedures; OHS, including use of PPE; etc. • Contractor to conduct training for construction management and regular drills involving workers irrespective of them being formally or informally employed by contractor, subcontractor or third-party on emergency preparedness and response procedures in case of an environmental or health and safety incident including spillage, fire, natural disaster, disease outbreak etc. Training for	and included in monitoring reports.				

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		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 the scenario of potential or confirmed COVID-19 infection on-site. • Contractor to continue to deliver short environmental, health and safety refresher sessions to construction management and all workers on a monthly basis throughout construction period, and cover pertinent environmental, health and safety topics on daily basis in toolbox talks. • Contractor to ensure workers with a specific role have attended specialized health and safety trainings related that role e.g. first aiders, fire safety officers, as well as ensuring workers have task-specific trainings for working at height, working with electricity, etc. **Community awareness:** • Contractor to undertake construction safety community awareness raising activities in local affected communities within 500m of substations and transmission lines, and especially with schools, prior to construction. • NEA to undertake electrical safety community awareness raising activities in local affected communities within 500m of substations and transmission lines prior to construction, and especially with schools, awareness raising activities to be repeated on completion of construction; to include electrocution risks, EMF, corona noise, etc.					
Detailed design.	Environment, health, and safety impacts and risks of the project in general	• NEA and Contractor to address all site-specific measures detailed in this EMP with regards biodiversity and physical cultural resources as well as other sensitive receptors during the detailed design, as well as ensuring the detailed designs reflect international engineering best practice/ good EHS practices. • Contractor's detailed designs will be reviewed by the PSC to confirm that all measures required by the final EMP have been adequately incorporated and that	NEA approved detailed designs minimize impacts and risks on environment, health and safety during construction and operation & maintenance stages.	PMD to comply with requirements prior approval of detailed design. PMD to supervise and monitor contractor to ensure their compliance	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and	Contractor to comply with requirements prior to approval of detailed design.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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		they reflect international engineering best practice/good EHS practice before they are approved by NEA. **<u>Disaster risk management:</u>** • During detailed route survey identify presence of any floodplain, waterlogged or unstable land, avoid locating any project components in such locations, including areas of the Terai that get waterlogged when temporary inundation occurs during the monsoon. • Select an appropriate foundation design for substations and towers considering climatic factors such as wind, geological factors such as seismic risk, and hydrological factors such as high groundwater table or karst in the project component locations. • Given high seismic risk across the project area, design of all substation and tower foundations and any structural components (e.g., buildings) to consider seismic zone, main frontal thrust, main boundary thrust etc. and be checked for seismic safety by the design team as well as by an independent expert, separate to the design team, to confirm that international good practice seismic design standards are met. • Buildings, transmission towers, and conductors to incorporate climate adaptation measures as per the CVRA, including to withstand extreme temperatures and gale force wind speeds, at minimum equal to upper end of gale conditions on Beaufort scale (40 knots) given 30 knots experienced during the 31 March 2019 tornado event in Nepal. • Consider placement of equipment within substations to avoid water logging in operation & maintenance, ensure placement above the maximum flood level (allowing for climate change) and incorporate adequate drainage design to avoid waterlogging during the wet season.		with delegated requirements.	monitoring of the contractor. PSC to review detailed design and confirm in accordance with final EMP and reflective of international engineering best practice/good EHS practice.		

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		• Drainage will be designed so that discharge from substation site is no more than greenfield runoff rates; so as not to exacerbate flooding on land which is outside of the substation/downstream. • Set all transmission towers back by at least 100m from the edge of river banks and irrigation canals. • Detailed design to avoid locating any towers in river beds and irrigation canals, tower design at crossing locations (single wire spans) to keep tower footing away from the river and irrigation canals by 100m. • In the event towers sited in locations that get waterlogged when temporary inundation occurs during the monsoon cannot be avoided, they will be of suitable construction and raised above the high-water level. **<u>Pollution risk management:</u>** • Use of PCBs will be prohibited in all new transformers and any other project facilities or equipment provided by the project. • Equipment purchased by NEA or Contractor for use on the project is to be accompanied by letter from the manufacturer stating that it is guaranteed PCB free and to be labelled as PCB free before its installation. • Contractor to provide NEA with material data sheets for insulating oil meeting technical specifications for use in new transformers. • During detailed route survey identify presence of any surface waterbodies including rivers/ponds and groundwater sources including springs/wells/pumps/water spouts and confirm if any are used by local communities for drinking water. • Contractor to coordinate with Department of Water Resources and Irrigation and relevant irrigation authority where ROW crosses rivers and water channels to obtain their no objection. • Detailed design of substations to locate new transformers; storage areas; and septic tanks/soakaway ideally 500 m from any surface waterbodies and groundwater sources but at least 100m to reduce pollution risk. If closer placement is					

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		required due to substation's proximity to surface waterbodies and groundwater sources, further assessment to be carried out by Contractor to demonstrate using source-pathway-receptor model that there will be no adverse impact on aquatic ecology or human health. • Detailed design of transformers and fuel, oil chemical, and waste storage areas to incorporate impermeable concrete surface bunded to 110% volume which is not connected to the drainage system to collect spills and leaks; ideally storage areas to be 500m to water sources (surface water and groundwater wells, springs, water spouts etc.) but if this is not possible minimum distance is to be 100m. • Detailed design of fuel, oil chemical, and waste storage areas to provide for a covered storage area of sufficient size to accommodate all anticipated storage requirements, ensure storage areas have the ability to be locked, are well-ventilated and will not reach extreme temperatures. • Substation detailed design to incorporate adequate drainage; no drainage water will be permitted to discharge direct to surface water, oil interceptors are to be fitted on all drainage to catch oil spill. • Detailed design of substations to minimize cut and fill and land raising in order to reduce the extent of earthworks and thus dust generation during construction. • Detailed design of substations to ensure operation noise will be limited to the following as 1 hour LAeq: (i) 70 dB(A) at the site boundary; (ii) at residential properties, 55 (day) and 45 (night) dB(A) in urban areas and 45 (day) and 40 (night) dB(A) in rural areas as defined by Nepal regulations; and (iii) at "peace areas" such as schools as defined by Nepal regulations, 50 (day) and 40 (night) dB(A) – if these levels are already exceeded by the background, the Contractor will ensure that the noise standards are				

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		met by the project design alone and/that substation operation will not result in an increase of 3dB(A) above background levels. • Detailed design of transformers and other noise sources to locate them as far as practical from the substation site boundary since noise diminishes with distance, at minimum given transformer noise is generally in the range 60-80 dBA they are to be located at least 15m but ideally 50m from substation site boundary – if this is not possible Contractor must carry out noise calculations (modelling) to demonstrate that site boundary levels can be met. • If any properties are within 100m of the substation site boundary then baseline measurements must be carried out during detailed design and noise calculations (modelling) considering low frequencies associated with transformer hum undertaken by the Contractor to demonstrate that these noise levels will be met. • If noise levels cannot be met through siting alone and where there are properties within 100m of the substation boundary detailed design to incorporate acoustic barrier designed to international good practice around either the noise source and/or substation site boundary to attenuate noise to level such that noise levels at the receptors will be met. **Health and safety:** • Use of any asbestos containing materials is prohibited. • Include in the design of all substations and transformers within the substation a secure wall or fence with lockable entry featuring written and visual warning signs to include the ISO 7010 "Hazard Type: Electrical Symbol" warning of the risk of electrocution. • Include in the design of all towers anti-climb features together with posting of written and visual warning signs to include the ISO 7010 "Hazard Type: Electrical Symbol" warning of the risk of electrocution.					

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		• Contractor to ensure detailed design of transmission lines incorporates lightening protection to minimize fire risks. • Detailed design of substations to include fire safety measures including detector, alarm, and firefighting equipment in accordance national regulations and IFC EHS Guidelines on OHS. • Indoor work areas at substations to be well ventilated and well-lit in accordance national regulations and IFC EHS Guidelines on OHS. • Detailed design of substations to ensure EMF levels within the substation boundary are within international good practice levels as per International Commission on Non-Ionizing Radiation Protection (ICNIRP https://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf) (reference and peak values) for the occupational exposure; in areas where EMF levels could be exceeded posting of written and visual warning signs. • Detailed design of substations and transmission lines to ensure EMF levels at all regularly occupied properties is within international good practice levels as per International Commission on Non-Ionizing Radiation Protection (ICNIRP) (reference and peak values) applicable to the public exposure. • Use of shielding equipment/materials to decrease electromagnetic field exposure. • Establish applicable right of way and safety clearance corridor in accordance with the Electricity Rule. During detailed route survey identify the presence and use of any structures found in the (i) right of way and (ii) safety clearance corridor. Consider re-siting of angle point towers such that any structures are outside the ROW or if not possible outside the safety clearance corridor. If it is not possible to avoid regularly occupied structures in the safety clearance corridor these are to be relocated with adequate compensation in accordance with the Resettlement					

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		Plan. Such properties must be relocated, and applicable compensation provided by NEA prior to the start of any works. Consider grounding roofs and other metallic surfaces on any properties remaining within ROW to avoid induced current and electricity related accidents. • During detailed route survey identify presence of any existing utilities such as power lines, communications, streetlights, groundwater pumps, water spouts as well as through consultation with service providers (electric, water, gas, telecoms etc.) • In cases where excavation works may be needed, including drilling or open trenching for underground cables, underground utility scans using a Cable Avoidance Tool (CAT) or equivalent must be undertaken by the Contractor to identify any services. • Contractor to coordinate with operators where ROW crosses existing utilities to obtain no objection. • Detailed design to consider the risk of damage to utilities and allow for sufficient vertical and horizontal safety clearances to minimize health and safety risks as per the Electricity Rules, and crossings for communications as per Electricity Regulation 1993. • Pit latrines and disposal of untreated sanitary wastewater to surface or groundwater is prohibited. Detailed design of substations to include adequate sanitation and welfare facilities for all NEA workers to be posted at or visiting the substations including indoor kitchen, eating and sleeping facilities (if applicable) and adequate number of indoor toilets/washrooms with a hot and cold running water supply which are connected to either existing sewerage system or to septic tank with soakaway. • Disposal of worker generated waste (e.g. plastic bottles) on-site is prohibited and adequate waste storage areas to be incorporated into the detailed design. Composting of food waste may be permitted on-site if detailed design incorporates enclosed composting facilities (enclosed to avoid attraction of vermin etc.) located away from accommodation and any properties outside the site boundary.				

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		Incineration may be permitted on-site if detailed design incorporates an enclosed, small volume solid waste incinerator with stack and pollution control that is designed for residence time and temperatures that minimize incomplete combustion for waste disposal at substation, to reduce the volume of solid waste to be removed off-site given lack of suitably engineered and licensed sanitary waste facilities in rural municipalities. • Source of drinking water that meets drinking water standards to be provided to substations. If substation is in district which suffers from arsenic contamination of drinking water, groundwater must not be used, and alternative source must be identified. If any surface or groundwater sources are proposed for use in substations, Contractor is to undertake a baseline water quality sampling per EMoP (Table 10.B) to confirm its suitability for use. If drinking water standards are not met, detailed design to consider alternative source or include water treatment facilities at the substation to facilitate safe drinking water supply. • Provide a dedicated shelter to security guards, shielding them from rain, wind, and extreme (hot and cold) temperatures. **<u>Greenhouse gas emissions:</u>** • Use of chlorofluorocarbons (CFCs) including halon is prohibited. • Detailed design of gas insulated switchgear and GIS substations will comply with international norms and standards for handling, storage, and management of SF6. • SF6 insulated equipment and GIS will be hermetically pressure sealed “sealed for life” units, tested and guaranteed by the supplier at less than 0.1% leakage rate.					

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		• Gas insulated switchgear and GIS will be designed such that any leakage of SF6 will trigger an alarm to the nearest concerned O&M location so that staff may immediately rectify any leak. • Provide SF6 leakage detection kit at each substation. • SF6 emergency response plan to be prepared by contractor for construction, NEA in relation to operation to deal with event of an accidental leak.					
Planning for on-site environment, health, and safety management.	Environment, health, and safety impacts and risks of the project during construction in general.	• NEA and Contractor to address all site-specific measures detailed in this EMP with regards biodiversity and physical cultural resources as well as other sensitive receptors before commencing construction works, including any enabling works, ensuring that all pre-construction preparations reflect international engineering best practice/good EHS practices. • Contractor's pre-construction documentation will be reviewed by the PSC to confirm that all measures required by the final EMP have been adequately incorporated and that they reflect international engineering best practice/good EHS practice before they are approved by NEA. • Contractor to prepare and submit a Construction Environmental Management Plan (CEMP) to NEA for approval, for each works package. CEMP to include details on how the Contractor plans to implement the construction mitigation measures specified in the final EMP, and the relevant parts of the IFC EHS General Guidelines including the Construction and Demolition section, and IFC EHS Electric Power Transmission and Distribution Guidelines. The CEMP will also identify the temporary construction facilities needed and their location e.g., laydown and storage areas, workers facilities, etc. • Contractor to keep CEMP as a living document, to be updated as required and re-approved by NEA if any changes in construction methods, site conditions etc.	CEMP and topic- and site-specific sub-plans including CPPP, CWMP, CTMP, BMP, HMP, CFP, CHSMP, CEPRP all prepared and approved prior to any construction works, including enabling works.	PMD to comply with requirements including approval of Contractor's pre-construction documentation, seeking review and comment of other concerned stakeholders as appropriate e.g. for protected areas etc. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements. PMD to ensure checklist of all pre-construction measures is cleared before giving go ahead for works to Contractor.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor. PSC to review Contractor's pre-construction documentation and confirm in accordance with final EMP and reflective of international engineering best practice/good EHS practice. PSC to verify checklist of all pre-construction measures is cleared before NEA gives go	Contractor to comply with requirements prior to any construction works, including enabling works.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

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		<u>Land take:</u> • Ensure relocation and compensation of any affected persons within the ROW has been paid and ensure effective relocation of any households living within the safety clearance corridor (Electricity Rules) has taken place prior to any construction work. **<u>Biodiversity management</u>**: • Contractor to strictly locate all temporary construction facilities outside of forest areas, all temporary workers camps unless within substation boundaries are to be located at least 500 m for forest areas. Location of related project facilities is to be identified by contractor, PSC international biodiversity expert to review if locations are suitable prior to NEA approval. • Include in CEMP or site-specific BMP prohibitions on fishing, hunting, poaching, entering forest land etc. and an emergency fauna rescue and handling procedure, including contacts of forest and protected area management, nearest veterinary etc. **<u>Physical cultural resources management (chance finds)</u>**: • Contractor to strictly locate all temporary construction facilities at least 100m from any identified physical cultural resource e.g., temple. • NEA to develop a Chance Find Procedure (CFP) to be followed by contractor as part of their CEMP prior to commencement of any works, including enabling works, to address the event any physical cultural resources (including fossils) are found during works. CFP is to include the following procedures: o If suspected physical cultural resources are encountered, halt all works at the find site immediately. o The find should be assessed by a competent DOA Official, and procedures to avoid, minimize or mitigate impacts to			ahead for works to Contractor.		

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		such physical cultural resources to be agreed in writing with them. ○ Work will not resume until the procedures to avoid, minimize, or mitigate impacts to the physical cultural resources have been agreed with DOA and confirmed by them in writing to have been implemented in full. ○ If avoidance is not feasible, and no alternatives to removal of the physical cultural resources exist, thorough cost-benefit assessment need to be carried out to assess whether the project works should continue or stop at site. If the project benefits outweigh the anticipated cultural heritage loss from removal from site, following clearance of ADB the physical cultural resources are to be removed and preserved using the best available technique in accordance with relevant national heritage protection laws and regulations as well as international best archeological practice. ○ Records to be maintained of all finds, including chain of custody instructions for movable finds. ○ Construction workers must be made aware of the chance-find procedure and the types of finds (including fossils) to be reported through training and induction before the commencement of any works. **Pollution risk management**: • The Contractor will prepare for NEA approval a construction pollution prevention plan (CPPP) as part of the CEMP 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 in					

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		accordance with national laws and regulations and the EHS General Guidelines prior to commencement of any works. • The Contractor will prepare for NEA approval a Construction Waste Management Plan (CWMP) as part of the CEMP for dealing with all solid and hazardous waste generated in an environmentally sound and safe manner in accordance with national laws and regulations and the EHS General Guidelines section on Waste Management prior to the start of any works. • Contractor to undertake air quality monitoring per the EMoP (Appendix 10, Table 10.B) to confirm current background levels in the project area at least one week prior to the commencement of any actively on-site. • Plan construction works in the vicinity of waterbodies, considering erosion issues and surface water pollution risk. • If any surface waterbodies or groundwater sources within 100m, Contractor is to undertake a baseline water quality sampling per EMoP (Table 10.B) to confirm their current water quality status at least one week prior to the commencement of any actively on-site. • Contractor to schedule, as far as practical, earthworks at substation sites and installation of towers during the dry season to minimize exposed areas subject to erosion by surface water runoff. • To inform development of the CPPP in relation to noise management, the Contractor will be required to measure and confirm the distance from their construction works to sensitive receptors during the detailed design, to confirm if the noise standards can be met based on their construction methods or temporary acoustic barriers are required. • Contractor to undertake noise monitoring per EMoP (Table 10.B) to confirm current background noise					

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		levels in the project area at least one week prior to the commencement of any actively on-site. • Construction methods to ensure construction noise will be limited to the following as 1 hour LAeq: (i) 70 dB(A) at the site boundary; (ii) at residential properties, 55 (day) and 45 (night) dB(A) in urban areas and 45 (day) and 40 (night) dB(A) in rural areas as defined by Nepal regulations; and (iii) at "peace areas" such as schools as defined by Nepal regulations, 50 (day) and 40 (night) dB(A). • If noise levels may be exceeded, Contractor to erect temporary acoustic barrier around either the noise source and/or site boundary to attenuate noise to level such that noise levels will be met. • For any sites where soil compaction, piling or blasting may be necessary for substation or tower foundations, Contractor to identify properties at risk of vibration damage, undertake a through structural survey, supported by photographic evidence of any properties at risk, and determine whether such buildings may require the installation of vibration monitors during construction to monitor movement. The Contractor will develop a detailed assessment and blasting/piling management plan for approval by NEA addressing both noise and vibration impacts. **Health and safety:** • For each contract package, the Contractor is to undertake a H&S risk assessment through a facilitated workshop to be attended by PMD, PSC and the Contractor during the detailed route survey so that it can inform both the detailed design and pre-construction preparations. H&S risk assessment to consider both occupational and community H&S risks resulting from the construction and operation & maintenance stages of the project. • Informed by the H&S risk assessment, Contractor to prepare a Construction Health and Safety Management Plan (CHSMP) for each package/lot including site-specific measures as needed for each construction site. CHSMP will address both					

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		occupational and community H&S risks and adherence to national health, safety labor laws and regulations. Measures reflected in the CHSMP will be in accordance with the EHS General Guidelines sections on Occupational and Community Health and Safety and the Electric Power Transmission and Distribution Guidelines. • Contractor to keep CHSMP as a living document, to be updated as required and re-approved by NEA if any changes in construction methods, site conditions, in response to accident, near miss etc. • In the absence of NEA records to confirm transformers are PCB free (ones installed post-1990 should have records, NEA to facilitate access to data archive) all existing transformers already in-situ must be assumed by the Contractor for health and safety purposes to contain PCBs and if needing to be disturbed by them the oil must be sampled and analyzed following UNEP Guidelines for the Identification of PCB and Materials Containing PCB and a health and safety risk assessment and plan prepared referring to the measures in UNEP (2002) PCB Transformers and Capacitors: From Management to Reclassification and Disposal. Provide workers with training on PCBs and their safe handling and disposal. • Label any equipment or container containing PCBs found in existing transformers and other project equipment and unless being retained in-situ replace it with new PCB free equipment under the project. NEA must ensure appropriate transport, storage, decontamination, and disposal of redundant contaminated units; disposal should involve facilities capable of safely transporting and disposing of hazardous waste containing PCBs. A hazardous waste management plan to be prepared for handling PCBs. • Assess surrounding soil exposed to PCB leakage from equipment removed or retained in-situ and implement appropriate removal and / or remediation.					

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		• CHSMP to include a Construction Emergency Preparedness and Response Plan (CEPRP) including communication systems and protocols to report an emergency situation (health emergency, work-related accident, traffic accident, accident involving the community, natural disaster, fire especially forest fire, virus outbreak etc.). • Contractor to 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 PMD within 24 hours of occurrence with a response plan detailing the incident and how its reoccurrence will be avoided. NEA to then report any lost time or fatal incidents to ADB 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. • CHSMP and its CEPRP are to be submitted for approval of NEA prior to commencement of any works, including enabling works • In undertaking H&S risk assessment and preparing CHSMP and CEPRP adequate attention will be given to the risks associated with COVID-19 pandemic and other communicable viral diseases. National restrictions for containing the spread of COVID-19 must be complied with and Government of Nepal (https://covid19.mohp.gov.np/) and ADB guidance (https://www.adb.org/publications/safety-well-being-workers-communities-covid-19) is to followed, as well as further guidance detailed in Appendix 8. Contractor will provide adequate sanitation and welfare facilities including hand washing and clean PPE in sufficient quantity are provided on-site and at accommodation; Contractor will also consider the ability of communities to comply with protective measures such as regular handwashing and the local health care facilities' capacity to deal with any infections agreeing with the with nearest Health Center and/or Hospital for emergency cares of workers. Particular attention must be paid to accommodation of workforce given the transient nature of work on transmission lines, to					

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		avoid spreading any virus between communities. CEPRP must include response flow chart and contact details to deal with any construction worker or community member being diagnosed with COVID-19 during the course of the works. To limit contacts and hence contamination risk, the same workers should be grouped in accommodation, transport, and work teams. Medical insurance will be provided by Contractor for all workers with sick leave allowance to ensure symptomatic workers do not attend site; Contractor will avoid no-work-no-pay policies, whereby by fear of not getting paid workers would be tempted to report to work and hide any symptoms, creating more risk for the wider workforce and community. Given the unprecedented nature of responding to COVID-19, public health officials/experts must be consulted in undertaking the risk assessment and management planning for COVID-19. **Traffic management:** • NEA and the Contractor to consult with and seek the agreement of the irrigation authority to use the existing irrigation access roads for the purposes of construction. • For all works on or adjacent to public roads, the Contractor will prepare for NEA approval a Construction Traffic Management Plan (CTMP) appropriate to the pedestrian and vehicular traffic flows on the road as part of the CEMP in consultation with relevant local authorities/traffic police to ensure proper execution of traffic controls including where temporary blockage of the road during installation is required for health and safety purposes and ensure that highly visible guides, advance warning signs or flag persons are in place to direct pedestrian and vehicular traffic.					

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		<u>Damage to crops, structures, and utilities</u>: • Contractor to schedule works affecting agricultural land outside the cropping season. • Contractor to maximize use of existing substation compounds for temporary construction facilities (e.g., laydown and storage areas, workers facilities etc.) • Contractor to locate temporary construction facilities as much as possible on uncultivated land (not natural habitat) to minimize disturbance to cultivated lands. • Contractor to locate temporary construction facilities (e.g., laydown and storage areas, workers facilities etc.) at least 500m away from residential areas/villages within rural areas, at least 500m from surface waterbodies, groundwater wells/springs/water spouts, and 100m from other sensitive receptors (e.g., individual houses, schools, clinics, temples, touristic areas etc.) avoiding land which is steeply sloping or in floodplain/waterlogged. • Construction methods to be selected to minimize risk of damage to roads, utilities, structures, drains etc. • Contractor to plan for using appropriate scaffolding or overhead bamboo frames during stringing works crossing roads, irrigation canals, utilities, structures, or drains to minimize traffic disruption, accident risk, and property damage. • For existing roads, irrigation canals, utilities, structures, drains etc. photographic and/or structural pre-condition surveys are to be completed by the Contractor and agreed with NEA and property owners prior to any works, including enabling works. These must be documented in a pre-project condition report submitted to NEA, which will serve as baseline in case any damage to property occurs • Contractor will be required to restore any property damage that is caused by their works including damage caused by heavy construction traffic using access roads to at least pre-project condition at their own cost. • Contractor to avoid piling or blasting and other vibration inducing activities as much as possible; in locations where this is unavoidable Contractor to					

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		identify properties within the zone of influence and undertake pre-construction structural surveys to identify level of risk. Risk may be high if structures previously damaged during earthquake and not repaired. 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.					
Employment of staff for construction	Temporary employment opportunities, both skilled and non-skilled laborers will be required.	• Contractor to abide by the Nepal Labor Code and labor regulations • Contractor must prohibit child labor (under 18 years old). • Contractor should not discriminate in employment • Contractor should proactively encourage employment from local communities where appropriately skilled. • Contractor should proactively encourage employment of women on the project where appropriately skilled. • GRM will be available to workers for receiving and handling complaints about unfair treatment or unsafe living or working conditions, ensuring no coercion nor reprisal. • Provide health/accident insurance for all workers (formal and informal) for the duration of their contracts. • Contractor to allow a minimum number of sick leave as per Nepal law or 10 days per year, whichever is the higher.	No child labor has been recruited, as per detailed record of employment, and gender/age/origin analysis, provided in monitoring reports.	PMD to comply with requirements throughout project implementation. PMD supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout contract implementation.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

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On-site enabling works, construction works, testing and commissioning of project components							
Biological Environment							
On-site pre-construction and construction activities	Impacts on biodiversity including Chure Conservation Area	• Comply with CEMP during construction works • Ensure clear demarcation of the working area and avoid encroachment outside the agreed corridor of impact. • Trees are to be cleared during non-bird breeding season, if this not possible due to weather restrictions on access, trees cleared during breeding season to be checked by field ecologist for nests prior to clearance, if present harvesting to be postponed until the young have fledged. • Unnecessary use of machinery to be avoided to minimize disturbance to fauna. • Revegetate any disturbed areas beyond footprint of substation and tower foundations to at least original condition through revegetation using native species etc. • Construction of new access track is not allowed. Use will be made of existing access roads and tracks for transporting tower materials and machinery, in locations where access is restricted use of manual labor to transport, install and string the towers and lines traversing uncultivated land (not natural habitat) as much as possible to avoid damage to crops • Prior to excavation for tower and substation foundation, area will be checked by a field ecologist for any signs of burrows etc. If determined to be occupied, only manual digging under the supervision of ecologist will be permitted. • Excavated pits will be robustly fenced or covered so as to prevent fauna accidentally falling in, further an escape ramp will be provided to allow their escape – particularly in Chure Conservation Area. • Keep written record, supported by photographs, of any animal casualties, including a cause of death if known. • In wet conditions, minimize use of heavy machinery and consider temporary installation of removable steel plates to protect soil and its vegetation cover.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks, photographic record etc. No outstanding biodiversity-related grievances from local communities.	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout construction	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line Indicative costs for purchase of bird divertors (excluding their installation) and support for the promotion and enhancement or protected areas are included in EMP budget table

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Strict prohibition on construction workers to enter forest areas whilst working for the project. • Strict prohibition on purchase, sale, and use of firewood, timber and NTFPs, hunting and poaching of fauna by workers. • Contractor to undertake regular, compulsory awareness raising activities for all workers related to prohibitions including tool box talks, and posting of information and warning signs at site offices, worker camps, patrols by security guards employed by the Contractor, regular inspections of the worker camps, and, disciplinary procedures for any contravention by the workers. • Contractor to provide good standard of worker accommodation with heating and all meals to help discourage breaches of prohibition by the workers. • Strict prohibition of fuelwood or timber being cut by the construction workers. • Contractor and construction workers will be prevented from the use of firewood for cooking their food and heating etc. • Contractor to provide alternative fuel source (e.g. kerosene/LPG, which will be stored in safe conditions) to communal kitchen and for heating of worker accommodation. • Fuel will be stored outside of and refueling will take place close to forest or plantation areas to minimize the risk of fire. • Contractor to provide fire-fighting equipment at work site with compulsory basic fire training for all workers and training drills undertaken in preparation for forest fire. • In case of forest fire, Contractor to act swiftly so as to minimize impacts on the environment and human life. • Remove and dispose of any identified invasive plant species in an ecologically sound manner.					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
Physical Environment							
On-site pre-construction and construction activities	Changes in topography/ terrain as a result of earthworks, primarily at substations	• Comply with CEMP during construction works • Contractor to examine stability of tower locations before excavation. • Balance cut and fill in the areas where leveling of sites is required. • Carry out landscaping at each tower location, including bioengineering and slope protection work. • On completion of works re-vegetate disturbed areas to avoid soil erosion. Restore temporarily used sites to at least their pre-project condition following works.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks, photographic record etc. No outstanding topography/ terrain related grievances from local communities.	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line
On-site pre-construction and construction activities	Changes in ambient air quality - dust and suspended particulate matter from earthworks, and other pollutants from vehicular emissions, may affect ambient air quality with impacts on the health of workers and community.	• Comply with CEMP, CPPP, and the IFC EHS General Guidelines in relation to air quality and avoid the occurrence of pollution incidents as far as practicable • Require construction equipment and vehicles to meet national emissions standards, see Appendix 2 of IEE. • Perform regular checks, upkeep, and maintenance of construction equipment and vehicles to keep them in good working order as per the manufacturer's specifications to meet emission standards. Keep log of maintenance undertaken. • Sprinkle water during earthworks to avoid dust being dispersed by wind, cover with materials like gravel to minimize re-suspension of dust. • Stockpiles of spoil and other dust generating materials to be kept to a minimum necessary to undertake works for the day • Cover stockpiles with tarpaulin. Locate stockpiles of loose material at least 500m from residential property to avoid inconvenience to avoid inconvenience from fugitive dust and ensure they are enclosed by a fence	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks, photographic record etc. Monitoring confirms ambient air quality within national standards or no worsening of the baseline situation if already exceeded.	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout construction, keep required maintenance records and undertake ambient air quality monitoring in accordance with the EMoP	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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		or similar to minimize windblown dust. Minimize double handling and drop loads. • Trucks importing loose raw materials or removing spoil to local approved disposal sites must be covered with tarpaulin to reduce dust generation, all trucks used are to be serviced and meet Nepal emission standards and belching of black smoke prohibited. • Position any stationary emission sources (e.g., water pumps, diesel generators, compressors, etc.) as far as practical from sensitive receptors (houses, schools, clinics, temples, touristic areas etc.) • Impose speed limits on construction vehicles to minimize exhaust and dust emissions along areas where sensitive receptors are located (houses, schools, clinics, temples, touristic areas etc.). • Trucks transporting loose material will be covered. • Limit engine idling to maximum 5 minutes. • Sprinkle excavations, earthen access road, and material stockpiles with water during the construction period to mitigate dust related issues due to frequent movement of construction vehicles as necessary i.e. 2-3 times per day but more often if needed during excavations, dry and windy conditions that enable dust to be easily mobilized and the dust to be visible. Clean dust from the access road after construction work is completed. • Strictly prohibit the burning of wastes generated by project-related activities. • Ensure workers working in close proximity to or having long exposure to vehicle exhausts and earthworks are provided with clean N95 dust masks to avoid inhalation or particulate matter and other pollutants.	No outstanding air quality-related grievances from local communities or workers.				
On-site pre-construction and construction activities	Changes in ambient noise and vibration levels - mobilization of heavy equipment and machinery, use of construction vehicles, and construction activities	• Comply with CEMP, CPPP, and the IFC EHS General Guidelines in relation to noise and avoid the occurrence of pollution incidents as far as practicable • Schedule construction activities so as to minimize nuisance to sensitive receptors (houses, schools, clinics, temples, touristic areas etc.) i.e., avoid works	Compliance with national laws and regulations. Mitigation measures successfully	PMD to comply with requirements during construction. PMD to supervise and monitor	PSC to supervise, monitor, and assist PMD in ensuring their own	Contractor to comply with requirements throughout construction, keep required	NEA counterpart funds Part of PSC budget

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
	may increase ambient noise level. Exposure to high levels of ambient noise may affect hearing of workers or cause anxiety and disturbance to community.	at night, on weekend, during holidays, school exam periods, etc. • Select construction techniques and low noise generating machinery and equipment e.g. less than 55dBA sound pressure level at 1m, and stage noisy works to limit their duration to minimize noise and vibration • Construction noise must be noise limited to the following as 1 hour LAeq: (i) 70 dB(A) at the site boundary; (ii) at residential properties, 55 (day) and 45 (night) dB(A) in urban areas and 45 (day) and 40 (night) dB(A) in rural areas as defined by Nepal regulations; and (iii) at "peace areas" such as schools as defined by Nepal regulations, 50 (day) and 40 (night) dB(A) – if these levels are exceeded the Contractor will be required to implement additional noise mitigation such as placing temporary acoustic barriers around the works site to ensure that the noise standards are met and/or the construction works do not result in an increase of 3dB(A) above background levels. • Use of piling or blasting and other vibration inducing activities are to be avoided. • Structural or cosmetic damage caused by vibration to be repaired by Contractor to at least pre-project condition at their own cost. • Require construction equipment and vehicles to meet national standards, see Appendix 2 of IEE– all trucks should carry fitness certificates issued by the Nepal Road Traffic Authority and renewed annually under the applicable regulations of Nepal. • Fit all vehicles, machinery and equipment used in construction with exhaust silencers where the manufacturer's design allows this • Perform regular checks and maintenance of construction equipment and vehicles to keep them in good working order as per the manufacturer's specifications to meet emission standards. Keep log of maintenance undertaken. • Position any stationary emission sources (e.g., water pumps, diesel generators, compressors, etc.) as far as	implemented by NEA and Contractor as determined through regular site checks, etc. Monitoring confirms ambient noise within national standards or no worsening of the baseline situation if already exceeded. No outstanding noise or vibration-related grievances from local communities or workers.	contractor to ensure their compliance with delegated requirements.	compliance and assist with supervision and monitoring of the contractor.	maintenance records and undertake noise monitoring in accordance with the EMoP	Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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		practical from sensitive receptors (houses, schools, clinics, temples, touristic areas etc.) • Prohibit use of horn by construction vehicles • Limit vehicle movement and offloading of construction materials to daytime in areas where sensitive receptors are located (houses, schools, clinics, temples, touristic areas etc.) transport of materials and spoil by truck will be limited to the daytime without hooting. • Outside of Kathmandu Valley noisy construction activity (especially piling works) will take place between 6 am to 6 pm. Residents will be informed will in advance of the construction schedule for noisy activities. • Impose speed limits on construction vehicles to minimize noise emissions along areas where sensitive receptors are located (houses, schools, clinics, temples, touristic areas etc.). • Limit engine idling to maximum 5 minutes. • Provide appropriate PPE (acoustic ear plugs or earphones capable of reducing noise levels to 80dB(A) for hearing protection) to any workers subjected to noise levels of 80dBA for more than 8hours per day and ensure they wear it e.g. if using breakers. • No unprotected ear should be exposed to a peak sound pressure level (instantaneous) of more than 140 dB(C) or average maximum sound levels of 110dB(A). • Periodic medical hearing checks to be performed on workers exposed to high noise levels.					
On-site pre-construction and construction activities	Changes in quality of surface and groundwater – due to sediment laden runoff or spills/leaks of fuel, oil and chemicals used in construction works.	• Comply with CEMP, CPPP, and the IFC EHS General Guidelines in relation to water quality and avoid the occurrence of pollution incidents as far as practicable. • Follow General EHS Guidelines in relation to water quality for the use and storage of fuel, oil, and chemical including prevention and control of hazards associated with spill prevention, emergency response, spill clean-up and remediation.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and	Contractor to comply with requirements throughout construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Establish dedicated fuel, oil, and chemicals stores on impermeable bunded area of 110% volume to avoid spills and leaks contaminating soil and affecting water quality • Avoid storage of fuel, oil, and chemicals in areas within 500m to water sources (surface water and groundwater wells, springs, water spouts etc.) to avoid direct contamination or contamination through run off, if this is not possible minimum distance is to be 100m. • Place all equipment that may leak fuel or oil on drip trays it not sited on impermeable surface with 110% bunded capacity. • Undertake refueling only on areas of hard protected soil, preferably bunded, at least 500m from surface water, but if this is not possible minimum distance to be 100m, with all drainage directed through oil interceptors. • Provide spill response kit with sufficient absorbent materials (e.g. sorbents, dry sand, sandbags) on-site for soaking up any fuel, oil, or chemical leaks/spills. • For transformers, follow the Spill Prevention Control and Countermeasures (SPCC) plan as recommended by United States Institute of Electrical and Electronics Engineer Inc. (IEEE) standard 908. • Undertake construction during the dry season as much as possible to minimize exposed areas subject to erosion by surface water runoff. • Undertake all construction 100m either side of river crossings and in floodplain during the dry season to avoid flood risk, leading to accidents and/or water contamination. • Works over or near watercourses will adopt protection measures to guard against loss of soil that would result in the turbidity of water. • Implement measures to prevent landslides to avoid contamination of rivers by soil. • Minimize soil erosion and surface water runoff by reducing the extent of earthworks, revegetating earthworks on completion, and covering stores of sand and spoil with tarpaulin.	regular site checks, photographic record etc. No outstanding water quality-related grievances from local communities or workers.	with delegated requirements.	monitoring of the contractor.		

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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		• Ensure sediment laden runoff shall not discharge directly to surface water but shall be discharged through sedimentation basin and oil interceptor. • If water from excavations is pumped it must either be disposed of to an adjacent defined area of ground for percolation, or to waiting tanker trucks for proper disposal, it must not be disposed of to surface water. • Do not allow washing of equipment or vehicles in surface water and ensure all washing water is discharged to sedimentation basin and oil interceptor instead of directly to surface water. • Cement will be stored in rented private storage facilities; enclosed and not exposed to the elements. • Do not undertake any concrete mixing within 500m of surface water, if this is not possible minimum distance to be 100m. • Provide portable sanitary facilities for construction workers, so as to avoid surface and ground water pollution. Locate these at least 500m away from surface waterbodies including rivers/ponds and groundwater sources including springs/wells/pumps/water spouts, away from floodplain, any waterlogged land and shallow groundwater. • Strict prohibition on open defecation and urination by construction workers; no use of pit latrines for worker camps. • Toilets and washing facilities to be connected to existing sewerage system, septic tank (with soak pit) or as portable self-contained units for disposal of wastewater off site to sewage treatment works. No untreated wastewater is to be discharged direct to surface water or the ground. • Construct adequate drainage with oil interceptors for all new substation sites according to detailed design; install adequate bunding to transformers and storage areas.					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
On-site pre-construction and construction activities	Use of raw materials and generation construction waste	• Comply with CWMP and with IFC EHS General Guidelines in relation to waste management. • Import all materials from existing licensed sources and keep records of all materials used, and sources. • Storage yards will be fenced. • Prior to the start of works the contractor will ensure the waste management system is established at the construction sites and workers camps. • Separate waste containers (drums, bins, skips or bags) will be provided for different types of waste. • Sensitize workers on good housekeeping and the environmentally sound storage and disposal of construction and wastes, and importantly not to leave garbage lying around. • Collect and segregate construction wastes including scrap metal, oil, and solid waste; ensure all workers are familiar with this segregation and arrange garbage bins to collect these wastes so they are not thrown on the floor • Store all the wastes produced in an environmentally sound manner in designated, labelled area with separate waste containers (drums, bins, skips or bags) for each distinct type of waste. • Store solid waste in enclosed bins to contain leachate and avoid vermin. • Encourage recovery of recyclable wastes that could be reused or sold to recyclers, rather than disposing of it. • Prohibit use of waste (e.g. empty cement bags and containers, plastic, wooden planks) for backfilling – only inert spoil may be used for backfilling to avoid need for off-site disposal (any excess inert spoil is to be disposed of at suitably licensed waste facilities). • Prohibit burning of construction wastes. • Prohibit dumping of construction wastes on-site, into drains, rivers, in agricultural fields etc. • Provide weekly toolbox talk to remind of the importance of waste disposal, prohibition of disposal on the road, in drains etc., prohibition on burning of wastes, and open defecation and urination. Develop a procedure/system to penalize through escalating	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks, photographic record etc. No outstanding material use or waste-related grievances from local communities or workers. 100% wastes removed off site have been disposed of by licensed waste contractors who reused/recycled or disposed of it to suitably licensed waste management facility, as confirmed by documented full-cycle transfer notes.	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout construction, keep records in accordance with the EMoP	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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		fines or similar any construction workers who breach these requirements. • Contractor may compost biodegradable kitchen scraps on site if of small volume in enclosed composting facilities (enclosed to avoid attraction of vermin etc.) located ideally 500m but at least 100m from water sources (surface water and groundwater wells, springs, water spouts etc.). • Document all wastes removed off site using transfer notes, to be taken by licensed waste contractors who should reuse/recycle or dispose of the waste to suitably licensed and engineered waste management facilities according to type – for solid waste disposal this will need to be to Kathmandu, and for hazardous waste this will need to be to a neighboring country since no such facilities currently exist in Nepal. • Excavated spoil that cannot be reused to a licensed disposal site as suitable for accepting inert wastes ensuring no solid or hazardous wastes are comingled with the inert excavated spoil • Collect solid waste and dispose of it to suitably engineered and licensed sanitary waste facilities– in Kathmandu as no such facilities are existing in rural municipalities. • Ensure any hazardous waste such as oily rags or old drums disposed of in suitably licensed hazardous waste facilities– out of country since no such facilities in Nepal.					
Socio-economic Impacts							
On-site pre-construction and construction activities	Changes to land use as substation compound and tower footing land is permanently lost and temporary crop loss during installation within the ROW	• Compensate private land required for the project through acquisition or rental in agreement with the land and/or property owners. Permanent land acquisition and crops or private trees lost due to construction will be compensated according to the project Resettlement and Indigenous People Plan. • Phase activities according to the agricultural cycle to allow farmers to harvest standing crops.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and	Contractor to comply with requirements throughout construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Except for substations as mentioned in the IEE, no construction of access track is allowed, use will be made of existing access roads and tracks for transporting tower materials and machinery, in locations where access is restricted use of manual labor to transport, install and string the towers and lines traversing uncultivated land (not natural habitat) as much as possible to avoid damage to crops • On completion of works restore all temporarily used sites to at least their pre-project condition following works; this will involve cleaning site of any debris or wastes, left over material and soil/rocks/sand, contaminated soil although this should have been avoided through EMP measures; revegetation if required; drainage if required; local topographical adjustments; addition of good quality soil if the latter was eroded/removed by construction works; etc. • Follow detailed design drawings and implement careful construction practices to avoid damage to existing structures (e.g. buildings) and roads, utilities, drains etc. • Contractor to repair and/or compensate for any unforeseen damage to at least pre-project condition in conjunction with relevant local authorities and/or property owner at cost to the contractor • Safe access to property will be maintained and alternative signed routes and access will be provided where there are temporary diversions or blockages. • Locate stockpiles away from properties and only in designated areas where no access will be blocked.	regular site checks, photographic record etc. No outstanding resettlement / economic-displacement / land-related grievances from local communities. 100% of land used for temporary facilities returned to initial condition upon finalization of construction works.	with delegated requirements.	monitoring of the contractor.		Budget for compensation included in Resettlement Plan and Indigenous People
On-site pre-construction and construction activities	Occupational health and safety of workers at risk due to the hazards created during the construction period, e.g. movement of heavy equipment, vehicles, and machineries, working conditions, etc. Workers may be exposed to	• Comply with CHSMP and with IFC EHS General Guidelines in relation to occupational H&S. • Ensure health and safety supervisor is on site at all times (implies an alternate off on leave or on sick). • Require subcontractors and workers to confirm they have seen and understood the requirements of the CHSMP before proceeding with their work. • Provide worker training on H&S and daily/weekly briefings led by site-appointed Health and Safety Officer.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks,	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and	Contractor to comply with requirements throughout construction, maintain records of health and safety incidents per the EMoP and	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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	occupational health risks and safety hazards, regarding site clearance for pre-construction and during construction relating to working with electricity and working at height, as well as from handling PCBs or asbestos in upgrade works at existing substations.	• PPE to be provided for all workers (regardless formal and informal, directly contracted or subcontracted) in accordance with Table 2.7.1. Summary of Recommended Personal Protective Equipment According to Hazard in IFC EHS Guidelines on OHS. • Enforce disciplinary system (e.g. immediate removal from site) for non-compliance with PPE requirements and other H&S measures (e.g. social distancing for COVID-19). • Check health condition of workers on daily basis, for example, use of self-certification forms and temperature checks before being allowed on the construction site with more thorough monthly health checks by qualified medical professional. • Check the load of the vehicles before use, all drivers, and passengers to fasten seatbelt and comply with all transportation-related H&S laws and regulations • Examination of all equipment and tools' quality and the presence of operational safety features before use • Implementation of safety measures while excavating to avoid collapse e.g. shoring if soil unstable • Untrained workers will not be permitted to work with live electricity or at height. • Observe IFC EHS Guideline on Electric Power Transmission and Distribution requirements for working with live power lines; only allow suitably trained workers that meet the requirements set out in above-referred IFC guideline to work on live power lines with strict adherence to safety standards including those listed in said guidelines; these workers must have training record of attending suitable training course on electrical safety and be provided with and wear the appropriate PPE for their role. • Ensure proper grounding and deactivation of any live power lines during construction work or before any work in close proximity to the lines and that this has been checked and certified by the on-site Health and Safety Officer in advance.	photographic record etc. No outstanding OHS related grievances No fatalities or lost time incidents, if they do occur to be reported to NEA board and management within 24h and to ADB within 48h. 100% of H&S incidents including near miss recorded, immediately investigated, and corrective action taken to prevent repeat		monitoring of the contractor. PSC international health and safety expert to work closely with PMD health and safety staff to ensure knowledge transfer and development of knowledgeable health and safety team at NEA.	maintain copies of training records.	Budget for compensation included in Resettlement Plan and Indigenous People

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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		• 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. • Require workers to observe the minimum approach distances for excavations, tools, vehicles, pruning, and other activities when working around power lines. • Observe IFC EHS Guideline on Electric Power Transmission and Distribution requirements for working at height; only allow suitably trained and qualified workers to work at height, these workers must have training record of attending suitable training course and be provided with and wear the appropriate PPE for their role. Require workers to test the structural integrity of towers prior to proceeding with the work. Use fall protection measures when working on towers, i.e. mobile elevated working platform, and all workers at height are required to wear body harness. Ensure sufficient harnesses and gear are available on site for all workers, that workers are trained to use such harness and are obligated to use the latter at all times when working at height. • Unless transformers have been certified PCB free workers must wear suitable chemical and/or oil resistant gloves, goggles, and protective clothing whilst working with transformers. Eye wash station and water supply to shower to be provided during works due to risk of PCB coming into contact with skin. • Ensure good housekeeping in the premises at all times, including on construction site, workers camps, storage areas, etc. Perimeter is to be kept neat and tidy, with no trip hazards on the ground e.g. open channels, materials, equipment, trash laying around. Do not leave hazardous conditions (e.g. unlit open excavations without means of escape) overnight unless no access by public can be ensured. • During construction works, ensure qualified first aider and trained fire marshal is available on-site at all times with an appropriately equipped first aid kit and					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		appropriate fire extinguisher and other firefighting equipment immediately available for use. • Provide an ambulance for more serious cases to transport the patient to the hospital for treatment • Prepare signboards reminding of health and safety measures and procedures to follow in case of accident, including key contact details (ambulance, doctor, hospital, etc.) • Keep a log of all incidents, near-misses and accidents and include these in monthly monitoring reports submitted to NEA and periodic monitoring reports to ADB • Temporary construction camps will include proper sanitation, alternative fuel to firewood, clean eating area, water supply, and secure storage of domestic solid wastes for disposal off site to suitably licensed waste management facilities. • Pit latrines prohibited, and adequate number (about 1 toilet per 10 workers, can refer to EBRD guidance note on workers' accommodation) of toilets and washing facility with hot and cold running water. Toilets to be connected to existing sewerage system, septic tank, or as portable self-contained units for disposal of wastewater off site to sewage treatment works to be provided. • Toilets to be equipped with soap and hand sanitizer. • There should be an indication of whether toilet and washing facility is "in use" or "vacant" if not gender segregated. • Toilets should be cleaned at least twice daily to ensure they are kept in a hygienic condition. • Prevent standing water as it may become a breeding habitat for mosquitoes etc. • Provide workers with access to a shaded rest area on-site. • Provide workers with a clean eating area for breaks and lunchtime.					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Provide all construction workers will an adequate supply of potable drinking water meeting national standards. Groundwater used must be appropriately treated and only be used where it will not put stress on local water resources. Where a risk of arsenic contamination is identified, prohibit the use of groundwater as a source of the drinking water. • If ground or surface water is used for drinking water, it must first be tested to confirm it meets drinking water standards and continue to be regularly tested every week. If drinking water standards are not met, potable water shall be imported to site. • If workers are not local to the area use may be made of existing accommodation facilities but if a construction camp is provided it must be adequately equipped with sufficient toilets, hand washing facilities, showers or baths, food preparation and clean eating area, etc.					
On-site pre-construction and construction activities	Community health and safety - at increased H&S risk from communicable diseases as workers coming from elsewhere, including COVID-19, social disturbances related to workers camps, traffic, electricity infrastructure etc.	• Comply with CHSMP and with IFC EHS General Guidelines in relation to community H&S. • Installation of barriers (a temporary fence ideally solid fence) at construction areas with hazard warning signs to deter people from accessing the construction site • Do not leave hazardous conditions (e.g. unfenced and unlit open excavations without means of escape) overnight unless no access by public can be ensured • Define construction schedule for sections along or crossing roads in coordination with local authorities/traffic police particularly where road closures required. • Implement CTMP during construction works with advance warning signs or flag persons to ensure traffic safety of construction workers and road users, in coordination with traffic police. • Road safety and warning signs must be posted at 500m, 100m, and immediately in advance of the works at least two weeks prior to the works	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks, photographic record etc. No outstanding CHS related grievances No project-related accident reported within community - if they do occur to be reported to NEA board	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor. PSC international health and safety expert to work closely with PMD health and safety staff to ensure knowledge	Contractor to comply with requirements throughout construction, maintain records of health and safety incidents per the EMoP.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line Budget for compensation included in Resettlement Plan and Indigenous People

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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		commencing to inform the public of the temporary blockage. • Access to the construction site will be under traffic controls when trucks enter and exit. • Require all project drivers to abide by Nepal road safety regulations at all times. • Use of scaffold and bamboo frames to support stringing to protect structures, roads, irrigation canals, utilities etc. as well as pedestrians, vehicles, and the conductor itself. • Restore the utilities immediately after all necessary works carried out to minimize public inconvenience • Construction workers including subcontractors will be given awareness raising in HIV/AIDS, other communicable diseases including COVID-19, and sexual, exploitation, abuse and harassment with strict penalties (e.g. immediate removal from site) for any non-compliance of workers to an agreed code of practice • Avoid ponding of water during construction to avoid habitat creation of vector borne diseases e.g. malaria. • Keep a log of all incidents, near-misses and accidents and include these in monthly monitoring reports submitted to NEA and periodic monitoring reports to ADB	and management within 24h and to ADB within 48h. 100% of H&S incidents including near miss recorded, immediately investigated, and corrective action taken to prevent repeat		transfer and development of knowledgeable health and safety team at NEA.		
On-site pre-construction and construction activities	Loss of physical cultural resources (PCR) - chance find procedures will be implemented in case of chance find (including fossils).	• Comply with CEMP and chance find procedure; implement as soon as any monuments or artefacts encountered during construction activities. • Strictly ensure no chance finds are tampered with. • Brief workers on chance find protocol and on apply penalties applying for tempering with them. • Contractor to declare a chance find to DOA and NEA within 24h of find. • PMD to report on any chance find having occurred within 48h to ADB.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks,	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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			photographic record etc. No outstanding PCR related grievances 100% of chance finds were reported to DOA and dealt with in accordance with chance find procedure				Budget for compensation included in Resettlement Plan
Operation & Maintenance							
General maintenance	Environment, health, and safety impacts and risks of the project in general	• During maintenance activities, mitigation measures applicable to the construction stage are also applicable to NEA maintenance activities and workers. • Regular visual and technical inspection of condition and maintenance as required to be carried out by NEA daily at substations to check any leaking oil from transformers or any SF6 leak both of which are to be immediately addressed. • Regular visual and technical inspection of condition and maintenance as required to be carried out by NEA quarterly for transmission lines to check: minimum vertical clearance (6.1m) is maintained; integrity of the towers and wires is in good condition, including bird diverters, insulation, anti-climbing devices; electrical safety warning signs and lighting arrestors; missing or corroded parts are immediately identified and replaced; and, any vegetation growth that may damage or threaten the integrity of the lines etc. • Keep photographic records and log of all inspections and actions taken in response.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA as determined through regular site checks, photographic record etc. No outstanding operation & maintenance related grievances Project infrastructure maintained in working order and good condition at all times.	PMD to implement EMP in collaboration with NEA operation & maintenance teams on site.	n/a	n/a	NEA's operational budget.
Biological Environment							
General maintenance of ROW	Impacts on biodiversity including biodiversity supported by Chure Conservation Area	**Protected Areas:** • NEA will continue to implement the promotion/enhancement measures agreed with Chure Conservation Area	Compliance with national laws and regulations.	PMD to implement EMP in collaboration with NEA operation &	n/a	n/a	Indicative costs for reforestation included in EMP budget table.

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		Maintenance and vegetation control: • Regularly visually inspect the lines to spot any low hanging lines to ensure 6.1 m clearance is kept at all times above ground for safe passage of terrestrial fauna and that "bird sensitive" design features including bird divertors have not be lost or damaged, immediately undertake maintenance work if required. • During inspections of transmission lines count fauna carcasses encountered, if any, record species and assess cause of death (e.g., electrocution/collision). • Prohibit the use of herbicides, pesticides or burning to control any vegetation growth or to manage vegetation waste, in substations and along ROW. • Regularly trim trees located within the RoW that are above 5 m high, at least once every two years, following maximum clearance as per Electricity Regulation, 1993 • During maintenance activities, all EMP requirements for construction phase, in particular strict prohibitions on workers are applicable.	Mitigation measures successfully implemented by NEA as determined through regular site checks, photographic record etc. Reforestation resulted in no-net loss of biodiversity as a result of the project. No outstanding biodiversity-related grievances from local communities.	maintenance teams on site.			
Physical Environment							
GIS substations	Climate change from fugitive emission of SF6	• Keep record of all gas insulated switchgear and gas insulated transformers, including presence, if any, and quantity of SF6 in these. • Provide SF6 leakage detection kit at each substation. • NEA to monitor SF6 emissions through inventory control and accounting per the requirements set out in the EMoP to confirm SF6 leakage is kept to an absolute minimum. • Proper handling and storage procedures to be implemented in accordance with equipment suppliers' specifications and best practices. Check for SF6 gas leakage in every shift of the operation. • Maintain SF6 leakage records in every substation and report in periodic monitoring reports to ADB.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA as determined through regular site checks, photographic record etc. SF6 leakage below 0.1% per annum	PMD to implement EMP in collaboration with NEA operation & maintenance teams on site.	n/a	n/a	NEA's operational budget.

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		• Define a safe SF6 retrieval arrangement, with appropriate handling, storage, disposal process for end of life equipment by a certified industrial waste management company who will need to remove SF6 and treat the equipment prior to disposal in accordance international good practice e.g., International Electrotechnical Commission (IEC) standard 61634 to ensure that the SF6 is not released to atmosphere.					
Substation operation	Noise in the form of buzzing or humming can often be heard around transformers or power lines producing corona. Transformer oil spill and leakage.	• Maintain transformers and other noise generating equipment to ensure noise to be limited to the following as 1 hour LAeq: (i) 70 dB(A) at the site boundary; (ii) at residential properties, 55 (day) and 45 (night) dB(A) in urban areas and 45 (day) and 40 (night) dB(A) in rural areas as defined by Nepal regulations; and (iii) at "peace areas" such as schools as defined by Nepal regulations, 50 (day) and 40 (night) dB(A). • Transformers to be routinely inspected and maintained to avoid spills and leakage. • Collect and segregate 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 or bags) for each distinct type of waste. • Store solid waste in enclosed bins to contain leachate and avoid vermin. • Encourage recovery of recyclable wastes that could be reused or sold to recyclers, rather than disposing of it. • Prohibit open/uncontrolled burning of wastes. • Prohibit dumping of O&M wastes on-site, into drains, rivers, in agricultural fields etc. • NEA may compost biodegradable kitchen scraps on site if of small volume in enclosed composting facilities (enclosed to avoid attraction of vermin etc.) located ideally 500m but at least 100m from water	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA as determined through regular site checks, etc. Monitoring confirms ambient noise within national standards or no worsening of the baseline situation if already exceeded. No outstanding O&M-related grievances from local communities	PMD to implement EMP in collaboration with NEA operation & maintenance teams on site.	n/a	n/a	NEA's operational budget.

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		sources (surface water and groundwater wells, springs, water spouts etc.). • Incineration may be permitted on-site if enclosed, small volume solid waste incinerator with stack and pollution control that is designed for residence time and temperatures that minimize incomplete combustion for waste disposal at substation is available. • Document all wastes removed off site using transfer notes, to be taken by licensed waste contractors who should reuse/recycle or dispose of the waste to suitably licensed and engineered waste management facilities according to type – for solid waste disposal this will need to be to Kathmandu, and for hazardous waste this will need to be to a neighboring country since no such facilities currently exist in Nepal. • Collect solid waste and dispose of it along with municipal waste to suitably engineered and licensed sanitary waste facilities– in Kathmandu as no such facilities are existing in rural municipalities. • Ensure any hazardous waste such as oily rags or old drums disposed of in suitably licensed hazardous waste facilities– out of country since no such facilities in Nepal. • Label all containers with its content and potential risk signs (e.g. flammable, corrosive, toxic, etc.) Display material data sheets for fuels, oil, or chemicals. If chemicals are handled on site, provide an emergency eye wash or shower. • Store end-of-life or unused equipment in designated areas on site, ensure these are not left lying around. • Store equipment in the dedicated, covered, labelled storage area (tools, machinery, material, equipment, and spare parts) • Ensure liquids (fuel, oil, and chemicals, empty drums, old transformers, etc.) are stored in area with impermeable floor with spill containment bund of 110% capacity. • Ensure liquids storage areas are locked at all times.					

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		• Keep track of any maintenance activities carried out with regards to transformers (in particular each time transformer oil is changed) on a maintenance logbook kept on the premises. • Ensure transformers have a label indicating it contains PCB (polychlorinated biphenyl) or is PCB free. Obtain and keep evidence to confirm transformers are PCB free, for future reference. • Perform visual checks of any evidence of oil leaking or having previously leaked from transformers, and if identified, address immediately - maintenance of and handling of transformer oil is to be carried out only by trained workers using appropriate PPE. • Keep spill prevention equipment available on site at all times.					
Socio-economic environment							
Presence of electrical infrastructure and need for maintenance	Occupational safety risks (project maintenance workers) and community safety risks	• Ensure adequate sag and tension always maintained. • Maintain warning / advisory signs in good and visible condition on all dangerous equipment. • Maintain the good condition of non-climb features on transmission towers. • Maintain the good condition of boundary fences, regularly check the security fence for any gaps and repair. Keep boundary gates locked at all times (except when workers are in-coming or exiting) but at times when the gate is unlocked, ensure one staff is always present to control any unauthorized entry. • Consider employing security personnel to guard the premises where the risk of entry for theft might be high. • Carry out periodic safety related awareness raising in neighboring communities regarding living in proximity to power lines and substations, including but not limited to, electrocution risks and effects of EMF; include information to the community regarding potential corona noise heard during operation.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA as determined through regular site checks, photographic record etc. No outstanding H&S related grievances All fatalities reported to government within 24h and to ADB within 48h. No project-related accident reported.	PMD to implement EMP in collaboration with NEA operation & maintenance teams on site.	n/a	n/a	NEA's operational budget.

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		• NEA to ensure all substation staff and maintenance workers have received appropriate OHS trainings for their role **EMF:** • Monitor electromagnetic field strength workers are exposed to and ensure occupational exposures are within the limits of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) reference level. If EMF limits are often reached, provide workers with personal radiation monitors that shall set off an alarm when exposure limits are reached. • Monitor electromagnetic field strength where regularly occupied properties are in the ROW and ensure public exposures are within the reference levels of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines. **Housekeeping:** • Keep the substation neat and tidy at all times. • Remove any trip hazards on the ground, e.g. open channels, materials, equipment, trash laying around. • Carry out regular pest control where pests are a risk; favor natural pest control measures when possible. • Display clear emergency exits signs (in working order, if light signs, ensure works) and keep exits clear of any blockage. • Visually inspect for any standing water on site, and when identified, remove or provide appropriate drainage to remove in timely manner; ensure drainage system is not blocked and fully operational. • Maintain all lights in working order. • Ensure all vents are free of blockages and regularly maintained.					

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		Emergency situations: • Ensure a recent, full, first aid kit and adequate firefighting equipment is available on site at all times, stored in clearly labelled and easily accessible area. • Replace the first aid equipment timely as required to keep all equipment within its expiry date. • Service the firefighting equipment timely as required to keep all equipment in date • Provide first aid and firefighting training to select, volunteer staff; at least one staff having recently carried out first aid and firefighting training must be present on site at all times. Refreshers are to be provided once a year. • Hang posters showing first aid procedures especially for electrocution, and fire procedures, as well as listing all emergency contacts. Display the emergency phone number and location of doctor and hospital in a clear and easily accessible location. • Keep an accident log and make accident logbook available on site upon request. • Monitor closely in case of extreme weather events and be ready to act immediately. • Ensure any buildings on site are structurally sound if any earthquake occurs, check building soundness prior to allowing workers back on site.					
Site-specific EMP							
Kohalpur-Nepalgunj Transmission Line and Nepalgunj Substation	Proximity of physical cultural resources, bird electrocution and collision, presence of Nepalgunj airport, flood risk due to selection of substation site on waterlogged land area, dust due to volume of land fill	• To inform the alignment review NEA and Contractor to consult with communities who utilize Shree Gawat Mata Mandir (Janaki Municipality Ward-5, Bakaspurwa) to seek their views on the routing and reflect their concerns in the detailed design, consultations are to be documented for KNTL • NEA to deliver awareness raising on bird electrocution and collision with power lines and adopting international good practice for "bird sensitive" design to contractor's staff with design responsibilities. • To minimize electrocution risk, "bird sensitive" design measures will include insulators/isolators between	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through review of pre-construction documentation, regular site checks,	PMD to comply with requirements during detailed design, preconstruction, construction, and operation & maintenance. PMD to supervise and monitor contractor to ensure their compliance	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout detailed design, preconstruction, construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line Indicative costs for purchase of bird divertors (excluding

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		live and earthed components of infrastructure, and between phase conductors, being over 2.7 m horizontally and over 1.8 m vertically, bird guards to prevent perching and nesting by birds, and considering insulating any lower voltage wires and/or jumpers at substation connections. • To minimize collision risk bird divertors, at most 10 m apart, as large as possible, of contrasting colors, and visible at night, will be installed on 10.46 km of earth wire on the Kohalpur-Nepalgunj transmission line. • Required cost for purchase of the bird divertors will be included in the contractor's cost, the contractor will also be required to install them. • Contractor will employ field ecologists during detailed route and topographic surveys of the transmission line and substation. They will perform habitat survey to confirm modified habitat is situated beneath the towers and right of ways in the final alignment; the field ecologists will also record any fauna observed in the project area. • Field Ecologist employed by Contractor to also undertake Sarus crane survey of wards/municipalities in which the OHL will pass during pre-construction to confirm baseline numbers present. • Contractor to site tower footprints to avoid the felling trees, cutting trees in ROW outside tower footprints will be kept to an absolute minimum and only be permitted when it is required for laying and stringing of conductors, to meet safety clearance requirements under the Electricity Rules. • In preference to being cut, trees in ROW that can survive it will be pruned in preference to being cut, such that they might reestablish quicker following works. • Contractor to ensure detailed design of transmission line incorporates lightening protection to minimize fire risks. • Detailed design will have minimum height from ground level 6.1 m sufficient for safe passage fauna	photographic record etc. No outstanding site specific-related grievances from local communities.	with delegated requirements.			their installation) are included in EMP budget table

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		(i.e., the lowest point of a conductor between two adjacent towers to be above 6.1m from the ground) • Contractor's detailed designs and CEMP will be reviewed by the PSC International Biodiversity Specialist to confirm that all the measures required by the IEE/EMP and the international good practice (APLIC, 2006 and 2012) have been adequately incorporated before approval of detailed designs and that the detailed designs have responded to any concerns raised by Bird Conservation Nepal. • For Nepalgunj Substation, NEA to fit any future lower voltage wires and/or jumpers at incoming and outgoing distribution line connections with "bird sensitive" design measures. • For K-N OHL contractor to ensure that the project adopts strict anti-hunting and poaching protocols for workers, undertakes conservation awareness raising activities etc. to minimize risks to priority species and Sarus Crane. • Field Ecologist to specifically check for any presence of pangolin in agricultural fields at K-N before construction to avoid any disturbance to their burrows. • Field Ecologist to specifically check for any presence of nesting Sarus crane in agricultural fields at K-N before construction to avoid any disturbance of the nests, eggs, or chicks, construction during monsoon season to also be avoided as this is their breeding season. • Permission from CAAN will be taken prior to contract award and then once detailed design confirmed the commencement of works and the written communication will be shared with ADB regarding its clearance. • The maximum height of the towers is to be 45m to meet CAAN requirements. Any spherical aviation markers, low-intensity lighting or other mitigation requested by CAAN will be incorporated into the detailed design of these project components.					

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		• For Nepalgunj Substation, Flood Risk Assessment will be undertaken by the Contractor as part of the detailed design to (i) confirm the extent of flood risk/inundation and thus land filling required, and (ii) determine drainage works that will enable the equivalent volume of storage lost and that surface water runoff from the site is not more than greenfield rates; it will be approved by CEB and shared with ADB. • Particular care will be taken to ensure the condition of the irrigation access road is maintained and it will be included in the scope of pre-construction condition surveys. • Filling for land raising at Nepalgunj substation will only be undertaken during the dry season due to the adjacent canal. • For Nepalgunj substation, the volume of land fill will be calculated and due to the volume of earthworks involved a site-specific Dust Management Plan will be prepared as part of the CEMP to ensure significant impacts will be avoided. • Given the rural location, the more stringent national noise limit must be complied with at residential receptors – 45dBA in the daytime and 40dBA at the nightime • For the transmission line undertake detailed calculations as part of the detailed design process for approval by NEA to confirm that the EMF limits will be complied with.					
Chobar-Lagankhel Underground Transmission Line and upgradation of	Impacts from laying underground line along the road in dense urban area of Kathmandu Valley with crossing of Bagmati River and locally important physical cultural resources	• NEA and Contractor to plan underground cable in conjunction with other construction works in Kathmandu to minimize the cumulative impacts they may cause to the local community. • Transport equipment only during non-rush hours i.e., avoid the hours of 6 am to 8 am and 4 pm to 6 pm.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA	PMD to comply with requirements during detailed design, preconstruction, construction, and operation & maintenance.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and	Contractor to comply with requirements throughout detailed design, preconstruction, construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs

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Lagankhel Substation		• In Kathmandu Valley noisy construction activity (especially breaking and drilling for underground cables) will take place between 6 am to 6 pm adjacent to residential areas but night time working will be permitted in commercial, tourist and school areas to minimize daytime disruption. • Loud construction noise, breaking activities in particular, must be limited to very short periods of activity adjacent to any given receptor to minimize disturbance. • Contractor to use suitably designed mufflers or sound reduction equipment on breakers and ensure all leaks in the air line are sealed on them. • Local communities will be informed will in advance of the construction schedule for noisy activities. • Construction works for the UG transmission line are to be confined entirely to the existing roadway – no forest land must be impacted and no trees to be cut. • Use horizontal directional drilling as opposed to open trench construction wherever feasible within the built-up area for underground cabling to minimize dust generation. • Contractor to carry out detailed line route survey of alignment of Chobar-Lagankhel UG Transmission Line, including undertaking detailed pre-construction structural survey and photographic record of all property adjacent to the road, in case of any damages claim during laying of cable works. Paying particular attention to weak and sensitive structures along the alignment determine the level of risk and whether such buildings may require the installation of vibration monitors during construction to monitor movement. • Contractor to coordinate with water supply organizations and adopt a suitable construction method where there is greater risk of damage to plastic water pipes. • Contractor to consultant with Department of Roads in relation to the design of the cable installation over the Bagmati Bridge and ensure it does not overload the bridge design.	and Contractor as determined through review of pre-construction documentation, regular site checks, photographic record etc. No outstanding site specific-related grievances from local communities.	PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	assist with supervision and monitoring of the contractor.		of implementing EMP as BOQ line

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		• Special coordination will be necessary with Nepal Traffic Police and pre-information on the planned construction schedule will need to conveyed to them. • For underground cabling adopt a rolling construction method and immediately restore the surface of the excavated roadway once construction activities on each section are completed. • For underground cable alignment, safe access to properties adjacent to the roadway and for informal street vendors will be maintained or, if not possible for health and safety reasons, compensation will be paid in accordance with the RIIP entitlement matrix. • For underground cable alignment, repaving will be done immediately once installation of the cable is complete. • Do not allow the use of oil or bentonite clay as a drilling fluid, if water is used any excess must be disposed of to an adjacent defined area of ground for percolation, or to waiting tanker trucks for proper disposal, it must not be disposed of to surface water. • For works in the Chobar area, the Contractor will develop a site-specific construction method for NEA approval detailing how construction works will factor in the engineering constraints of working in a karst landscape and avoid damage to the karst geology. • For works in the Chobar area, clear demarcation of the working area and avoid encroachment outside the agreed corridor of impact. Natural geological formations adjacent to the working area will also be demarked to avoid accidental damage during construction work. • Crossing of the Chobar Gorge in proposed Pulchocki Conservation Area will ideally be underground within the road or attached the side of the bridge; overhead line is the least preferred option due to electrocution/collision risk – the detailed design and construction method for this crossing is to be determined with the input of DNPWC and BCN.					

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		• If overhead line required at Bagmati River crossing NEA to deliver awareness raising on bird electrocution and collision with power lines and adopting international good practice for "bird sensitive" design to contractor's staff with design responsibilities. • To minimize electrocution risk, "bird sensitive" design measures of any overhead line crossing of the Chobar Gorge will include insulators/isolators between live and earthed components of infrastructure, and between phase conductors, being over 2.7 m horizontally and over 1.8 m vertically, bird guards to prevent perching and nesting by birds, and considering insulating any lower voltage wires and/or jumpers at substation connections. To minimize collision risk bird divertors, at most 10 m apart, as large as possible, of contrasting colors, and visible at night, will be installed. • Required cost for purchase of the bird divertors will be included in the contractor's cost, the contractor will also be required to install them. • Contractor's detailed designs and CEMP will be reviewed by the PSC International Biodiversity Specialist to confirm that all the measures required by the IEE/EMP and the international good practice (APLIC, 2006 and 2012) have been adequately incorporated before approval of detailed designs and that the detailed designs have responded to any concerns raised by Bird Conservation Nepal. • In the proposed Pulchoki Conservation Area, Contractor will not allow any works to be undertaken from 1 hour before sunset to 1 hour after sunrise to avoid disturbance to the fauna, and within 500m of the Bagmati River crossing no noisy works will be undertaken during the bird overwintering period to minimize disturbance to birds. • No lighting is to be used by the Contractor in the proposed Pulchoki Conservation Area. • Contractor to ensure that the project adopt strict anti-hunting and poaching protocols for workers, prohibitions on entry to forest land, undertaking conservation awareness raising activities etc.					

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		• Contractor to develop as part of CEMP a site-specific biodiversity management plan (BMP) detailing mitigation and monitoring measures as required for approval by NEA prior to the commencement of any works, including enabling works. BMP will set out how impacts on the proposed protected area and its forest land will be minimized through the detailed design, construction methods, siting of temporary construction facilities, restrictions on construction workers etc. • Contractor to prepare as part of the CEMP Cultural Heritage Protection Plan and individual construction method statements for sections of work adjacent to locally important physical cultural resources for NEA approval prior to the commencement of any works. These will set out how impacts on the physical cultural resources will be minimized through the detailed design, construction methods, siting of temporary construction facilities, restrictions on construction workers etc. • Contractor to appoint one part-time heritage officer for the Chobar-Lagankhel underground transmission line to monitor and supervise works adjacent to locally important physical cultural resources on a full-time basis. • NEA will obtain written approval from the Department of Archaeology on the Chobar-Lagankhel Transmission Line. • NEA to organize third-party support of Department of Archaeology (DOA) officials to monitor and supervise on a full time-basis construction works adjacent to locally important physical cultural resources for their duration to ensure no damage is caused. • Department of Archaeology must be informed of and agree to construction schedule in order that they can facilitate on-site supervision. • Contractor to provide trainings and awareness raising activities for construction workers in relation to					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		informing them of the presence of/avoiding accidental damage to/change finds of physical cultural resources and help NEA liaise with Department of Archaeology and community users. • Contractor will undertake a detailed pre-construction structural and photographic record of all physical cultural resources within 10m of the alignment of UG transmission line. • If physical cultural resources are used by community and access must be restricted to ensure health and safety Contractor to notify affected communities well in advance, and time works to avoid any such restrictions during important festivals etc. • For the Pati/traditional resting place, Saraswathi Temple and old well on the underground cable route alignment near Lagankhel Substation the cable alignment will be routed on the other side of the road to maximize the distance between construction works and these resources. • To inform the alignment review NEA and Contractor to consult with communities who utilize the physical cultural resources within at least 50m of the transmission line to seek their views on the routing and reflect their concerns in the detailed design, all consultations are to be documented. • For underground cables place warning marks above ground or over the cable to avoid others digging into the underground cable which can result in cable break incidents. • NEA to share the information of the routing of all underground cables to the relevant authorities so when underground works need to be done by others, the location of the cables would be known and can plan to be avoided by their contactors. • Detailed design for underground transmission line to include protection relays in the substation to detect a break in the cable armor and stop sending electricity immediately by automatically opening switchgear in the substation to minimize the risk of live shock.					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Use of trenchless technology for underground cables to substantially minimize traffic congestion and disruption and disturbance to livelihoods, residences, businesses, and community facilities. • Ensure safe access to property and roads/sidewalks is maintained wherever possible by provision of checkered steel plates or stone slabs and diversions and alternative access provided and clearly signed where there are temporary blockages that are a health and safety risk. • Safety guides should be provided where works are on sidewalks or in locations of pedestrian crossings to help guide pedestrians, especially vulnerable persons, safely around the working area. • For road blockages flag men are to be utilized during works to control the traffic flow and protect construction workers and the road users. • Avoid rush hour (6am to 8 am, and 4pm to 6 pm) where works affect roads and sidewalks. • Stockpiling of spoil and cable reels shall be away from properties and only in designated areas where no access will be blocked. • Contractor 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 Contractor (via service providers if appropriate) to notify affected communities well in advance of any power outage etc. • The Contractor will act in accordance with the agreed site-specific EMP, BMP, Heritage Protection Plan etc. • NEA to suspend the Contractor's works if needed due to an unanticipated impact/risk or non-compliance with requirements until corrective action is taken to address this; the Contractor must immediately stop work if requested by Department of Archaeology and before resuming works agree and implement					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		appropriate corrective action for dealing with unanticipated impact or non-compliance with NEA. • Contractor's environment safeguard team to oversee all activities on this component with Contractor engaging security to ensure workers do not engage in prohibited activities. • Contractor will be responsible for repairing at their costs any damage to utilities, roads, and structures prior to completion of their contract. • Contractor will be responsible for repairing at their cost any damage to physical cultural resources within 10 m distance from the UG transmission line. Repairs to would need to be undertaken under the instruction of Department of Archaeology by appropriately qualified and experienced restoration contractors using appropriate materials and construction techniques etc.				
Chobar-Lagankhel Underground Transmission Line and upgradation of Lagankhel Substation	Environment, health, and safety impacts and risks related to existing facilities i.e., Lagankhel substation	• Ensure that the IEE and EMP for PTDEEP Project (Loan 3542) are updated to incorporate Chobar Substation, cleared by ADB, and disclosed, and that works at Chobar Substation are then undertaken in accordance with its EMP. • NEA to implement the project-level Corrective Action Plan (CAP) set out in Appendix 3 of the IEE for existing facility and ensure that prior to start of work by the contractor at Lagankhel Substation all existing facilities meet national laws and regulations and are consistent with the SPS requirements. On completion of corrective actions by NEA, PSC to revisit substation to confirm the status. • PSC to submit a report, including photos, on the status of corrective actions, compliance with national laws and regulations, and consistency with SPS requirements to ADB for clearance, NEA must receive ADB clearance of this report before contractor given access to a substation. • If asbestos is identified by NEA, PSC or Contractor but does not need to be disrupted and appears in good condition, consider leaving it where it is, as main health risks occur when asbestos is moved.	Existing facility meet national laws and regulations and are consistent with the SPS requirements prior to contractor being given access to substation site. Report on the successful completion of CAP cleared by ADB prior to contractor being given access to substation site.	PMD to comply with requirement to implement CAP prior to allowing Contractor access to existing substation site.	PSC to supervise, monitor, and assist PMD in ensuring compliance with CAP including preparation on-site verification and reporting	n/a	NEA budget as per CAP in Appendix 3 Part of PSC budget

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• If any asbestos was found to be present and it will be disturbed by construction works, it must be removed following national requirements and international good practice per EHS General Guidelines on OHS and disposed of as hazardous waste material. • For Lagankhel Substation, NEA will remove all used substation equipment from the extension area and document its disposal using transfer notes, it is to be taken by licensed waste contractors who should reuse/recycle or dispose of the waste to suitably licensed and engineered waste management facilities according to type – for solid waste disposal this will need to be to Kathmandu, and for hazardous waste this will need to be to a neighboring country since no such facilities currently exist in Nepal. • For Lagankhel Substation, the Contractor will undertake a detailed contaminated land site investigation of the extension area including soil quality testing from across the upgrade site to determine if soil contamination is present. If it is the Contractor will prepare for NEA approval a contaminated land remediation plan to either clean the soil before reuse or for its removal off site as a hazardous waste.					
Dumkibas Substation	Substation located with Chure Conservation Area, noise levels due to proximity of residential properties	• NEA to continue to consult with and secure written confirmation from the Chure Conservation Area with specific reference to the substation proposals as to (i) actions required to ensure works are in accordance with their management plans and (ii) measures NEA can support to promote and enhance their conservation aims. • NEA will implement the promotion/enhancement measures agreed with the protected area management in parallel with construction works. • NEA will not award any contract for Dumkibas substation until ADB SPS (2009) protected area management requirements have been confirmed as met by ADB.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through review of pre-construction documentation, regular site checks, photographic record etc.	PMD to comply with requirements during detailed design, preconstruction, construction, and operation & maintenance. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout detailed design, preconstruction, construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• NEA and the Contractor will continuously liaise with the protected area management of Chure Conservation Area to keep them informed of progress on construction. • NEA to deliver awareness raising on bird electrocution and collision with power lines and adopting international good practice for "bird sensitive" design to contractor's staff with design responsibilities. • To minimize electrocution risk, "bird sensitive" design measures will include insulators/isolators between live and earthed components of infrastructure, bird guards to prevent perching and nesting by birds, and considering insulating any lower voltage wires and/or jumpers at substation connections. • Contractor's detailed designs and CEMP will be reviewed by the PSC International Biodiversity Specialist to confirm that all the measures required by the IEE/EMP and the international good practice (APLIC, 2006 and 2012) have been adequately incorporated before approval of detailed designs and that the detailed designs have responded to any concerns raised by Bird Conservation Nepal. • For Dumkibas Substation, NEA to fit any future lower voltage wires and/or jumpers at incoming and outgoing distribution line connections with "bird sensitive" design measures. • Field Ecologist to specifically check for any presence of pangolin in agricultural fields at Dumkibas before construction to avoid any disturbance to their burrows. • For Dumkibas, contractor to ensure that the project adopts strict anti-hunting and poaching protocols for workers, restricts access to the adjacent forest land, undertaking conservation awareness raising activities etc. to minimize risks to forest habitat and priority species. • Construction works including temporary construction facilities are to be confined to agricultural land and within the boundaries of the proposed substation, no encroachment on forest area.	No outstanding site specific-related grievances from local communities.				

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Contractor will not allow any works to be undertaken from 1 hour before sunset to 1 hour after sunrise to avoid disturbance to the fauna. • No lighting is to be used by the Contractor in Chure Conservation Area. • Detailed design will need to include firefighting provision at substation with development of emergency response plan with basic fire training and training drills undertaken for substation staff in event of forest fire. • Contractor to coordinate with DFO and community forest user groups for definition of additional measures for inclusion in the Construction Emergency Preparedness and Response Plan for Dumkibas Substation where works are to be carried out in proximity (within 500m of) to forested areas and there is risk of forest fire to plan for. • Contractor to develop as part of CEMP a site-specific biodiversity management plan (BMP) detailing mitigation and monitoring measures as required for approval by NEA prior to the commencement of any works, including enabling works. BMP will set out how impacts on the protected area will be minimized through the detailed design, construction methods, siting of temporary construction facilities, restrictions on construction workers etc. • The Contractor will act in accordance with the agreed site-specific EMP and BMP as well as in manner consistent with the protected area management plan. • NEA to suspend the Contractor's works if needed due to an unanticipated impact/risk or non-compliance with requirements until corrective action is taken to address this. • Contractor's environment safeguard team to oversee all activities in Chure Conservation Area with Contractor engaging security to ensure workers do not engage in prohibited activities.					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Contractor's environment officer for monitoring and supervision at Dumkibas substation is to have an ecological background given the location in Chure Conservation Area. • For Dumkibas Substation the contractor's Environment Officer will help liaise with the protected area management, and support implementation of promotion/enhancement measures agreed with them. • Prior to connecting the substation to the Bardhaghat-Sardi 132 kV DC transmission line, NEA will obtain written confirmation from MEWRI, Department of Forests, and the President Chure Terai Madhesh Conservation Development Board all requisite national environmental clearance requirements have been complied with. • For Dumkibas substation the more stringent national noise limit must be complied with at residential receptors – 45dBA in the daytime and 40dBA at the night time. • Infrastructure and thus the construction footprint must be set back as far as possible from the site boundaries adjacent to properties, ideally at least 50m. • A sufficiently tall, engineered acoustic barrier must be installed around the boundary of the substation site prior to the commencement of any works including site preparation, this may be temporary structure for construction to ensure noise limits are complied with at the receptors. • Permanent engineered acoustic barrier of sufficient height will need to be incorporated into the detailed design and installed prior to operation, due to the proximity of the residential properties within 15m to ensure noise limits are complied with at the receptors. • Reinforcement of gravel access road to Dumkibas will be undertaken only within its existing footprint whilst still facilitating safe use of the access road by the local community.					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Information on construction method and schedule will be shared with neighboring household regarding prior to commencement of works.					
Mulpani Substation	Vibration, Noise and damage to neighboring structures	• NEA and the Contractor will ensure that during detailed design a safe and well-constructed access will be provided to the houses which are affected by the land take required for the substation construction, the access design will be determined in consultation with the residents and their agreement obtained in writing before the detailed designs for the substation are approved. • The Contractor will undertake a noise and vibration assessment as part of the detailed design stage and prepare a management plan as part of the CEMP for soil compaction and/or piling activities demonstrating how the construction noise requirements will be met (e.g., 70dBA at site boundary, 55dBA day and 45dBA night at residential receptors) and property damage as a result of any vibration due to compaction will be avoided and monitored. • Infrastructure and thus the construction footprint must be set back as far as possible from the site boundaries adjacent to properties, ideally at least 50m. • Ensuring safe distance to the neighboring houses are kept from the piling locations within the substation premises. • A sufficiently high engineered acoustic barrier must be installed around the boundary of the substation site prior to the commencement of any works including site preparation, this may be temporary structure for construction to ensure that noise limits are met at the receptors.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through review of pre-construction documentation, regular site checks, photographic record etc. No outstanding site specific-related grievances from local communities.	PMD to comply with requirements during detailed design, preconstruction, construction, and operation & maintenance. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout detailed design, preconstruction, construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Permanent engineered acoustic barrier of adequate height will need to be incorporated into the detailed design and installed prior to operation, due to the proximity of the residential properties to ensure noise limits are complied with. • Contractor to identify properties around substation site which are at risk of vibration damage, undertake a through structural survey, supported by photographic evidence of any properties at risk, and determine whether such buildings may require the installation of vibration monitors during construction to monitor movement. • Information on construction method and schedule will be shared with neighboring household regarding prior to commencement of works. • Any structural damage to the neighboring houses caused by the construction works will be compensated. • Ground works will ensure coordination with the neighboring households on disruption of any utility such as power, water supply etc.					

Table 10.B: Minimum Provision for Quantitative Environmental Monitoring (EMoP)

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Detailed design and pre-construction preparations								
Air quality: SPM, PM10, PM2.5, SO2, and NO2	Nearest receptor within 100m of substations. Sample of one representative location along Kohalpur-Nepalgunj transmission line. Sample of three representative locations along Chobar-Lagankhel UG transmission line.	One time for baseline establishment prior to the start of any activity on site	To be measured as 1-hour and 24-hour averages along with meteorological data- temperature humidity, wind speed, and wind direction-over a fortnight during dry season.	No exceedance of national ambient air quality standards (or no worsening if exceeded) at sensitive receptors	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report to PMD.	Professional, calibrated, portable outdoor air quality monitoring sensors Part of contract cost, include costs of implementing EMP as BOQ line
Noise level: dB(A)	Site boundary and nearest receptor within 100m of substations. Sample of one representative location along Kohalpur-Nepalgunj transmission line. Sample of three representative locations along Chobar-Lagankhel UG transmission line.	One time for baseline establishment prior to the start of any activity on site	1hr LAeq over a 48-hour period including workday and weekend using professional, calibrated portable monitoring devices.	No exceedance noise standards specified in Table 10.A (or less than 3dBA increase if already exceeded) at site boundary and sensitive receptors	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report to PMD.	Portable real-time calibrated decibel (dB) meter Part of contract cost, include costs of implementing EMP as BOQ line

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Water quality	Surface waterbodies or groundwater sources within 100m	One time for baseline establishment prior to the start of any activity on site	Water sample is to be taken in a clean, non-contaminated, well-sealed container and tested within the next 48h. Water quality tests by accredited laboratory (physical, chemical, and bacteriological tests) to include pH, turbidity, color, TSS, DO, BOD, TPH, fecal coliform. If used as source of drinking water to also test against Nepal drinking water standards	No pollution incident affected surface or groundwater quality	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line
PCBs	All transformers for which documentation confirming PCB-status is not available from NEA.	Once at the onset of project, no additional impact as all equipment and oil procured will be PCB-free	Testing of transformer oil should follow UNEP Guidelines for PCB-testing	All existing substation transformers PCB-free	PMD to recruit licensed entity for testing and report quarterly to ADB	PSC to assist PMD in ensuring that testing is carried out	n/a	To be included in third party bid, around $100 per sample plus costs of collecting the samples
Soil quality	Lagankhel Substation	One time for baseline establishment prior to the start of any activity on site	Soil samples to be taken from across the extension area in a clean, non-contaminated, well-sealed container and tested within the next 48h. Soil quality tests by accredited laboratory to include pH, heavy metals, TPH and PCBs.	No soil contamination or any present remediated prior to construction works	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line
Health and Safety/Physical Cultural Resources: condition surveys in relation to property damage including due to noise and vibration	All properties/ physical cultural resources along transmission lines and adjacent to substations requiring condition survey as per Table 10.A	One time for baseline establishment	Photographic and/or structural pre-condition surveys of existing property condition including roads, irrigation canals, utilities, structures, drains etc. Risk assessment of potential damage to structures and additional recommendations for monitoring were there is a risk of property damage	Damages avoided but if caused paid for by contractor National Building Code to be referred to	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake surveys and report to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Health and Safety: drinking water supplies	Substations	One time for baseline establishment to inform detailed design	Water sample is to be taken in a clean, non-contaminated, well-sealed container and tested within the next 48h. Drinking water quality tests against Nepal drinking water standards by accredited laboratory (physical, chemical, and bacteriological tests including arsenic levels)	Drinking water provided meets national drinking water standards	PMD to appoint third-party laboratory to undertake testing and report results semi-annually to ADB	n/a	n/a	Budget around $200 per sample for third-party laboratory testing
On-site enabling works, construction works, testing and commissioning of project components								
Air quality: SPM, PM10, PM2.5, SO2, and NO2	Nearest receptor within 100m of substations. Sample of three representative locations along Chobar-Lagankhel UG transmission line; additional locations at request PMD/PSC in event visible dust pollution or grievance received during construction	Once during active construction involving earthworks, and then as requested by PMD/PSC in event of visible dust pollution or grievance received during construction.	To be measured as 1-hour and 24-hour averages along with meteorological data- temperature humidity, wind speed, and wind direction-over a fortnight during dry season.	No exceedance of national ambient air quality standards (or no worsening if exceeded) at sensitive receptors	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report monthly to PMD.	Professional, calibrated, portable outdoor air quality monitoring sensors Part of contract cost, include costs of implementing EMP as BOQ line

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Noise level: dB(A)	Site boundary and nearest receptor within 100m of substations. Sample of three representative locations along Chobar-Lagankhel UG transmission line; additional locations at request PMD/PSC in event noise pollution concerns or grievance received during construction	Once during active construction involving noisy activities, and then as requested by PMD/PSC in event of noise pollution concerns or grievance received during construction.	1hr LAeq over a 48-hour period including workday and weekend using professional, calibrated portable monitoring devices.	No exceedance noise standards specified in Table 10.A (or less than 3dBA increase if already exceeded) at site boundary and sensitive receptors	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report monthly to PMD.	Portable real-time calibrated decibel (dB) meter Part of contract cost, include costs of implementing EMP as BOQ line
Water quality	Surface waterbodies or groundwater sources within 100m	Only required if requested by PMD/PSC in event water pollution concerns or grievance received during construction.	Water sample is to be taken in a clean, non-contaminated, well-sealed container and tested within the next 48h. Water quality tests by accredited laboratory (physical, chemical, and bacteriological tests) to include pH, turbidity, color, TSS, DO, BOD, fecal coliform. If used as source of drinking water to also test against Nepal drinking water standards	No pollution incident affected surface or groundwater quality	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report monthly to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line
Construction materials and waste management: record keeping	All construction sites, including construction camps	Monthly reporting by contractor	Keep records of all types of materials used and wastes produced by type, volume/weight. Document waste handling full-cycle through transfer notes (including type, volume, source, transport, intermediaries if any and final treatment or disposal facility (with its license and capacity)	Transfer of all construction wastes documented, and all wastes disposed of in an environmentally sound manner in accordance with IFC EHS Guidelines and agreed CWMP.	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to keep records and report monthly to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Occupational and community health and safety incidents: record keeping	All construction sites, including construction camps	Monthly reporting by contractor	Keep records of near miss, minor, lost time, and fatal health and safety incidents related to the project, compile records from construction sites; carry out interviews with workers and the community to identify if any unrecorded incidents occurred During the COVID-19 pandemic, temperature checks to be carried out at entrance of the work site at start of shift, and records of all suspected and confirmed cases to be kept.	Zero lost time incidents or fatalities (among workers and community) All near miss, minor, lost time, and fatal incidents as well as suspected/confirmed COVID-19 instances having adequate response plan, with lessons learnt for future if they occur.	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake monitoring and report monthly to PMD.	For COVID-temperature checks frontal thermometer. Part of contract cost, include costs of implementing EMP as BOQ line
Health and Safety: drinking water supplies	Construction camps	Monthly reporting by contractor	Water sample is to be taken in a clean, non-contaminated, well-sealed container and tested within the next 48h. Drinking water quality tests against Nepal drinking water standards by accredited laboratory (physical, chemical, and bacteriological tests including arsenic levels) Alternatively, evidence that drinking water meeting national standards is being imported for workers consumption is to be provided	Drinking water provided meets national drinking water standards	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake monitoring and report monthly to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line Budget around $200 per sample for third-party laboratory testing
Health and Safety/Physical Cultural Resources: condition surveys in relation to property damage including due to noise and vibration	All properties/ physical cultural resources along transmission lines and adjacent to substations requiring condition survey as per Table 10.A	Monthly reporting by contractor	Ongoing photographic record of the condition of roads, irrigation canals, utilities, structures, drains etc. Structural condition monitoring of properties at risk as recommended from the pre-construction surveys	Damages avoided but if caused paid for by contractor National Building Code to be referred to	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake surveys and report to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Operation & Maintenance								
GHG emissions: SF6 leakage	All GIS substations	Daily, as part of daily shift checks.	Record of all SF6 leakage and any SF6-related maintenance activities in GIS substations.	Leakage <0.1% and records of undertaking a regular maintenance	PMD (supported by third party if needed) to undertake monitoring and report semi-annually to ADB.	n/a	n/a	Portable SF6 leakage detector - one per site (around $100 each)
Noise level: dB(A)	Site boundary and nearest receptor within 100m of substations.	Once at the completion of construction	1hr LAeq over a 48-hour period including workday and weekend using professional, calibrated portable monitoring devices.	No exceedance noise standards specified in Table 10.A (or less than 3dBA increase if already exceeded) at site boundary and sensitive receptors	PMD (supported by third party if needed) to undertake monitoring and report semi-annually to ADB.	n/a	n/a	Portable real-time calibrated decibel (dB) meter ($1000 per site)
Health and Safety: accident records	For all project components	Monthly	Keep records of health and safety incidents, compile records from substations and carry out interviews with workers and the community to identify if any unrecorded incidents occurred	Zero lost time incidents or fatalities (among workers and community) All near miss, minor, lost time, and fatal incidents having adequate response plan, with lessons learnt for future.	PMD to keep accident records and report semi-annually to ADB, report any lost time incident or fatality within 48h to ADB	n/a	n/a	NEA operational budget

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Health and Safety: electromagnetic field (EMF)	Overhead transmission lines with regularly occupied properties in ROW Substations	Once at the completion of construction at transmission lines. Daily monitoring for workers at substations working in close contact EMF.	EMF spot checks along length of transmission lines at locations with regularly occupied properties in ROW Continuous check for substation workers working in close contact with EMF, through personal EMF monitor carried by worker at all times while working on live equipment.	No exceedance of ICNIRP reference levels	PMD (supported by third party if needed) to undertake monitoring and report semi-annually to ADB.	n/a	n/a	Portable site EMF detector, personal EMF radiation exposure monitoring equipment for workers (around $100 each)
Health and Safety: drinking water supplies	Substations	Once at the completion of construction, then annually retest.	Drinking water quality tests against Nepal drinking water standards by accredited laboratory (physical, chemical, and bacteriological tests including arsenic levels) Alternatively, evidence that drinking water meeting national standards is being imported for workers consumption is to be provided	Drinking water provided meets national drinking water standards	PMD to appoint third-party laboratory to undertake testing and report results semi-annually to ADB	n/a	n/a	Budget around $200 per sample for third-party laboratory testing

CHAPTER 2- GENERAL TECHNICAL REQUIREMENT

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1.0 FOREWORD

1.1 The provisions under this chapter are intended to supplement general requirements for the materials, equipment and services covered under other chapters of tender documents and are not exclusive.

2.0 GENERAL REQUIREMENT

2.1 The contractor shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification during detailed engineering.

2.2 It is recognised that the Contractor may have standardised on the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to Employer.

2.3 Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification and bid price schedule but which are necessary for commissioning and satisfactory operation of the switchyard/substation unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment provided, shall be inter-changeable with one another.

3.0 STANDARDS

3.1 The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of Nepal / relevant IEC standard or Acceptable International Standard.

3.2 The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the date of bid opening) of standard specified under Annexure-A of this chapter, unless specifically mentioned in the specification.

3.3 The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement each other.

3.4 The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IEC or equivalent international standard.

3.5 When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

3.6 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under Annexure-A /

individual chapters for various equipment shall also, be accepted, however the salient points of difference shall be clearly brought out in the Additional information schedule of the bid along with English language version of such standard. The equipment conforming to standards other than specified under Annexure-A / individual chapters for various equipment shall be subject to Employer's approval.

4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

4.1 The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc under such over voltage conditions.

4.2 All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.

4.3 All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc for the equipment.

4.4 The bidder shall design terminal connectors of the equipment taking into account various forces that are required to withstand.

4.5 The equipment shall also comply to the following:

a) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".

b) All piping, if any between equipment control cabinet/ operating mechanism to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.

4.6 Equipment and system shall be designed to meet the following major technical parameters as brought out hereunder.

4.6.1 System Parameters

132kV, 33kV, 22kV & 11kV System

SL No	Description of parameters	132 kV System	33 kV System	66 kV System	11 kV System
1.	System operating voltage	132kV	33kV	66kV	11kV
2.	Maximum operating voltage of the system(rms)	145kV	36kV	72.5kV	12kV Iec 61936
3.	Rated frequency	50Hz	50Hz	50Hz	50Hz
4.	No. of phase	3	3	3	3
5.	Rated Insulation levels				
i)	Full wave impulse withstand voltage (1.2/50 microsecond.)	650 kVp	170 kVp	325 kVp	75 kVp
ii)	One minute power frequency dry and wet withstand voltage (rms)	275kV	70kV	140kV	28kV
6.	Corona extinction voltage	105kV	-	-	-
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 92kV rms for 132kV system	500 micro-volt	-	-	-
8.	Minimum creepage distance (25mm/kV)	3625 mm	900 mm	25mm/kV	300 mm
9.	Min. Clearances				
i.	Phase to phase	1300 mm	320 mm	790 mm	120 mm

SL No	Description of parameters	132 kV System	33 kV System	66 kV System	11 kV System
					Indoor
ii.	Phase to earth	1300 mm	320 mm	690 mm	120 mm
iii)	Sectional clearances	4000 mm	3000 mm	3100 mm	
10.	Rated short circuit current	31.5 kA for 1 Sec	25 kA for 3 Sec	25 kA for 3 Sec	25 kA for 3 Sec
11.	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed

Note:

1. The above parameters are applicable for installations up to an altitude of 1000m above mean sea level. For altitude exceeding 1000m, necessary altitude correction factor shall be applicable.
2. The insulation and RIV levels of the equipment shall be as per values given in the respective chapter of the equipment.

4.6.2 Major technical parameters of bushings / hollow column / support insulators are given below:

132kV, 33kV, 11kV System

S.N.	Parameters	132 kV	33kV	66kV	11kV
(a)	Max. System voltage Um(kV)	145	36	72.5	12
(b)	Impulse withstand voltage (dry & wet) (kVp)	± 650	± 170	± 325	± 75
(c)	Power frequency withstand voltage (dry and wet) (kV rms)	275	70	140	28
(d)	Total creepage distance (min) (mm)	3625	900	1815	300

4.6.3 Major Technical Parameters

The major technical parameters of the equipment are given below. For other parameters and features respective technical chapters should be referred.

4.6.3.1 (A) For 145 kV Circuit Breaker and Isolator

Rated voltage kV (rms)	145
Rated frequency (Hz)	50
No. of Poles	3
Design ambient temperature (°C)	50

Rated insulation levels:

1) Full wave impulse withstand voltage (1.2/50 micro sec.)

- between line terminals and ground ±650 kVp
- between terminals with circuit breaker open ±650 kVp
- between terminals with isolator open ±750 kVp

2) One minute power frequency dry and wet withstand voltage

- between line terminals and ground 275 kV (rms)
- between terminals with circuit breaker open 275 kV (rms)
- between terminals with Isolator open 315kV (rms)

Max. radio interference voltage (microvolts) for frequency between 0.5 MHz and 2 MHz in all positions of the equipment. 500 (at 156 kV rms)

System neutral earthing	Effectively earthed
Seismic acceleration	- 0.5g horizontal -
Rating of Auxiliary Contacts	10 A at 220/110 V DC (as applicable)
Breaking capacity of Auxiliary Contacts	2 A DC with circuit time constant of not less than 20ms.
Phase to phase spacing (mm)	1300mm

Auxiliary Switch shall also comply with other clauses of this chapter.

(B) FOR 145 kV CT/CVT/SA

Rated voltage kV (rms)	145
Rated frequency (Hz)	50
No. of poles	1
Design ambient temperature (°C)	50

Rated insulation levels:

1) Full wave impulse withstand voltage (1.2/50 micro sec.)

- between line terminals and ground for CT and CVT ±650 kVp
- for arrester housing ±650 kVp

2) One minute power frequency dry and wet withstand voltage

- between line terminals and ground for CT and CVT	275 kV rms	
- for arrester housing	275kV rms	
Max. radio interference voltage (microvolts) for frequency between 0.5 MHz and 2 MHz in all positions of the equipment.	500	(at 92 kV rms)
Minimum creepage distance :-		
Phase to ground (mm)	3625	
System neutral earthing	- Effectively earthed -	
Seismic acceleration	- 0.5g horizontal -	
Partial discharge for :-		
- Surge arrester at 1.05 COV	- Not exceeding 50 pc. -	
- for CT/CVT	- Not exceeding 10 pc. –	

5.0 ENGINEERING DATA AND DRAWINGS

5.1 The list of drawings/documents which are to be submitted to the Employer shall be discussed and finalised by the Employer at the time of award.

The Contractor shall necessarily submit all the drawings/ documents unless anything is waived.

5.2 The Contractor shall submit 4 (four) sets of drawings/ design documents /data / detailed bill of quantity and 2 (Two) set of test reports for the approval of the Employer. The contractor shall also submit the softcopy of the above documents in addition to hardcopy.

5.3 Drawings

5.3.1 All drawings submitted by the Contractor shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

5.3.2 Drawings submitted by the Contractor shall be clearly marked with the name of the Employer, the unit designation, the specifications title, the specification number and the name of the Project. Employer/Consultant has standardized few drawings/documents of various make including type test reports which can be used for all projects having similar requirements and in such cases no project specific approval (except for list of applicable drawings along with type test reports) is required. However, distribution copies of standard drawings/documents shall be submitted as per provision of the Contract. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in SI units.

5.3.3 The review of these data by the Employer will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might

affect substation layout. This review by the Employer may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

5.5 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Employer. Approval of Contractor's drawing or work by the Employer shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

5.6 All engineering data submitted by the Contractor after final process including review and approval by the Employer shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Employer in Writing.

5.7 Approval Procedure

The scheduled dates for the submission of the drawings as well as for, any data/information to be furnished by the Employer would be discussed and finalised at the time of award. The following schedule shall be followed generally for approval and for providing final documentation.

i)	Approval/comments/ by Employer on initial submission	As per agreed schedule
ii)	Resubmission (whenever required)	Within 3 (three) weeks from date of comments
iii)	Approval or comments	Within 3 (three) weeks of receipt of resubmission.
iv)	Furnishing of distribution copies (5 hard copies per substation and one scanned copy (pdf format) for Corporate Centre)	2 weeks from the date of approval
v)	Furnishing of distribution copies of test reports	
	(a) Type test reports (one scanned softcopy in pdf format per substation plus one for corporate centre & one hardcopy per substation)	2 weeks from the date of final approval
	(b) Routine Test Reports (two copies for each substation)	-do-
vi)	Furnishing of instruction/ operation manuals (4 copies	As per agreed schedule

	per substation and one softcopy (pdf format) for corporate centre & per substation)	
(vii)	As built drawings (Four sets of hardcopy per substation & one softcopy (pdf format) for corporate centre & per substation)	On completion of entire works

NOTE :

(1) The contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Employer or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

(2) All drawings should be submitted in softcopy form, however substation, underground transmission line design drawings like elevation, profile, SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version. SLD, GA & layout drawings shall be submitted for the entire substation in case of substation extension also.

(3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.

(4) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/ additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Employer.

(5) The Contractor shall furnish to the Employer catalogues of spare parts.

(6) All As-built drawings/documents shall be certified by site indicating the changes before final submission.

6.0 MATERIAL/ WORKMANSHIP

6.1 General Requirement

6.1.1 Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.

6.1.2 In case where the equipment, materials or components are indicated in the specification as “similar” to any special standard, the Employer shall decide upon the question of similarity. When required by the specification or when required by the Employer the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings

shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfil their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Employer.

6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

6.1.5 All materials and equipment shall be installed in strict accordance with the manufacturer's recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer's tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer's limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

6.1.6 The Contractor shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him.

6.2 Provisions for Exposure to Hot and Humid climate

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipment located in non-air conditioned areas shall also be of same type.

6.2.1 Space Heaters

6.2.1.1 The heaters shall be suitable for continuous operation at 230V as supply voltage. On-off switch and fuse shall be provided.

6.2.1.2 One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

6.2.1.3 Suitable anti condensation heaters with the provision of thermostat shall be provided.

6.2.2 FUNGI STATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due

to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

6.2.3 Ventilation opening

Wherever ventilation is provided, the compartments shall have ventilation openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds and suitable provision shall be made so as to avoid any communication of air / dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

6.2.4 Degree of Protection

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

a) Installed out door: IP- 55

b) Installed indoor in air conditioned area: IP-31

c) Installed in covered area: IP-52

d) Installed indoor in non air conditioned area where possibility of entry of water is limited: IP-41.

e) For LT Switchgear (AC & DC distribution Boards): IP-52

The degree of protection shall be in accordance with IEC-60947 (Part-I) / IEC-60529. Type test report for degree of protection test, shall be submitted for approval.

6.3 RATING PLATES, NAME PLATES AND LABELS

6.3.1 Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the Employer. The rating plate of each equipment shall be according to IEC requirement.

6.3.2 All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipment shall be provided with English inscriptions.

6.4 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into successful Operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

7.0 DESIGN IMPROVEMENTS / COORDINATION

7.1 The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. However, the Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the Employer & contractor agree upon any such changes, the specification shall be modified accordingly.

7.2 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

7.3 The Contractor shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

7.4 The Contractor has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Employer. The names of agencies shall be intimated to the successful bidders.

7.5 The Contractor will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Employer (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at Employer's Corporate Centre, Nepal or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

8.0 QUALITY ASSURANCE PROGRAMME

8.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's Works or at his Sub-contractor's premises or at the Employer's site or at any other place of Work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be broadly outlined by the contractor and finalised after discussions before the award of contract. The detailed programme shall be submitted by the contractor after the award for reference. A quality assurance programme of the contractor shall generally cover the following:

(a) His organisation structure for the management and implementation of the proposed quality assurance programme:

(b) Documentation control system;

(c) Qualification data for bidder's key personnel;

(d) The procedure for purchases of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

(e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;

(f) Control of non-conforming items and system for corrective actions;

(g) Inspection and test procedure both for manufacture and field activities.

(h) Control of calibration and testing of measuring instruments and field activities;

(i) System for indication and appraisal of inspection status;

(j) System for quality audits;

(k) System for authorising release of manufactured product to the Purchaser.

(l) System for maintenance of records;

(m) System for handling storage and delivery; and

(n) A quality plan detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

The Employer or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendor's quality management and control activities.

8.2 Quality Assurance Documents

The contractor would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Employer's inspection of equipment/material

9.0 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

9.1 All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective chapters.

9.2 The reports for all type tests as per technical specification shall be furnished by the Contractor along with equipment / material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by Utility or representative of accredited test lab or reputed consultant.

The test reports submitted shall be of the tests conducted within last 10 (ten) years prior to the originally **Scheduled date of bid opening. In case the test reports are of the test conducted earlier than 10 (Ten) years prior to the originally Scheduled date of bid opening, the contractor shall repeat these test(s) at no extra cost to the Employer.**

However, in case of instrument transformers, the following type tests should have been conducted within 5 (five) years prior to the originally Scheduled date of bid opening.

i) Lightning Impulse Test

ii) Switching Impulse Test

iii) Multiple Chopped Impulse Test (For CT)

iv) Chopped Impulse Test (For CVT)

In case the test reports are of these tests (for instrument transformers) as mentioned above are conducted earlier than 5 (five) years prior to the originally Scheduled date

of bid opening, the contractor shall repeat these test(s) at no extra cost to the Employer.

Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Employer.

The Contractor shall intimate the Employer the detailed program about the tests at least two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

Further, in case type tests are required to be conducted/repeated and the deputation of Inspector/Employer's representative is required, then all the expenses shall be borne by the Contractor.

9.3 The Employer, his duly authorized representative and/or outside inspection agency acting on behalf of the Employer shall have at all reasonable times free access to the Contractor's/sub-vendors premises or Works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain for the Engineer and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, despatch or at site at the option of the Employer and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

9.4 The Contractor shall give the Employer /Inspector fifteen (15) days written notice for on-shore and six (6) weeks notice for off-shore material being ready for joint testing including contractor and ***Employer.*** Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Employer /inspector, unless witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed alone with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.

9.5 The Employer or Inspector shall, within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Employer /Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

9.6 When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Employer/inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Employer /Inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer/Inspector. Failure of the Employer /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Employer to accept the equipment should, it, on further tests after erection,

be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of CIP by the Employer.

9.7 In all cases where the Contract provides for tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Employer /Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Employer /Inspector or to his authorised representative to accomplish testing.

9.8 The inspection by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

9.9 The Employer will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

9.10 The Employer reserves the right for getting any field tests not specified in respective chapters of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the Employer.

10.0 TESTS

10.1 Pre-commissioning Tests

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Employer and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed are given in respective chapters and shall be included in the Contractor's quality assurance programme.

10.2 Commissioning Tests

10.2.1 The available instrumentation and control equipment will to be used during such tests and the Employer will calibrate, all such measuring equipment and devices as far as practicable.

10.2.2 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

10.2.3 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.

10.3 The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard. However necessary fee shall be reimbursed on production of requisite documents.

11.0 PACKAGING & PROTECTION

11.1 All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Employer, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to

facilitate the Employer to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes should be taken into account. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Employer takes no responsibility of the availability of the wagons.

11.2 All coated surfaces shall be protected against abrasion, impact, discolouration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

12.0 FINISHING OF METAL SURFACES

12.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts & bolts and spring washers shall be electro galvanized to service condition 4. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to Equivalent International Standards.

12.2 HOT DIP GALVANISING

12.2.1 The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq. m minimum.

12.2.2 The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

12.2.3 After galvanizing. no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

12.2.4 The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IEC.

12.2.5 Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.

- Coating thickness
- Uniformity of zinc

- Adhesion test
- Mass of zinc coating

12.2.6 Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

12.3 PAINTING

12.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005/Equivalent International standard "Code of practice for phosphating iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

12.3.2 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

12.3.3 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

12.3.4 The exterior and interior colour of the paint in case of new substations shall preferably be RAL 7032 for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective chapters of the equipment. Glossy white colour inside the equipment /boards /panels/junction boxes is also acceptable. The exterior colour for panels shall be matching with the existing panels in case of extension of a substation. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipment.

12.3.5 In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted alongwith the Bids for Employer's review & approval.

12.3.6 The colour scheme as given below shall be followed for Fire Protection and Air Conditioning systems

S.No.	PIPE LINE	Base colour	Band colour
Fire Protection System			
1	Hydrant and Emulsifier system pipeline	FIRE RED	-
2	Emulsifier system detection line – water	FIRE RED	Sea Green
3	Emulsifier system detection line –Air	FIRE RED	Sky Blue

4	Pylon support pipes	FIRE RED	
Air Conditioning System			
5	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-
6	Refrigerant gas pipeline – at compressor discharge	Canary Yellow	Red
7	Refrigerant liquid pipeline	Dark Admiralty Green	-
8	Chilled water pipeline	Sea Green	-
9	Condenser water pipeline	Sea Green	Dark Blue

The direction of flow shall be marked by → (arrow) in black colour.

Base Colour Direction of flow Band Colour

12.3.7 For aluminium casted surfaces, the surface shall be with smooth finish. Further, in case of aluminium enclosures the surface shall be coated with powder (coating thickness of 60 microns) after surface preparation for painting.

13.0 HANDLING, STORING AND INSTALLATION

13.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Employer or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.

13.2 Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.

13.3 The contractor shall have to ensure that the hard and flat indoor and outdoor storage areas are in place prior to commencement of delivery of material at site. Contractor shall also ensure availability of proper unloading and material handling equipment like cranes etc. and polyester/nylon ropes of suitable capacity to avoid damage during unloading and handling of material at site. All indoor equipment shall be stored indoors. Outdoor equipment may be stored outdoors but on a hard and flat raised area properly covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress. However, all associated control panels, marshalling boxes operating boxes etc. of outdoor equipment are to be stored indoors only.

Storage of equipment on top of another one is not permitted if the wooden packing is used. Material opened for joint inspection shall be repacked properly as per manufacturer's recommendations.

During storage of material regular periodic monitoring of important parameters like oil level / leakage, SF6 / Nitrogen pressure etc. shall be ensured by the contractor.

13.4 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Employer. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

13.5 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

13.6 Contractor shall be responsible for examining all the shipment and notify the Employer immediately of any damage, shortage, discrepancy etc. for the purpose of Employer's information only. The Contractor shall submit to the Employer every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

13.7 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Employer in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Employer, as well as protection of the same against theft, element of nature, corrosion, damages etc.

13.8 Where material / equipment is unloaded by Employer before the Contractor arrives at site or even when he is at site, Employer by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.

13.9 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.

13.10 The words 'erection' and 'installation' used in the specification are synonymous.

13.11 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

13.12 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances as given in clause 4.7.1 the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

13.13 Equipment Bases

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Employer. Each base plate shall support the unit and its drive assembly, shall be of a

neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

14.0 TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment. However, these tools and tackles shall be separately, packed and brought on to Site.

15.0 AUXILIARY SUPPLY

15.1 The sub-station auxiliary supply is normally met through a system indicated under chapter "Electrical & Mechanical Auxiliaries" having the following parameters. The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation and PLCC system shall also conform the parameters as indicated in the following.

Normal Voltage	Variation in Voltage	Frequency in HZ	Phase/Wire	Neutral connection
400V	± 10	50 ± 2.5%	3/4 Wire	Solidly Earthed.
230V	± 10	50 ± 2.5%	1/2 Wire	Solidly Earthed.
220V	190V to 240V	DC	-	Isolated 2 wire System
110V	95V to 120V	DC	-	Isolated 2 wire System
48V	_	DC	_	2 wire system (+) earthed

Combined variation of voltage and frequency shall be limited to ± 10%.

16.0 SUPPORT STRUCTURE

16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e 5.9 meter from plinth level for 245 kV substations respectively. All equipment support structures shall be supplied alongwith brackets, angles, stools etc. for attaching the operating mechanism, control cabinets & marshalling box (wherever applicable) etc.

16.2 Support structure shall meet the following mandatory requirements:

16.2.1 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.

17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

17.1 All power clamps and connectors shall conform to ANSI/NEMA CC1/ Equivalent International standard and shall be made of materials listed below :

	For connecting ACSR conductors	Aluminium alloy casting conforming to BS:1490/ Equivalent International Standard
	For connecting	Bimetallic connectors made from aluminium alloy casting

	equipment terminals made of copper with ACSR conductors	conforming to BS:1490/ Equivalent International Standard with 2mm thick bimetallic liner.
	For connecting GI	Galvanized mild shield wire
	i) Bolts nuts and plain washers	Electrogalvanised for sizes Plain, washers below M12, for others hot dip galvanised.
	ii) Spring washers for item 'a' to 'c'	Electrogalvanised mild steel

17.2 Necessary clamps and connectors shall be supplied for all equipment and connections. The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of work.

17.3 Where copper to aluminium connections are required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress.

17.4 Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified in each particular case, are also included in the scope of Work.

17.5 No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner of minimum 2 mm thickness shall be cast integral with aluminium body or 2 mm thick bi-metallic strips shall be provided for Bi-metallic clamps.

17.6 All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

17.7 Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/sliding) type connection of 4" IPS AL. tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.

17.8 Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.

17.10 Clamps and connectors shall be designed to be corona controlled.

17.11 Tests

17.11.1 Clamps and connectors should be type tested as per NEMA CC1/ Equivalent International Standard and shall also be subjected to routine tests as per NEMA CC1/

Equivalent International Standard. Following type test reports shall be submitted for approval as per clause 9.2 above except for sl. no.(ii) & (iii) for which type test once conducted shall be applicable (i.e. the requirement of test conducted within last ten years shall not be applicable).

i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)

ii) Short time current test

iii) Corona (dry) and RIV (dry) test (for 220 kV and above voltage level clamps)

iv) Resistance test and tensile test

18.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

18.1 All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IEC-60439, as applicable, and the clauses given below:

18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminium enclosure and shall be dust, water and vermin proof. Sheet steel used shall be at least 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.6 mm thick stainless steel can also be used. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminium enclosed box the thickness of aluminium shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

18.3 A canopy and sealing arrangements for operating rods shall be provided in marshalling boxes / Control cabinets to prevent ingress of rain water.

18.4 Cabinet/boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.

18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene gaskets. The gasket shall be tested in accordance with approved quality plan, BS:4255/ Equivalent International Standard Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

18.6 All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.

18.7 A 230V, single phase, 50 Hz, 15A AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade.

18.8 For illumination, a fluorescent tube or CFL of approximately 9 to 15 watts shall be provided. The switching of the fittings shall be controlled by the door switch. .

For junction boxes of smaller sizes such as lighting junction box, manual operated earth switch mechanism box etc., plug socket, heater and illumination is not required to be provided.

18.9 All control switches shall be of MCB/rotary switch type and Toggle/piano switches shall not be accepted.

18.10 Positive earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of self etching washer. Earthing of hinged door shall be done by using a separate earth wire.

18.11 The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door.

18.12 a) The following routine tests along with the routine tests as per IEC 60529/ Equivalent International Standard shall also be conducted:

i) Check for wiring

ii) Visual and dimension check

b) The enclosure of bay marshalling kiosk, junction box, terminal box shall conform to IP-55 as per IEC 60529/ Equivalent International Standard including application of, 2.0 kV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.

19.0 Void.

20.0 TERMINAL BLOCKS AND WIRING

20.1 Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All interphase and external connections to equipment or to control cubicles will be made through terminal blocks.

20.2 Terminal blocks shall be 650V grade and have continuous rating to carry the maximum expected current on the terminals and non breakable type. These shall be of moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type of Elmex or Phoenix or Wago or equivalent make.

20.3 Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

20.4 The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.

20.5 The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable.

20.6 The terminal blocks shall be of extensible design.

20.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

20.8 The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

20.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

a)	All circuits except CT/PT circuits	Minimum of two of 2.5 sq mm copper flexible.
b)	All CT/PT circuits	Minimum of 4 nos. of 2.5 sq mm copper flexible.

20.10 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

20.11 At least 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.

20.12 There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate for outdoor ground mounted marshalling box and the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

20.13 The Contractor shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets.

20.14 All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.

21.0 LAMPS & SOCKETS

21.1 Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round plug as per Nepalese Standard. They shall be switched sockets with shutters.

21.2 Hand Lamp:

A 230 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

21.3 Switches and Fuses:

21.3.1 Each panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breaker / switchfuse units. Selection of the main and Sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

21.3.2 All fuses shall be of HRC cartridge type conforming to IS:9228/ Equivalent International Standard mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

22.0 Bushings, Hollow Column Insulators, Support Insulators:

22.1 Bushings shall be manufactured and tested in accordance with IEC-60137 while hollow column insulators shall be manufactured and tested in accordance with IEC-62155.The support insulators shall be manufactured and tested as per IEC-60168 and IEC-60273. The insulators shall also conform to IEC-60815 as applicable.

The bidder may also offer composite hollow insulators, conforming to IEC-61462.

22.2 Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

22.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

22.4 Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

22.5 When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.

22.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

22.7 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

22.8 Tests

In bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS: 2099 & IS: 2544 & IS: 5621/ Equivalent International Standard .

23.0 MOTORS

Motors shall be “Squirrel Cage” three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall be subjected to routine tests as per applicable standards. The motors shall be of approved make.

23.1 Enclosures

a) Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP-55 as per IEC 60529/ Equivalent International Standard For motors to be installed indoor i.e. inside a box, the motor enclosure, shall be dust proof equivalent to IP-44 as per IS: 4691/ Equivalent International Standard.

b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.

c) Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing.

d) Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

23.2 Operational Features

a) Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be over loaded at any operating point of driven equipment that will rise in service.

b) Motor shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Chapter.

23.3 Starting Requirements:

a) All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.

b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

c) The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS:325/ Equivalent International Standard.

d) Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 15.0 shall be capable of withstanding at least two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of

winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.

e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

23.4 Running Requirements:

a) The maximum permissible temperature rise over the ambient temperature of 50 degree C shall be within the limits specified in IS:325/ Equivalent International Standard (for 3 - phase induction motors) after adjustment due to increased ambient temperature specified.

b) The double amplitude of motor vibration shall be within the limits specified in IS: 4729/ Equivalent International Standard. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

c) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

23.5 TESTING AND COMMISSIONING

An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Contractor or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Employer for approval.

(a) Insulation resistance.

(b) Phase sequence and proper direction of rotation.

(c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

24.0 TECHNICAL REQUIREMENT OF EQUIPMENT

24.1 1.1 kV Grade Power & Control Cables

24.1.1 Applicable for PVC Control Cable

The manufacturers, whose PVC control cables are offered, should have designed, manufactured, tested and supplied in a single contract at least 100 km of 1.1 kV grade PVC insulated control cables as on the date of bid opening. Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 27C x 2.5 Sq.mm or higher size as on the originally Scheduled date of bid opening.

24.1.2 Applicable for PVC Power Cable

The manufacturer, whose PVC Power Cables are offered, should have designed, manufactured, tested and supplied in a single contract at least 100 kms of 1.1 kV or higher grade PVC insulated power cables as on the date of bid opening. Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 1C x 150 Sq. mm or higher size as on the originally Scheduled date of bid opening.

24.1.3 Applicable for XLPE Power Cables

The Manufacturer, whose XLPE Power cables are offered, should have designed, manufactured, tested and supplied in a single contract at least 25 km of 1.1 kV or higher grade XLPE insulated power cables as on the date of bid opening. Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 1C x 630 Sq. mm or higher size as on the originally Scheduled date of bid opening.

24.2 LT Switchgear

24.2.1 The Manufacturer whose LT Switchgear are offered, should be a manufacturer of LT Switchboards of the type and rating being offered. He should have designed, manufactured, tested and supplied at least 50 nos. draw out circuit breaker panels, out of which at least 5 nos. should have been with relay and protection schemes with current transformer. He should have also manufactured at least 50 nos MCC panels comprising of MCCBs (ie Moulded Case Circuit Breakers) modules of the type offered which should be in successful operation as on originally Scheduled date of bid opening.

24.2.2 The Switchgear items (such as circuit breakers, fuse switch units, contactors etc.), may be of his own make or shall be procured from reputed manufacturers and of proven design. At least one hundred circuit breakers of the make and type being offered shall be operating satisfactory as on originally Scheduled date of bid opening.

24.3 Fire Fighting System

The bidder or his sub-vendor should have designed, supplied, tested, erected and commissioned at least one number fire protection system of the each type described in (i), (ii) and (iii) below in installations such as power plants, substations, refineries, fertilizer plants or other industrial or commercial installations. Such systems must have been designed and comply to International Standard code (FOC, LONDON or NFPA, USA etc) executed during last ten (10) years and should have been in successful operation for at least 2 years as on the originally Scheduled date of bid opening.

(i) Automatic hydrant type fire protection system.

(ii) Automatic high velocity or automatic medium velocity water spray type fire protection system

(iii) Smoke detection system.

(iv) Nitrogen Based Fire fighting system

In case bidder himself do not meet the requirement of design, he can engage a consultant(s) who must have designed i) Automatic hydrant type fire protection system, ii) Automatic high velocity or automatic medium velocity water spray type fire protection system and iii) Smoke detection system, which must be in successful operation for at least two years as on the originally Scheduled date of bid opening.

ANNEXURE - A

LIST OF SPECIFICATIONS

GENERAL STANDARDS AND CODES

IEC-60060 (Part 1 to P4)	-	High Voltage Test Techniques
IEC 60068	-	Environmental Test
IEC-60117	-	Graphical Symbols
IEC-60156,	-	Method for the Determination of the Electrical Strength of Insulation Oils.
IEC-60270,	-	Partial Discharge Measurements.
IEC-60376	-	Specification and Acceptance of New Sulphur Hexafloride
IEC-60437	-	Radio Interference Test on High Voltage Insulators.
IEC-60507	-	Artificial Pollution Tests on High Voltage Insulators to be used on AC Systems.
IEC-62271-1	-	Common Specification for High Voltage Switchgear & Controlgear Standards.
IEC-60815	-	Guide for the Selection of Insulators in respect of Polluted Conditions.
IEC-60865 (P1 & P2)	-	Short Circuit Current - Calculation of effects.
ANSI-C.1/NFPA.70	-	National Electrical Code
ANSI-C37.90A	-	Guide for Surge Withstand Capability (SWC) Tests
ANSI-C63.21,	-	Specification for Electromagnetic Noise and
C63.3	-	Field Strength Instrumentation 10 KHz to 1 GHZ
C36.4ANSI-C68.1	-	Techniquest for Dielectric Tests
ANSI-C76.1/EEE21	-	Standard General Requirements and Test Procedure for Outdoor Apparatus Bushings.
ANSI-SI-4	-	Specification for Sound Level Metres
ANSI-Y32-2/C337.2	-	Drawing Symbols
ANSI-Z55.11	-	Grey Finishes for Industrial Apparatus and Equipment No. 61 Light Grey
NEMA-107T	-	Methods of Measurements of RIV of High Voltage Apparatus
NEMA-ICS-II	-	General Standards for Industrial Control and Systems Part ICSI-109
CISPR-1	-	Specification for CISPR Radio Interference Measuring Apparatus for the frequency range 0.15 MHz to 30 MHz
CSA-Z299.1-1978h	-	Quality Assurance Program Requirements
CSA-Z299.2-1979h	-	Quality Control Program Requirements
CSA-Z299.3-1979h	-	Quality Verification Program Requirements
CSA-Z299.4-1979h	-	Inspection Program Requirements

TRANSFORMERS AND REACTORS

IEC-60076 (Part 1 to 5)	-	Power Transformers
IEC-60214	-	On-Load Tap-Changers.
IEC-60289	-	Reactors.
IEC- 60354	-	Loading Guide for Oil - Immersed power transformers
IEC-60076-10	-	Determination of Transformer and Reactor Sound Levels
ANSI-C571280	-	General requirements for Distribution, Power and Regulating Transformers
ANSI-C571290	-	Test Code for Distribution, Power and Regulation Transformers
ANSI-C5716	-	Terminology & Test Code for Current Limiting Reactors
ANSI-C5721	-	Requirements, Terminology and Test Code for Shunt Reactors Rated Over 500 kVA
ANSI-C5792	-	Guide for Loading Oil-Immersed Power Transformers upto and including 100 MVA with 55 deg C or 65 deg C Winding Rise
ANSI-CG,1EEE-4	-	Standard Techniques for High Voltage Testing

CIRCUIT BREAKERS

IEC-62271-100	-	High-voltage switchgear and controlgear - Part 100: Alternating current circuit-breakers
IEC-62271-101	-	High-voltage switchgear and controlgear - Part 101: Synthetic testing
IEC-62155	-	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V
IEC-62271-110	-	High-voltage switchgear and controlgear - Part 110: Inductive load switching
IEC-62271-109	-	High-voltage switchgear and controlgear - Part 110: Inductive load switching

CURRENT TRANSFORMERS, VOLTAGE TRANSFORMERS AND COUPLING CAPACITOR VOLTAGE TRANSFORMERS

IEC-60044-1	-	Current transformers.
IEC-60044-2	-	Inductive Voltage Transformers.
IEC-60044-5	-	Instrument transformers - Part 5: Capacitor voltage transformers
IEC-60186	-	Voltage transformers
IEC-60358	-	Coupling capacitors and capacitor dividers.

IEC-60044-4	-	Instrument Transformers: Measurement of Partial Discharges
IEC-60481	-	Coupling Devices for power Line Carrier Systems.
ANSI-C5713	-	Requirements for Instrument transformers
ANSIC92.2	-	Power Line Coupling voltage Transformers
ANSI-C93.1	-	Requirements for Power Line Carrier Coupling Capacitors
BUSHING		
IEC-60137	-	Insulated Bushings for Alternating Voltages above 1000V

SURGE ARRESTERS

IEC-60099-4	-	Metal oxide surge arrestors without gaps
IEC-60099-5	-	Selection and application recommendation
ANSI-C62.1	-	IEE Standards for S A for AC Power Circuits
NEMA-LA 1	-	Surge Arresters

CUBICLES AND PANELS & OTHER RELATED EQUIPMENT

IEC-60068.2.2	-	Basic environmental testing procedures Part 2: Test B: Dry heat
IEC-60694	-	Switchgear and controlgear
IEC-60529	-	Degree of Protection provided by enclosures.
IEC-60947-4-1	-	Low voltage switchgear and control gear.
IEC-61095	-	Electromechanical Contactors for household and similar purposes.
IEC-60439 (P1 & 2)	-	Low Voltage Switchgear and control gear assemblies
ANSI-C37.20	-	Switchgear Assemblies, including metal enclosed bus.
ANSI-C37.50	-	Test Procedures for Low Voltage Alternating Current Power Circuit Breakers
ANSI-C39	-	Electric Measuring instrument
ANSI-C83	-	Components for Electric Equipment
NEMA-AB	-	Moulded Case Circuit and Systems
NEMA-CS	-	Industrial Controls and Systems
NEMA-PB-1	-	Panel Boards
NEMA-SG-5	-	Low voltage Power Circuit breakers
NEMA-SG-3	-	Power Switchgear Assemblies
NEMA-SG-6	-	Power switching Equipment
NEMA-5E-3	-	Motor Control Centers
1248 (P1 to P9)	-	Direct acting indicating analogue electrical measuring instruments & their accessories.

Disconnecting switches

IEC-62271-102	-	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches
IEC-60265 (Part 1 & 2)	-	High Voltage switches
ANSI-C37.32	-	Schedule of preferred Ratings, Manufacturing Specifications and Application Guide for high voltage Air Switches, Bus supports and switch accessories
ANSI-C37.34	-	Test Code for high voltage air switches
NEMA-SG6	-	Power switching equipment
PLCC and line traps		
IEC-60353	-	Line traps for A.C. power systems.
IEC-60481	-	Coupling Devices for power line carrier systems.
IEC-60495	-	Single sideboard power line carrier terminals
IEC-60683	-	Planning of (single Side-Band) power line carrier systems.
CIGRE	-	Teleprotection report by Committee 34 & 35.
CIGRE	-	Guide on power line carrier 1979.
CCIR	-	International Radio Consultative Committee
CCITT	-	International Telegraph & Telephone Consultative Committee
EIA	-	Electric Industries Association
Protection and control equipment		
IEC-60051: (P1 to P9)	-	Recommendations for Direct Acting indicating analogue electrical measuring instruments and their accessories.
IEC-60255 (Part 1 to 23)	-	Electrical relays.
IEC-60297		
(P1 to P4)	-	Dimensions of mechanical structures of the 482.6mm (19 inches) series.
IEC-60359	-	Expression of the performance of electrical & electronic measuring equipment.
IEC-60387	-	Symbols for Alternating-Current Electricity meters.
IEC-60447	-	Man machine interface (MMI) - Actuating principles.
IEC-60521	-	Class 0.5, 1 and 2 alternating current watt hour metres
IEC-60547	-	Modular plug-in Unit and standard 19-inch rack mounting unit based on NIM Standard (for electronic nuclear instruments)
ANSI-81	-	Screw threads
ANSI-B18	-	Bolts and Nuts
ANSI-C37.1	-	Relays, Station Controls etc.

ANSI-C37.2	-	Manual and automatic station control, supervisory and associated telemetering equipment
ANSI-C37.2	-	Relays and relay systems associated with electric power apparatus
ANSI-C39.1	-	Requirements for electrical analog indicating instruments

MOTORS

IEC-60034 (P1 to P19:)	-	Rotating electrical machines
IEC-Document 2	-	Three phase induction motors
(Central Office) NEMA-MGI	Motors and Generators	

Electronic equipment and components

MIL-21B, MIL-833 & MIL-2750

IEC-60068 (P1 to P5)	-	Environmental testing
IEC-60326 (P1 to P2)	-	Printed boards
		Material and workmanship standards
ASTM	-	Specification and tests for materials

Clamps & connectors

NEMA-CC1	-	Electric Power connectors for sub station
NEMA-CC 3	-	Connectors for Use between aluminium or aluminium-Copper Overhead Conductors

Bus hardware and insulators

IEC-60120	-	Dimensions of Ball and Socket Couplings of string insulator units.
IEC-60137	-	Insulated bushings for alternating voltages above 1000 V.
IEC-60168	-	Tests on indoor and outdoor post insulators of ceramic material or glass for Systems with Nominal Voltages Greater than 1000 V.
IEC-62155	-	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V
IEC-60273	-	Characteristices of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
IEC-61462	-	Pressurized and un-pressurized insulator for use in electrical equipment with rated voltage greater than 1000V – Definitions, Test methods, acceptance criteria and design recommendations
IEC-60305	-	Insulators for overhead lines with nominal voltage above 1000V-ceramic or glass insulator units for a.c. systems Characteristics of String Insulator Units of the cap and pintype.
IEC-60372 (1984)	-	Locking devices for ball and socket couplings of string insulator units: dimensions and tests.
IEC-60383 (P1 and P2)	-	Insulators for overhead lines with a nominal voltage above 1000 V.
IEC-60433	-	Characteristics of string insulator units of the long rod type.
IEC-60471	-	Dimensions of Clevis and tongue couplings of string insulator units.
ANSI-C29	-	Wet process proelain insulators
ANSI-C29.1	-	Test methods for electrical power insulators
ANSI-C92.2	-	For insulators, wet-process porcelain and toughened glass suspension type

ANSI-C29.8	-	For wet-process porcelain insulators apparatus, post-type
ANSI-G.8	-	Iron and steel hardware
CISPR-7B	-	Recommendations of the CISPR, tolerances of form and of Position, Part 1
ASTM A-153	-	Zinc Coating (Hot-Dip) on iron and steel hardware
Strain and rigid bus-conductor		
ASTM-B 230-82	-	Aluminium 1350 H19 Wire for electrical purposes
ASTM-B 231-81	-	Concentric - lay - stranded, aluminium 1350 conductors
ASTM-B 221	-	Aluminium - Alloy extruded bar, road, wire, shape
ASTM-B 236-83	-	Aluminium bars for electrical purpose (Bus-bars)
ASTM-B 317-83	-	Aluminium-Alloy extruded bar, rod, pipe and structural shapes for electrical purposes (Bus Conductors)
Batteries and batteries charger		
Battery		
IEC:60896-21&22	-	Lead Acid Batteries Valve Regulated types – Methods of Tests & Requirements
IEC: 60623	-	Vented type nickel Cadmium Batteries
IEC:60622	-	Secondary Cells & Batteries – Sealed Ni-Cd rechargeable single cell
IEC:60623	-	Secondary Cells & Batteries – Vented Ni-Cd rechargeable single cell
IEC:60896-11	-	Stationary Lead Acid Batteries – Vented Type – General requirements & method of tests
IEEE-485	-	Recommended practices for sizing of Lead Acid Batteries
IEEE-1115	-	Sizing of Ni-Cd Batteries
IEEE-1187	-	Recommended practices for design & installation of VRLA Batteries
IEEE-1188	-	Recommended practices for design & installation of VRLA Batteries
IEEE-1189	-	Guide for selection of VRLA Batteries
Battery Charger		
IEEE-484	-	Recommended Design for installation design and installation of large lead storage batteries for generating stations and substations.
IEEE-485	-	Sizing large lead storage batteries for generating stations and substations
Wires and cables		
ASTMD-2863	-	Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)
IEC-60096 (part 0 to p4)	-	Radio Frequency cables.

IEC-60183	-	Guide to the Selection of High Voltage Cables.
IEC-60189 (P1 to P7)	-	Low frequency cables and wires with PVC insulation and PVC sheath.
IEC-60227 (P1 to P7)	-	Polyvinyl Chloride insulated cables of rated voltages up to and including 450/750V.
IEC-60228	-	Conductors of insulated cables
IEC-60230	-	Impulse tests on cables and their accessories.
IEC-60287 (P1 to P3)	-	Calculation of the continuous current rating of cables (100% load factor).
IEC-60304	-	Standard colours for insulation for low-frequency cables and wires.
IEC-60331	-	Fire resisting characteristics of Electric cables.
IEC-60332 (P1 to P3)	-	Tests on electric cables under fire conditions.
IEC-60502	-	Extruded solid dielectric insulated power cables for rated voltages
IEC 60840		
IEC 62067		
IEC-754 (P1 and P2)	-	Tests on gases evolved during combustion of electric cables.
IEC 62271		
Painting		
ANSI-Z551	-	Gray finishes for industrial apparatus and equipment
SSPEC	-	Steel structure painting council
HORIZONTAL CENTRIFUGAL PUMPS		
API-610	-	Centrifugal pumps for general services
	-	Hydraulic Institutes Standards
BS:599	-	Methods of testing pumps
PTC-8.2	-	Power Test Codes - Centrifugal pumps
DIESEL ENGINES		
ASME Power Test Code	-	Internal combustion engine PTC-17
	-	Codes of Diesel Engine Manufacturer's Association, USA
PIPING VALVES & SPECIALITIES		
BS:5150	-	Specification for cast iron gate valves
PG Test Procedures		
NFPA-13	-	Standard for the installation of sprinkler system
NFPA-15	-	Standard for water spray fixed system for the fire protection
NFPA-12A	-	Standard for Halong 1301 Fire Extinguishing System

NFPA-72E	-	Standard on Antomatic Fire Detectors
NFPA-12	-	Standard on Carbon dioxide extinguisher systems

Electrical generating and distributing stations code of practice

Steel structures

ANSI-B18.2.1	-	Inch series square and Hexagonal bolts and screws
ANSI-B18.2.2	-	Square and hexagonal nuts
ANSI-G8.14	-	Round head bolts
ASTM-A6	-	Specification for General Requirements for rolled steel plates, shapes, sheet piling and bars of structural use
ASTM-A36	-	Specifications of structural steel
ASTM-A47	-	Specification for malleable iron castings
ASTM-A143	-	Practice for safeguarding against embilement of Hot Galvanized structural steel products and procedure for detaching embrilement
ASTM-A242	-	Specification for high strength low alloy structural steel
ASTM-A283	-	Specification for low and intermediate tensile strength carbon steel plates of structural quality
ASTM-A394	-	Specification for Galvanized steel transmission tower bolts and nuts
ASTM-441	-	Specification for High strength low alloy structural manganese vanadium steel.
ASTM-A572	-	Specification for High strength low alloy colombium-Vanadium steel of structural quality
AWS D1-0	-	Code for welding in building construction welding inspection
AWS D1-1	-	Structural welding code
AISC	-	American institute of steel construction
NEMA-CG1	-	Manufactured graphite electrodes

Piping and pressure vessels

ASME	-	Boiler and pressure vessel code
ASTM-A120	-	Specification for pipe steel, black and hot dipped, zinc-coated (Galvanized) welded and seamless steel pipe for ordinary use
ASTM-A53	-	Specification for pipe, steel, black, and hot-dipped, zinc coated welded and seamless
ASTM-A106	-	Seamless carbon steel pipe for high temperature service
ASTM-A284	-	Low and intermediate tensile strength carbon-silicon steel plates for machine parts and general construction.

ASTM-A234	-	Pipe fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures
ASTM-S181	-	Specification for forgings, carbon steel for general purpose piping
ASTM-A105	-	Forgings, carbon steel for piping components
ASTM-A307	-	Carbon steel externally threated standard fasteners
ASTM-A193	-	Alloy steel and stainless steel bolting materials for high temperature service
ASTM-A345	-	Flat rolled electrical steel for magnetic applications
ASTM-A197	-	Cupola malleable iron
ANSI-B2.1	-	Pipe threads (Except dry seal)
ANSI-B16.1	-	Cast iron pipe flanges and flanged fitting. Class 25, 125, 250 and 800
ANSI-B16.1	-	Malleable iron threaded fittings, class 150 and 300
ANSI-B16.5	-	Pipe flanges and flanged fittings, steel nickel alloy and other special alloys
ANSI-B16.9	-	Factory-made wrought steel butt welding fittings
ANSI-B16.11	-	Forged steel fittings, socket-welding and threaded
ANSI-B16.14	-	Ferrous pipe plug, bushings and locknuts with pipe threads
ANSI-B16.25	-	Butt welding ends
ANSI-B18.1.1	-	Fire hose couplings screw thread.
ANSI-B18.2.1	-	Inch series square and hexagonal bolts and screws
ANSI-B18.2.2	-	Square and hexagonal nuts
NSI-B18.21.1	-	Lock washers
ANSI-B18.21.2	-	Plain washers
ANSI-B31.1	-	Power piping
ANSI-B36.10	-	Welded and seamless wrought steel pipe
ANSI-B36.9	-	Stainless steel pipe

ACSR MOOSE CONDUCTOR

IEC:437-1973	Test on High Voltage Insulators NEMA:107-1964 CISPR
Part - V	Overhead Transmission Purposes
BS:215(Part-II)	Aluminium Conductors galvanized IEC:209-1966 steel reinforced extra high
BS:215(Part-II)	voltage (400 kV and above)

GALVANISED STEEL EARTH WIRE

P5:1992)	overhead transmission purposes.

ANNEXURE - B

Sl No.	LIST OF DRAWINGS/DOCUMENTS
1	Route Drawing of Underground Transmission line from Chobhar SS to New Patan SS
2	Sectional Drawing of Underground Layout of Transmission Line
3	EHV XLPE Power Cable Trench Layout at Substation
4	Cable Bridge Layout
5	Joint Pit Layout
6	Joint Pit Details
7	SLD of New Patan SS and GA layout
8	SLD of Chobhar SS and GA layout
9	
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NOTE:

The above list of drawing/document is only illustrative and not exhaustive and only for tender purpose. The contractor shall submit drawings/documents as per requirement of Technical specification.

CHAPTER 3 – SWITCHGEAR SURGE ARRESTERS

CONTENTS

Chapter 3- SURGE ARRESTERS

1.0 GENERAL:

1.1 The Surge arresters shall conform to IEC: 60099-4 except to the extent modified in the specification and shall also be in accordance with requirements under Chapter 2 - GTR.

1.2 Arresters shall be of hermetically sealed units, self supporting construction, suitable for mounting on tubular support structures to be supplied by the Contractor.

1.3 The Surge Arrestors shall be designed for use in the geographic and meteorological conditions as given in the Chapter 2 -GTR.

2.0 DUTY REQUIREMENTS:

a. The surge arresters shall be of heavy duty station class and gapless type without any series or shunt gaps.

b. The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and long lines.

c. 245/145/36 kV class arrester shall be capable for discharging energy equivalent to class 3 of IEC for 245/145/36 kV system on two successive operations.

d. The surge arresters shall be suitable for withstanding forces as defined in Chapter 2-GTR.

e. The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

f. The surge arresters are being provided to protect the following equipment whose insulation levels are indicated in the table given below:-

Equipment to be protected	Lightning impulse(kVp) for 66 kV system	Lightning Surge for 145 kV system
Power transformer	± 325	± 550
Instrument Transformer	± 325	± 650
Reactor	--	--
CB/Isolator Phase to ground	± 325	± 650
CB/Isolator Across open contacts	± 325(for CB) ± 350 (for Isolator	± 750

g. The duty cycle of CB installed in 66/145 kV System of the Employer shall be O-0.3 sec-CO-3 min-CO. The Surge Arrester shall be suitable for such circuit breaker duties in the system.

3.0 CONSTRUCTIONAL FEATURES:

The features and constructional details of surge arresters shall be in accordance with requirement stipulated hereunder:

a) The non-linear blocks shall be of sintered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.

b) The surge arresters shall be fitted with pressure relief devices suitable for preventing shattering of porcelain housing and providing path for flow of rated fault currents in the event of arrester failure. Details shall be furnished in the bids along with quality checks.

c) The arresters shall not fail due to arrester porcelain contamination.

d) Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.

e) Outer insulator shall be porcelain/polymer conforming to requirements stipulated in Chapter 2-GTR. Terminal connectors shall conform to requirements stipulated under Chapter 2-GTR. The outer insulator housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage up to the maximum design value for arrester.

f) The end fittings shall be made of corrosion proof material and preferably be nonmagnetic.

g) The name plate shall conform to the requirements of IEC incorporating the year of manufacture.

h) The heat treatment cycle details along with necessary quality checks used for individual blocks along with insulation layer formed across each block are to be furnished. Metalizing coating thickness for reduced resistance between adjacent discs is to be furnished with additional information schedule of bid proposal sheets along with procedure for checking the same. Details of thermal stability test for uniform distribution of current on individual disc is to be furnished.

i) The manufacturer will submit Data for rejection rate of Zinc Oxide blocks during manufacturing/operation for the past three years.

j) The sealing arrangement of the Surge Arrester stacks shall be done incorporating grooved flanges with the O-rings/elliptical cross-section gaskets of Neoprene or Butyl rubber.

k) The surge arrester with porcelain housing shall have a cantilever strength of not less than 350 kg for 216/120kV surge arresters respectively or as per the

value obtained vide Chapter 2-GTR, whichever is higher. For Surge arrester with polymer housing, the cantilever strength shall not be less than 150kg.

4.0 FITTINGS AND ACCESSORIES:

a) 216/120/30 kV Arresters shall be complete with insulating base and Surge monitor having provision for bolting to flat surface of structure.

b) Self contained discharge counters, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit along with necessary connection. Suitable leakage current meters should also be provided. The reading of milliammeter and counters shall be visible through an inspection glass panel. The terminals shall be robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends.

c) Surge monitor consisting of discharge counters and milliammeters should be suitable to be mounted on support structure of the arrester and should be tested for IP66 degree of protection. The standard supporting structure for surge arrester should be provided with a mounting pad, for fixing the surge monitor. The surge monitor should be suitable for mounting on this standard mounting pad. Also all nuts, bolts, washers etc. required for fixing the surge monitor shall have to be supplied by the Contractor.

The arrangement for Surge Monitor enclosure fixing to the structure shall be at its rear/bottom. Connection between the Surge Arrester base and Surge Monitor shall be through a 2.0 m(minimum) long insulated copper rod/strip of at least 75 sq.mm cross sectional area. The cable shall be terminated at rear/bottom side of the Surge Monitor. The gaskets of the surge monitors shall be of Neoprene, Butyl or equivalent material.

d) Grading/corona rings shall be provided on each complete arrester unit as required. Suitable terminal connectors shall be supplied by the Contractor.

5.0 TESTS:

5.1 In accordance with the requirements stipulated under Chapter 2-GTR, the surge arresters should have been type tested as per IEC and shall be subjected to routine and acceptance tests in accordance with IEC document For contamination test, procedures outlined in 60099-3 shall be followed. The test reports of the type tests and the following additional type tests (additional type tests are required for Surge Arresters above 72.5 kV class only) shall also be submitted for the Employer's review.

i) Radio interference voltage test as per IEC 60099-4.

ii) Seismic withstand test.

iii) Contamination test.

iv) Test to verify the Power frequency versus time characteristics. Temporary over voltage profile for arresters are to be mutually agreed. Each metal oxide block

of surge arresters shall be tested for the guaranteed specific energy capability in addition to the routine/acceptance test as per IEC: 60099-4.

5.2 (a) **Acceptance Tests:**

1. Measurement of power frequency reference voltage of the arrester units.
2. Lightning Impulse Residual voltage on arrester units. (IEC clause 6.3.2).
3. Internal Ionisation or partial Discharge test.

(b) **Special Acceptance Test:**

1. Thermal stability test on three sections. (IEC Clause 7.2.2).
2. Aging & Energy Capability test on blocks (procedure to be mutually agreed).
3. Wattloss test.

(c) **Routine Tests:**

1. Sealing test: Water dip test at 1.5m depth from top of Surge Arrestor for 30 minutes shall be performed during assembly of Surge Arrester stacks (followed by other routine tests, i.e. P.D. Measurement, Reference Voltage, Residual Voltage & IR measurement).
2. Measurement of reference voltage.
3. Residual voltage test of arrester unit.
4. Internal Ionisation test or partial discharge test.
5. Verticality check on completely assembled Surge arresters as a sample test on each lot.

(d) **Test on Surge Monitors:**

The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstand tests to verify efficacy of the same. Additional routine/ functional tests with one 100A and 10kA current impulse (8/20 micro sec.) shall also be performed on the Surge monitor.
Surge monitors shall be routinely tested for water dip test at 1.5m for 30 minutes. No water vapours shall be visible on the monitor glass.

(e) **Test on insulators**

All routine tests shall be conducted on the hollow column insulators as per IEC 62155. Polymer housing shall be tested in accordance to IEC-61462.

6.0 SPARE PARTS AND MAINTENANCE EQUIPMENT:

Bidder shall include in his proposal spare parts and maintenance equipment, as mentioned in Chapter 1-PSR.

7.0 TECHNICAL PARAMETERS:

A. 245 kV CLASS SURGE ARRESTER (Not Applicable)

A7.0(a)	Rated arrester voltage	216 kV

A7.0(b)	Nominal discharge current	10 kA of 8/20 microsecond wave
A7.0(c)	Minimum discharge capability	5kJ/kV (referred to rated arrester voltage corresponding to minimum discharge characteristics.
A7.0(d)	Continuous operating voltage at 50 deg.C	168 kV rms
A7.0(e)	Max. switching surge residual voltage (1kA)	500 kVp
A7.0(f)	Max. residual voltage at	
	i) 5 kA	560 kVp
	ii) 10 kA nominal discharge current	600 kVp
A7.0(g)	Max. steep current impulse residual voltage at 10 kA.	650 kVp
A7.0(h)	Long duration discharge class	3
A7.0(i)	High current short duration test value (4/10 micro second wave)	100 kAp
A7.0(j)	Current for pressure relief test	40 kA rms / 50 kA rms (as applicable)
A7.0(k)	Low current long duration test value (2400 micro sec)	As per IEC.
A7.0(l)	Pressure relief class	40 kA / 50 kA (as applicable)

B. 145 / 66 kV CLASS SURGE ARRESTER

B7.0(a)	Rated arrester voltage	120 kV / 60kV
B7.0(b)	Nominal discharge current	10 kA of 8/20 microsecond wave
B7.0(c)	Minimum discharge capability	5kJ/kV (referred to rated arrester voltage corresponding to minimum discharge characteristics.
B7.0(d)	Continuous operating voltage at 50ºC	102 kV rms / ……

B7.0(e)	Max. switching surge residual voltage (1kA)	280 kVp / …….
B7.0(f)	Max. residual voltage at	
	i) 5 kA	310 kVp
	ii) 10 kA nominal discharge current	330 kVp
B7.0(g)	Long duration discharge class	3
B7.0(h)	High current short duration test value (4/10 micro second wave)	100 kAp / 62.5kAp
B7.0(i)	Current for pressure relief test	40 kA rms / 25kA
B7.0(j)	Low current long duration test value (2400 micro sec)	As per IEC.
B7.0(k)	Pressure relief class	31.5 kA / 25kA

C 33kV Surge Arresters (Not Applicable)

C7.0(a)	Rated arrester voltage	30 kV
C7.0(b)	Nominal discharge capability	10 kA of 8/20 microsecond wave
C7.0(c)	Minimum discharge capability	5kJ/kV (referred to rated arrester voltage corresponding to minimum discharge characteristics).
C7.0(d)	Continuous operating voltage at 50ºC	24 kV rms
c7.0(e)	Max. switching surge residual voltage (0.5kA)	63 kVp
C7.0(f)	Max. residual voltage (i) 5 kA (ii) 10 kA nominal discharge current	 80 kVp 85 kVp
C7.0(g)	Long duration discharge class	2
C7.0(h)	High current short duration test value (4/10 micro second wave)	100 kAp
C7.0(i)	Current for Pressure Relief test	40kA rms

C7.0(j)	Low current long duration test value (2000 micro sec)	As per IEC.
C7.0(k)	Pressure relief class as per IEC-60099-1	A

D 11kV Surge Arresters (Not Applicable)

D7.0(a)	Rated arrester voltage	9 kV
D7.0(b)	Nominal discharge capability	10 kA of 8/20 microsecond wave
D7.0(c)	Minimum discharge capability	5kJ/kV (referred to rated arrester voltage corresponding to minimum discharge characteristics).

8.0 PRE-COMMISSIONING TESTS

8.1 An indicative list of tests is given below.

(a) operation check of LA counter.

(b) Insulation resistance measurement

(c) Capacitance and Tan delta measurement of individual stacks.

(d) Third harmonic resistive current measurement (to be conducted after energisation.)

Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Employer for approval.

CHAPTER 4: POWER AND CONTROL CABLE

Table of contents

CHAPTER 4: POWER & CONTROL CABLES

1. POWER & CONTROL CABLES[FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V]

CRITERIA FOR SELECTION OF POWER & CONTROL CABLES

1.1.2 Aluminium conductor PVC insulated armoured power cables shall be used for various other applications in switchyard area/control room except for control/protection purposes.

1.1.3 For all control/protection/instrumentation purposes PVC insulated armoured control cables of minimum 2.5 sq. mm. size with stranded Copper conductors shall be used.

1.1.4 Employer has standardised the sizes of power cables for various feeders. Bidders are to estimate the quantity of cables and quote accordingly. The sizes of power cables and control cable to be used in different application shall be as per design calculation approved by the Employer :

1.1.5 Bidder may offer sizes other than the sizes specified in clause 1.1.4. In such case and for other application where sizes of cables have not been indicated in the specification, sizing of power cables shall be done keeping in view continuous current, voltage drop & short-circuit consideration of the system. Relevant calculations shall be submitted by bidder during detailed engineering for employer's approval.

1.1.6 Cables shall be laid as per relevant IEC/International Standards.

1.1.7 While preparing cable schedules for control/protection purpose following shall be ensured:

1.1.7.1 Separate cables shall be used for AC & DC.

1.1.7.2 Separate cables shall be used for DC1 & DC2.

1.1.8 For different cores of CT & CVT separate cable shall be used

1.1.9 Atleast one (1) cores shall be kept as spare in each copper control cable of 4C, 5C or 7C size whereas minimum no. of spare cores shall be two (2) for control cables of 10 core or higher size.

1.1.10 For control cabling, including CT/VT circuits, 2.5 sq.mm. size copper cables shall be used per connection. However, if required from voltage drop/VA burden consideration additional cores shall be used. Further for potential circuits of energy meters separate connections by 2 cores of 2.5 sq.mm. size shall be provided.

1.1.11 Technical data requirement sheets for cable sizes are being enclosed at Annex-I.

1.2 TECHNICAL REQUIREMENTS

1.2.1 General

1.2.2.1 The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.

1.2.2.2 They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE /PVC insulated L.T. power cables of sizes 240 sq. mm. and above shall withstand without damage a 3 phase fault

current of at least 45 kA for at least 0.12 second, with an initial peak of 105 kA in one of the phases at rated conductor temperature (70 degC for PVC insulated cables and 90 degC for XLPE insulated cables). The armour for these power cables shall be capable of carrying 45 kA for at least 0.12 seconds without exceeding the maximum allowable temperature of PVC outer sheath.

1.2.2.3 The XLPE insulated cables shall be capable of withstanding a conductor temperature of 250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.

1.2.2.4 The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects. All Aluminium used in the cables for conductors shall be of H2 grade. In case of single core cables armours shall be of H4 grade Aluminium.

1.2.2.5 The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.

1.2.2.6 Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.

1.2.2.7 Strip wire armouring method shall not be accepted for any of the cables. For control cables only round wire armouring shall be used.

1.2.2.8 The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.

1.2.2.9 All the cables shall pass fire resistance test as per IEC: 60502 (Part-I)

1.2.2.10 The normal current rating of all PVC insulated cables shall be as per IEC: 60502.

1.2.2.11 Repaired cables shall not be accepted.

1.2.2.12 Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.

1.2.3 XLPE Power Cables

1.2.3.1 The XLPE insulated cables shall be of FR type, C1 category conforming to IEC: 60502 (Part-I) and its amendments read along with this specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC to type ST-2 of IEC: 60502. When armouring is specified for single core cables, the same shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC to Type ST-2 of IEC: 60502 for all XLPE cables.

1.2.4 PVC Power Cables

1.2.4.1 The PVC (70°C) insulated power cables shall be of FR type, C1 category, conforming to IEC: 60502 (Part-I) and its amendments read alongwith this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IEC: 60502. A distinct inner sheath shall be provided in all multicore cables. For multicore armoured cables, the

inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IEC: 60502 for all cables.

1.2.5 **PVC Control Cables**

1.2.5.1 The PVC ***(70°C) insulated*** control cables shall be of FR type C1 category conforming to IEC: 60502 (Part-1) and its amendments, read alongwith this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IEC: 60502. A distinct inner sheath shall be provided in all cables whether armoured or not. The over sheath shall be extruded PVC to type ST-1 of IEC: 60502 and shall be grey in colour .

1.2.5.2 Cores shall be identified as per IEC: 60502 (Part-1) for the cables up to five (5) cores and for cables with more than five (5) cores the identification of cores shall be done by printing legible Hindu Arabic Numerals on all cores as per IEC: 60502 (Part-1).

2 HV POWER CABLES [FOR WORKING VOLTAGES FROM 3.3 kV AND INCLUDING 33 kV] (Not Applicable)

2.1.2 **HV POWER CABLE FOR AUXILIARY POWER SUPPLY**

The HV cable of as per BPS of voltage class as specified for 315 kVA LT transformer for interconnecting LT transformer to the NEA feeder shall be, XLPE insulated, armoured cable conforming to IEC: 60502 (Part-2).
Terminating accessories shall conform to IEC 61442-1997/IEC60502-4 1998.

2.1.3 Copper conductor XLPE insulated armoured cables 3C, 300 Sq.mm Copper Conductor shall be used for main power transformer to Incomer switchgear panel.

2.1.4 Aluminum conductor XLPE insulated armoured cables 3C, 300 Sq.mm Aluminum Conductor shall be used for Incomer to outgoing feeder.

Bidder may offer sizes other than the sizes specified in clause 2.1. In such case sizing of power cables shall be done keeping in view continuous current, voltage drop & short-circuit consideration of the system. Relevant calculations shall be submitted by bidder during detailed engineering for Employer's approval.

2.1.5 Copper conductor XLPE insulated armoured cables shall be used for main power transformer to Incomer switchgear panel.

2.1.6 Aluminum conductor XLPE insulated armoured cables shall be used for Incomer to outgoing feeder.

2.1.7 Aluminium conductor XLPE insulated armoured cables shall be used for main power supply purpose from LT Aux. Transformers to control room, between distribution boards and for supply for colony lighting from control room.

2.2 Constructional Requirements

Cable shall have compacted circular Aluminium / Copper conductor, Conductor screened with extruded semi conducting compound, XLPE insulated, insulation screened with extruded semi conducting compound, armoured with non-magnetic material, followed by extruded PVC outer sheath (Type ST-2), with FR properties.

- Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of the cable.

- The cables shall have outer sheath of a material with an Oxygen Index of not less than 29 and a Temperature index of not less than 250°C.

- Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.

3 CABLE DRUMS

3.1 Cables shall be supplied in returnable wooden or steel drums of heavy construction. Wooden drum shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum.

3.2 Standard lengths for each size of power and control cables shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. The employer shall have the option of rejecting cable drums with shorter lengths. Maximum, One (1) number nonstandard lengths of cable size(s) may be supplied in drums for completion of project.

3.3 A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

3.4 A clear space of at least 40 mm shall be left between the cables and the lagging.

3.5 Each drums shall carry the manufacturer's name, the employer's name, address and contract number and type, size and length of the cable, net and gross weight stencilled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

3.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

4 TYPE TESTS

4.1 All cables shall conform to all type, routine and acceptance tests listed in the relevant IEC.

4.2 XLPE INSULATED POWER CABLES (For working voltages up to and including 1100V):-

4.2.1 Following type tests (on one size in a contract) as per IEC: 60502 (Part 1) including its amendments shall be carried out as a part of acceptance tests on XLPE insulated power cables for working voltages up to and including 1100 V:

a) Physical tests for insulation

i) Hot set test

ii) Shrinkage test

b) Physical tests for outer sheath

i) Shrinkage test

ii) Hot deformation

iii) Heat shock test

iv) Thermal stability

4.2.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Chapter 2: GTR for the following tests-

a) Water absorption (gravimetric) test.

b) Ageing in air oven

c) Loss of mass in air oven

d) Short time current test on power cables of sizes 240 sqmm and above on

i) Conductors.
ii) Armours.
e) Test for armouring wires/strips.
f) Oxygen and Temperature Index test.
g) Flammability test.

4.3 PVC INSULATED POWER & CONTROL CABLES (For working voltages up to and including 1100V)-

4.3.1 Following type tests (on one size in a contract) as per IEC: 60502 (Part 1) including its amendments shall be carried out as a part of acceptance tests on PVC insulated power & control cables for working voltages up to and including 1100 V:

a) Physical tests for insulation and outer sheath
i) Shrinkage test
ii) Hot deformation
iii) Heat shock test
iv) Thermal stability
b) High voltage test.

4.3.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Chapter 2: GTR for the following-

a) High voltage test.
b) Ageing in air oven.
c) Loss of mass in air oven.
d) Short time current test on power cables of sizes 240 sqmm and above on
i) Conductors.
ii) Armours.
e) Test for armouring wires/strips.
f) Oxygen and Temperature Index test.
g) Flammability test.

4.4 XLPE INSULATED HV POWER CABLES(For working voltages from 3.3 kV and including 33 kV)-

4.4.1 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Chapter 2: GTR for XLPE insulated HV power cables (as per IEC: 60502 Part-2).

4.5 Terminating/jointing accessories as per IEC 60840:1999/ IEC62067

5. LAYING AND INSTALLATION

1.1 The bidder is advised to visit the site and acquaint themselves with the topography, infrastructure etc. The contractor shall be fully responsible for providing all equipment, materials, system and services specified or otherwise which are required to complete the erection and successful commissioning of XLPE cables in all respects.

1.2 Cables shall be laid in the trench throughout the route. Further, as per requirement of the field, the cables shall also have to be laid in the followings (with prior approval of employer):

a. In ducts
b. In HDPE pipes (pipes to be filled with sand/suitable material after cabling)
c. In air at terminations
d. At varying depths due to obstructions
e. As per approved drawings

1.3 At places where the cables cross private roads, gates of residential houses or buildings, the cables shall be laid in trenches/pipes of adequate strength.

1.4 Concrete trenches with precast covers may be used in exceptional cases in smaller portions, wherever bending of cables are involved and HDPE pipes can't be laid.

1.5 The arrangement of laying the cable en-route shall be submitted by contractor during detailed engineering for Employer's acceptance.

6 TRENCHING

6.1 The cable trench work involves earth excavation for cable trench, back filling and removal of excess earth from site. The work site shall be left as clean as possible.

6.3 The trench shall be excavated using manual /mechanical modes as per field conditions. Most main roads are of asphalt surface and some of the roads with cement concrete surface. The sides of the excavated trenches shall wherever required, be well shored up.

6.4 Where paved footpaths are encountered, the pavement slabs shall be properly stored and reinstated. Identification markers of other services shall be properly stored and restored. The excavated material shall be properly stored to avoid obstruction to public and traffic movement.

6.5 Suitable barriers should be erected between the cable trench and pedestrian/ motorway to prevent accidents. The barriers shall be painted with yellow and black or red and white coloured cross stripes. Warning and caution boards should be consciously displayed. Red lights as warning signal should be placed along the trench during the nights.

6.6 The bottom of the excavated trench should be levelled flat and free from any object which would damage the cables. Any gradient encountered shall be gradual.

6.7 For installation in ducts, the XLPE cables shall be installed in the flexible pipe conduits. Cleats, spacers, supporting structures and other necessary materials for installation of the cables and flexible pipes shall be provided by the Contractor.

7 TREFOIL/FLAT FORMATION

Cables shall be laid in trefoil/flat formation for entire route. The contractor shall submit drawings and arrangements for Employer approval.

8 CABLE HANDLING

The inspection of cable on receipt, handling of cables, paying out, flaking, cushioning with sand or sieved compacted soil, back-filling, reinstatement of road surfaces, providing and fixing joint markers, route indicators, precautions of joint holes, sump holes and all necessary precautions that are required shall be carefully planned and in accordance with acceptable standard practices/statutory requirements.

9 TOOLS AND PLANTS

The successful bidder shall arrange, at his own cost, all necessary tools, plant and equipment to carry out the survey and cable installation work. The bidders are instructed to give all the details of equipment at their disposal, to carry out the work successfully and speedily.

10 BENDING RADIUS

The minimum bending radius of XLPE insulated cables shall be 20XD where “D” means the Outer diameter of the cable.

11 JOINTING AND TERMINATION OF CABLES

The cable jointing personnel and his crew shall have good experience in the type of joints and terminations that are used. The jointing work shall commence as soon as two or three lengths of cables have been laid. All care should be taken to protect the factory-plumbed caps/ seals on the cable ends, and the cable end shall be sealed whenever the end is exposed for tests.

Jointing of cables in carriage ways, drive ways under costly pavings, under concrete or asphalt surfaces and in proximity to telephone cables and water mains should be avoided whenever possible.

Sufficient over lap of cables shall be allowed for making the joints.

The joints of different phases shall be staggered in the jointing bay.

IDENTIFICATION

The identification of each phase, shall be clearly and properly noted. The cables shall be jointed as per the approved design. Each cable shall have identification for phase at joint bays.

MAKING A JOINT

Comprehensive jointing instructions should be obtained from the manufacture of jointing kits and meticulously followed.

The materials used in the joints like ferrules, screen/sheath continuity bonds, lugs etc., shall be of good quality and conform to standards.

The jointing tools shall be appropriate and as per the requirement of jointing EHV XLPE cables.

12 CABLE LAYING & TERMINATIONS

The preparation of the cable end for installing the terminations and the precautions to be taken before fixing the terminations shall be followed as in the case of the cable jointing procedures. The instructions furnished by the termination manufacturer shall be strictly followed.

At cable terminating end, the following provisions for supply and erections are to be included:

(i) A sufficient length of spare cable shall be left in the ground, for future needs.
(ii) The rise of the cable immediately from the ground shall be enclosed in PVC/PE pipe of suitable diameter to protect against direct exposure to the sun.
(iii) The cable shall be properly fastened using non-metallic clamps.
(iv) Appropriate labels shall be fixed identifying the phase circuit, voltage and date of commissioning etc., on the cable supporting structure.
(v) The sealing end shall be mounted on pedestal insulators to isolate them from their supporting steel work.
(vi) Protection from contact with the exposed metal work at the termination shall be provided by resin bonded glass fibre shroud.

(vii) Providing earth stations with all required materials, like leads, connectors etc. Earth pits shall conform to IS–3043:1987 (Code of practice for earthing)/ or equivalent International standards.

30 MEASUREMENT (for Civil Works)

The buried cable trench shall be measured in the running meters including excavation, back filling, thermal back filling (if applicable), compaction, laying of concrete/ reinforcement, placing of warning tap markers, dewatering as required as per the drawing & specification & any other job required for successful completion of work.

Chapter 5: EHV XLPE POWER CABLE

1.1 CABLE CONSTRUCTION DETAILS

1.1.1 The 132KV single core cables shall comprise of copper conductor XLPE insulation simultaneously applying a semiconducting conductor screen, a thermosetting insulating dielectric and a semiconducting insulation screen. The extruded core shall be cured by using a dry curing process and the by products of crosslinking removed by a prolonged degassing process. The core shall be sheathed overall with an appropriate metal sheath and protected with a continuously extruded polymeric outer sheath. A thin layer of graphite or semi-conducting polymer shall be applied overall and firmly bonded to permit testing of the cable outer sheath. 132 kV XLPE insulated cables shall comply with the requirements of IEC 60502 & IEC 60840 plus any additional requirements specified hereafter.The cable shall be designed for a reliable service life of at least 30 years. The XLPE insulated EHV cable shall conform to the requirements of IEC 60502-2 (applicable clauses only) for construction and IEC 60840/IEC 62067 (as applicable) for testing. The terminating accessories shall conform to IEC 60840/ IEC 62067 (as applicable). The offered cables and its terminating accessories shall be compatible with each other.

1.1.2 The EHV grade cable shall be single core, stranded, compacted **Copper (as specified in BPS)** conductor, core screening by a layer of semiconducting tape followed by a layer of semiconducting compound, cross linked polyethylene (XLPE) dry cured insulation, insulation screening with semiconducting compound extruded directly over the insulation, longitudinal sealing by a layer of non-woven tape with water swell able absorbent over insulation screen, followed by radial sealing (Metal sheath of extruded/seam welded corrugated aluminium), metallic screening by concentric layer of plain copper wire (if required) to meet short time current requirement, followed by an open helix of copper (if required) & overall HDPE sheathed & graphite coated and conforming to the technical particulars of specification. Bidder may offer necessary layers such as separation tape, binder tapes etc additionally as per their manufacturing practices for meeting required performance of the offered cable.

1.1.3 The cable shall be suitable for laying under the climate conditions (as specified in Section-Project) and underground buried installation with uncontrolled back fill and chances of flooding by water.

1.1.4 Cable shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions.

1.1.5 Progressive sequential marking of the cable length (in metres), at every one metre, shall be provided on the outer sheath of the cable.

1.1.6 Repaired cables shall not be accepted. No joint shall be within 300 mm of any other joint in the same layer. The jointing of wires shall be by brazing, silver soldering cold welding or electrical welding. No joint shall be made in the wire after it has been formed up into the required length.

1.1.7 Allowable tolerance on the overall diameter of the cables shall be ± 2 mm.

1.2 CONDUCTOR

The conductor shall be of **Copper** wires as specified in the Bid Price Schedule **(BPS)**. The shape of conductor shall be compacted stranded having high compactness and smooth surface finish. Conductors shall be stranded, annealed, high conductivity copper. The copper wire before shaping shall be smooth, uniform in quality, free from scale, inequalities, spills, splits and other defects and should comply with the requirements of international specification IEC 60228. When made up from shaped wires the conductor shall be clean and uniform in size and shape and its surface shall be free from sharp edges and unless otherwise approved shall be taped with a layer of conducting or semi-conducting material.

1.3 CONDUCTOR SCREEN

The conductor screen shall consist of extruded semi-conducting XLPE. Semi-conducting separator tapes may be applied between conductor and the extruded semi-conductor XLPE. The conductors screen (non-metallic semi-conductive) shall be extruded in a single one-time process to ensure homogeneity and absence of voids. A conductor screen shall be used to provide a smooth interface between the conductor and the cable insulation. A suitable semi-conducting binder tape will be applied over the conductor to prevent the extruded screen falling between the interstices of the conductor strands.
The semi-conducting screen will have a spot minimum thickness of 0.5mm. The conductor screen will be made from semiconducting crosslinked polyethylene (XLPE) using carbon black material and will be applied as part of a triple extrusion process. The conductor screen shall be extruded and consist of a black, semi-conducting thermoset material fully compatible with the conductor and extruded insulation. The outer surface of the semi-conducting screen shall be super smooth, cylindrical and firmly bonded to the overlying insulation. A smoothness assessment should be conducted on extruded tape samples of the semiconducting screen material. The contact surface between the screen and the insulation shall be cylindrical, smooth and free from protrusions and irregularities that extend more than 0.125mm into the insulation.

1.4 INSULATION

The extruded XLPE insulation shall be applied over the conductor screen to the desired thickness in a void free manner. The extruded conductor screen, insulation and insulation screen shall be manufactured to the highest standards of concentricity, diameter roundness and longitudinal diameter stability. The materials for the manufacture of 132kV cables shall be delivered in clean bulk containers. The specified and required manufacturing process shall be as per the requirement mentioned in the schedule of technical particulars and guarantee to ensure the highest standards of concentricity. Every effort is to be made by the manufacturer to ensure the purity of the insulation extruded on the cable core. The thickness of the insulation shall be as the minimum average value measured according to IEC Publication 62067 and IEC 60840 respectively.

1.5 INSULATION SCREEN

The insulation screen shall consist of extruded semi-conducting XLPE. Suitable bedding tapes shall be applied over the extruded semi-conducting XLPE. The insulation screen shall be extruded and consist of a black, semiconducting thermoset material fully compatible with the extruded insulation. The interface between the insulation and the semiconducting screen shall be super smooth, cylindrical and firmly bonded. Testing of the material should be as for the conductor screen. To reduce the methane content of XLPE at a heat treatment after curing shall be carried out. The extruded conductor screen, insulation and insulation screen shall be manufactured to the highest standards of concentricity, diameter roundness and longitudinal diameter stability. The Bidder/Contractor shall provide a detailed description on the extrusion, curing, cooling and heat treatment after curing processes

1.6 MOISTURE BARRIER

Longitudinal water barrier:
The longitudinal water barrier shall be applied over insulation screen by a layer of non woven synthetic tape with suitable water swell able absorbent.

Radial Moisture Barrier:
This shall be of corrugated aluminium sheath/extruded corrugated seamless aluminum sheath.

1.7 METALLIC SCREEN:

The metal sheath shall consist of a tube of corrugated aluminium of at least 99.5% purity. The thickness of the corrugated aluminium sheath shall be designed to meet the requirement of the system short circuit rating as specified in **the bidding documents**.

The sheath shall be continuously extruded, of uniform thickness and homogeneous construction, close fitting, seamless and free from defects. Aluminium used for the sheath shall have the minimum purity of 99.5% and shall be of best quality metal free from pinhole flaws and other imperfections.The minimum thickness at any point shall not fall below 85% of the specified nominal thickness by more than 0.1mm.

A thin layer of bitumen or other suitable anti-corrosion compound shall be applied over the aluminium sheath.

1.8 OUTER SHEATH

The outer sheath shall consist of extruded black coloured HDPE with graphite coating. The outer sheath shall be suitably designed by the addition of chemicals in the outer sheath for protection against termite and rodent attack and shall be coated with graphite.

1.9 Anti Termite Protection

An approved chemical additive shall be added to the cable outer sheath compound to protect it from termite attack.

1.10 RATING

The contractor/ manufacturer shall declare current rating of cable for maximum conductor temperature of 90 degree C under continuous operation and 250 degree C during short-circuit condition. The contractor/ manufacturer shall also declare over load curve with duration for conductor temperature of 105 Deg C. A complete set of calculation made in arriving at the current rating shall be furnished, for laying condition envisaged under the project, during detailed engineering for Employer/Employer's reference.

1.11 CABLE JOINTING ACCESSORIES

1.11.1 The cable jointing accessories shall include all the straight through joints, Cross bonding, earth continuity cables, Link boxes, Sheath Voltage Limiters (SVLs) etc as required for entire cable route. Bidder shall arrange all special tools and tackles required for making these joints at his own cost. **Unless specified separately** in BPS, **cable end terminating kits** shall be deemed included as part of cable jointing accessories.

1.11.2 The straight through joint shall preferably be built up from the same material as the main cable and shall have electrical and mechanical withstand capabilities same as or better than the main cable. The joints shall be suitable for tropical conditions as specified in **Section-Project**.

1.11.3 The straight through joints and cable end terminations shall be of proven design and should have been type tested as per relevant IEC. A list of supply of cable jointing accessories which are in successful operation in projects, shall be furnished. The type of joint should be such that it occupies the minimum space to be fit in the specified joint pit details. All joints shall be supplied complete according to the Bidder"s practice. Conductor connection (Crimping, screw connector etc.) (Welding should be avoided). EPR or Silicon rubber pre-moulded insulating block including the semi-conducting layers. (Slip on type) The joints shall be Pre-moulded type suitable for the type of cables offered and shall be suitable for underground-

underground-buried installation. The Interface pressure between cable insulation and joint rubber block insulator shall be maintained over 0.15 MPa.Metallic sheath separation shall be provided at the insulation joint. The cable metallic sheaths shall be connected by soldering to the copper tube. The copper tube shall be connected to the cable sheath in such a way to withstand short-circuit currents as specified in the technical data sheets. The two sides of the metallic sheaths shall be isolated, and each to be connected to the link box. Finally, the outer covering of a protective glass fiber box casing shall be provided. The protective glass fiber box casing shall be filled with water-proof compound, to the full satisfaction of the Engineer.

1.11.4 The detailed description on jointing procedure shall be furnished during detailed engineering.

1.11.5 Outdoor terminations

Termination insulators must be manufactured from Porcelain or polymeric materials, all materials shall be fully factory tested during production. In accordance with IEC 60815 the pollution level specified is „Heavy", due to the exposure of the terminations to salt-laden winds of the sea. The stress control method must allow for the thermal expansion of the cable and the tenderer must state how this is achieved. The sealing ends shall be filled with high viscosity poly iso butylene, silicone oil, or equivalent and expansion devices shall be provided where necessary. Corona shields and arcing rings or horns shall be provided at the top of each open type termination and a horn or ring at the base. The base itself shall be insulated from supporting steelwork by mounting upon porcelain pedestal type insulators. Outdoor sealing end supporting structure shall be constructed of galvanised steel and their design shall be subject to the written approval of the Engineer. The minimum height above ground of the structure shall be 2000mm for 132kV power cables.The cable end terminations shall be of anti-fog type and shall be of Polymer type/Porcelain type suitable for withstanding the climatic conditions with required Creepage distance as specified in **bidding documents**. The cable end terminals for terminating the cables shall be complete with accessories & fully compatible with the cables to be supplied. The terminations shall also be capable to withstand mechanical forces during normal and short circuit operations.

1.11.6 Gas Immersed Terminations

Gas immersed terminations at the SF6 switchgear shall comply with the requirements of the latest version of IEC 60859. The Contractor shall demonstrate that terminations meet the mechanical loading of IEC 60859. The terminations shall be of plug-in “dry type” construction, containing an epoxy resin insulator and an elastomeric stress cone, such that the terminations can be made separate from the GIS and then subsequently plugged into GIS without the need for degassing. The insulator shall have a blind-ended construction to eliminate the possibility of SF6 gas leaking into the cable termination via the conductor connection. The conductor connection will be made using a compression connector. The cable glands of the sealing ends shall be insulated from the SF6 switchgear, and transformers. The cable end terminations envisaged for **GIS interface,** shall comply to IEC 60840. It will be the responsibility of the contractor to ensure smooth interface with GIS equipment.

1.12 CABLE DRUMS

1.12.1 Cables shall be supplied in returnable steel drums of heavy construction of suitable size and packed conforming to applicable standards.

1.12.2 Standard drum lengths for manufacturing shall be finalised during detailed engineering. Each drum shall carry the manufacturer's name, the employer's name, address and contract number and type, size and length of the cable, net and gross weight stencilled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

1.12.3 Packing shall be sturdy and adequate to protect the cables from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PE/Rubber caps so as to eliminate ingress of water during transportation and erection.

1.13 TESTS ON CABLES

All XLPE insulated EHV cables shall conform to all Type, Routine and Acceptance tests listed in the relevant IEC & shall submit the type test reports for Employer's approval. If specified in Section-Project, Type tests shall be carried out on the EHV cable as per relevant standard.

1.14 TESTS ON ACCESSORIES

Contractor shall submit type test reports for accessories, as per IEC 60840:1999/ IEC 62067 for Employer's acceptance. Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Section: GTR for Employer's acceptance.

1.15 TESTS AFTER INSTALLATION

All tests on cable system as prescribed in IEC 60840:1999/IEC 62067 (as applicable) shall be performed after installation.

1.16 FLEXIBLE PIPES FOR XLPE Cable (May not be required)

a) General

The flexible conduit pipe of (minimum 200 mm but higher diameter as per design requirement), corrugated hard polyethylene pipe shall be used for installation of XLPE power cable at bends. The flexible pipe shall be buried before the cable installation and, then the cables shall be pulled in.

b) Requirement

The flexible conduit pipe shall be of polyethylene and shall be strong enough to withstand the compression force from heavy trucks or lorries when it is buried more than 80 cm below the ground level and temperature rise up to 800 degree Celsius.
The pipe's projected cross section shall be practically rounded.
The pipe shall be corrugated to get flexibility.
The colour of the pipes shall be black.

b) Accessories

The flexible conduit pipe shall be provided with necessary accessories, such as joints and sealing material etc. The straight joint sleeve shall be made of high density polyethylene black coloured and to be so designed as to be screwed on to flexible pipe.
Bell mouth shall be fixed to the end of corrugated pipe to facilitate cable pulling in. The bell mouth shall be so designed as to screwed into the pipe. It shall be made of hard density polyethylene and colored black.
Water proof materials for pipes in manhole shall be mounted to an outlet of duct to keep the water tightness.
The waterproof materials shall be comprised the components such as sand-proof seal, sealing tape, neo seal compound, VUL-CO tape, PVC tape and other necessary materials to complete the specified scope of works.

1.17 Route Survey

The successful contractor shall make a detailed survey of the cable route after the award of

contract to decide the requirements of the following: Cable delivery length per drum,location of joint bay position. Quantity of joints required. Design of cable laying-directly buried/cables in ducts/pipes for road, communication circuit,gas line, drainage etc. crossing.

1.18 LAYING AND INSTALLATION

1.18.1 The bidder is advised to visit the site and acquaint themselves with the topography, infrastructure etc. The contractor shall be fully responsible for providing all equipment, materials, system and services specified or otherwise which are required to complete the erection and successful commissioning of XLPE cables in all respects.

1.18.2 Cables shall be laid in the trench in HDPE pipes throughout the route. Further, as per requirement of the field, the cables shall also have to be laid in the followings (with prior approval of employer):

a. In ducts/GI pipes/Hume pipes
b. In HDPE pipes (pipes to be filled with sand/suitable material after cabling)
c. In air at terminations
d. At varying depths due to obstructions
e. As per approved drawings

1.18.3 At places where the cables cross private roads, gates of residential houses or buildings, the cables shall be laid in HDPE pipes of adequate strength.

1.18.4 Concrete trenches with precast covers shall be used in all cases, except for cables through HDD. Cables shall be installed by direct burial at an average depth of 1.5 meter from finished ground level. Construction of trench for cable shall also include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of concrete protective covers back filling and compacting supply and installation of route marker and joint marker. Back filling shall be by the material excavated. However, bigger stones and pieces of rock etc. shall be removed. Concrete protective covers (RCC slabs) shall be installed/provided directly over the compacted thermally stable sand over the cable surface, RCC slabs shall sufficiently cover the width of all the cables. Thermal resistivity of sand shall be verified and inspected before the source approval.

1.18.5 The arrangement of laying the cable en-route shall be submitted by contractor during detailed engineering for Employer's acceptance. Similarly, Cable length/schedule, type, joints, joint type, terminations shall be approved by the Employer.

1.19 The spare cable and spare HDPE pipe shall be designed and laid in considering the quick replacement of the faulty cable through that spare cable with clear necessary modification to be made during charging of that spare cable with full guarantee of its working at rated capacity as other cables. If the contractor/bidder provide suitable clarification that it's functional guarantee cannot be achieved then he should propose other alternatives for quick replacement of faulty cables through spare cable.

1.20 **TRENCHING**

1.20.1 The cable trench work involves earth excavation for cable trench, back filling and removal of excess earth from site. The work site shall be left as clean as possible.

1.20.2 The trench shall be excavated using manual /mechanical modes as per field conditions. Most main roads are of asphalt surface and some of the roads with cement concrete surface. The sides of the excavated trenches shall wherever required, be well shored up.

1.20.3 Where paved footpaths are encountered, the pavement slabs shall be properly stored and reinstated. Identification markers of other services shall be properly stored and restored. The excavated material shall be properly stored to avoid obstruction to public and traffic movement.

1.20.4 Suitable barriers should be erected between the cable trench and pedestrian/ motorway to prevent accidents. The barriers shall be painted with yellow and black or red and white coloured cross stripes. Warning and caution boards should be consciously displayed. Red lights as warning signal should be placed along the trench during the nights.

1.20.5 The bottom of the excavated trench should be levelled flat and free from any object which would damage the cables. Any gradient encountered shall be gradual.

1.21 TREFOIL/FLAT FORMATION

Cables shall be laid in trefoil/flat formation for entire route. The contractor shall submit drawings and arrangements for Employer approval.

1.22 CABLE HANDLING

The inspection of cable on receipt, handling of cables, paying out, flaking, cushioning with sand or sieved compacted soil, back-filling, reinstatement of road surfaces, providing and fixing joint markers, route indicators, precautions of joint holes, sump holes and all necessary precautions that are required shall be carefully planned and in accordance with acceptable standard practices/statutory requirements.

1.23 DAMAGE TO PROPERTY

The contractor shall take all precautions while excavation of trench, trial pits etc., to protect the public and private properties and to avoid accidental damage. Any damage so caused shall be immediately repaired and brought to the notice of the concerned and to the Employer. The contractor shall bear all responsibilities and liabilities and shall bear all costs of the damages so caused by him or by his workman or agents.

1.24 CABLE ROUTE MARKERS/CABLE JOINT MARKERS

Permanent means of indicating the position of joints and cable route shall be fabricated supplied and erected as per approved drawings.

Markers provided shall be as per the field requirement, if the route passes through open fields, markers should be conspicuously visible and above ground surface.

The marker should incorporate the relevant information such that the name of the Employer, voltage, circuit and distance of cable from the marker.

1.25 DEPTH OF LAYING OF CABLES

Depth of laying shall be as per drawing enclosed with Specification. Laying at varying depths due to obstructions/site conditions may be accepted in extreme cases with prior approval of Employer during detailed engineering.

1.26 PAYING OUT THE CABLE

The excavated cable trench shall be drained of all water and the bed surface shall be smooth, uniform and fairly hard before paying out the cable. The cable shall be rolled in

the trench on cable rollers, spaced out at uniform intervals. The paying out process must be smooth and steady without subjecting the cable to abnormal tension. The cable on being paid out shall be smoothly and evenly transferred to the ground after providing the cushion. The cables shall never be dropped. All snake bends shall be straightened. Suitable size cable stocking pulling eye shall be used for pulling the cable. While pulling the cable by winches or machines, the tension/ loading shall be monitored by tension indicator and shall not exceed the permissible value for the cable. The cable laying shall be performed continuously at a speed as recommended by manufacturer.

The cable end seals shall be checked after laying and if found damaged shall immediately be resealed. Sufficient number of heat shrinkable cable end sealing caps shall be stocked at site stores for testing and jointing work. The integrity of the outer sheath shall be checked after the cable is laid in position.

1.27 SAND BEDDING

The cable shall be completely surrounded by well-compacted cable thermally stable sand to such a thickness and of such size that the cable is protected against damage (applicable where cables are not to be laid in pipes).

1.28 SNAKING

Snaking shall be done at necessary places recommended by manufacturer with prior approval of Employer.

1.29 THERMAL BACKFILL

If specifically mentioned in Section-Project, Thermal Backfilling shall be carried out based on the evaluation of soil thermal resistivity along the cable route and after approval from the Employer the contractor shall design, specify, supply, lay and monitor the installation of thermal backfill surrounding the cables. Thermal back fill shall be of thermal resistivity of 1.20 Km/W or better.

1.30 IMMEDIATE ENVELOPE TO CABLE

The option on the use of the material that immediately envelopes the cable viz., thermal backfill or sand or sieved native soil rests with the Employer/Employer. The contractor shall seek prior approval on the use of the envelop material from the Employer/Employer before execution of the works.

1.31 BACK FILLING

Normally back filling shall consist of the material earlier excavated. However, bigger stones or pieces of rock should be removed.

1.32 WARNING TAPE

A pre-warning, Red colour plastic/ PVC tape, of atleast 250 mm wide 100 microns thick, shall be laid at approx. 0.4 m above the cable specified depth, throughout the cable route. The tape shall carry the legend printed in black continuously as under CAUTION; EMPLOYER, VOLTAGE CLASS of CABLES.

1.33 PREVENTION OF DAMAGE DUE TO SHARP EDGES

After the cables have been laid in the trench and until the cables are covered with protective covering, no sharp metal tool shall be used in the trench or placed in such a

position that may fall into the trench. Straight and curved rollers used shall have no sharp projecting parts liable to damage the cable. While pulling through pipes and ducts, the cable shall be protected to avoid damage due to sharp edges. The cables shall never be bent, beyond the specified bending radius.

1.34 ROAD, RAIL & CANAL CROSSINGS

1.34.1 The road cutting, whether cement concrete asphalt or macadam road surface; Railway track crossing and canal crossing shall be taken after obtaining approval for cutting/crossing from the concerned authorities i.e. civic authorities, traffic police, telephone authorities, Railway authorities, Irrigation dept etc., and work should be planned to be completed in the shortest possible time. Where necessary the work shall be planned during night or light traffic periods. HDPE pipes shall be used for crossing. HDPE pipes diameter should not be less than 1.5 times the cable diameter.

1.34.2 **Trenchless Digging**:

It is envisaged that trenchless digging shall be used for crossing the National highways, Railway tracks and Canals etc. and the same shall be in the scope of bidder. Trenchless digging shall also be used where the concerned authorities do not permit open cut method and it is essentially required to carry out for installation of underground cables. The trenchless digging methods shall generally conform to ITU-T L.38. The various methods of trenchless digging such as hand/ manual auguring (up to 15m), impact moling (from 16m to about 40-50m), HDD (above 40-50m) shall be adopted based on the soil/site conditions and the requirement. The exact method for trenchless digging shall be finalised during detail engineering as per actual site/soil condition. The equipment used for HDD shall be capable of drilling at least 100m at one go. The contractor shall propose the exact methods and procedures for implementation of trenchless digging at various crossings taking into consideration the following guidelines, for approval by the Employer.

a) Excavation and backfilling of trial pits and verification of soil condition
b) Excavation of entry and Exit pits
c) Erection of drill machine for Drilling of pilot hole
d) Placement and driving hand augur
e) Placement and carrying out impact moling
f) Reaming and widening of bore holes in steps (if required)
g) Pulling of product pipe

1.35 FOOTPATH CUTTING

The slabs, kerbstones, on the roads shall be removed and reinstated without damage.

1.36 REINSTATEMENT

After the cables and pipes have been laid and before the trench is backfilled all joints and cable positions should be carefully plotted and preserved till such time the cable is energized and taken over by the Engineer in charge. The protective covers shall then be provided, the excavated soil riddled, sieved and replaced. It is advisable to leave a crown of earth not less than 50 mm and not more than 100 mm in the centre and tapering towards the sides of the trench.

The temporary reinstatement of roadways should be inspected at regular intervals, more frequently in rainy season and immediately after overnight rain for checking settlement and if required the temporary reinstatement should be done.

After the subsidence has ceased the trench may be permanently reinstated and the surface restored to the best possible condition.

1.37 MANHOLES

Manholes shall be provided at every proposed joint location for jointing bays. The bidder shall identify the location of the joint bays after carrying out detailed survey of the cable route and excavation of the trial pits. The delivery lengths of the cables shall match the location.

The Contractor shall get inspected, by a representative of the Employer, all manholes before carrying out the backfilling. Pipe & cable sealing, installation of joint box and cable service loops as per approved drawings shall be visually inspected and checked for tightness.

The contractor shall submit design and drawing of joint bay including manholes for withstanding a live load of 20 ton vehicle plus 30% for impact from moving vehicle. The Contractor shall propose a suitable procedure for testing the manhole for approval by the Employer. Manholes type approved by the Employer only shall be acceptable. The manhole shall include sufficient number of suitable entries.

1.38 TOOLS AND PLANTS

The successful bidder shall arrange, at his own cost, all necessary tools, plant and equipment to carry out the survey and cable installation work. The bidders are instructed to give all the details of equipment at their disposal, to carry out the work successfully and speedily.

1.39 BENDING RADIUS

The minimum bending radius of XLPE insulated cables shall be 20XD where “D” means the Outer diameter of the cable.

1.40 JOINTING AND TERMINATION OF CABLES

The cable jointing personnel and his crew shall have good experience in the type of joints and terminations that are used. The jointing work shall commence as soon as two or three lengths of cables have been laid. All care should be taken to protect the factory-plumbed caps/ seals on the cable ends, and the cable end shall be sealed whenever the end is exposed for tests.

Jointing of cables in carriage ways, drive ways under costly pavings, under concrete or asphalt surfaces and in proximity to telephone cables and water mains should be avoided whenever possible.

Sufficient over lap of cables shall be allowed for making the joints.

The joint bay should be of sufficient dimensions to allow the jointers to work with as much freedom of movement and comfort as possible. Sufficient space should be kept below the cable to be jointed.

The joints of different phases shall be staggered in the jointing bay.

1.41 SUMPHOLES

When jointing cables in water logged ground or under unforeseen rainy conditions, a sumphole should be made at one end of the joint bay, in such a position so that the

accumulated water can be pumped or baled out by buckets, without causing interference to the jointing operation.

1.42 TENTS/COVERS

An enclosure or suitable protection cover shall be used in all circumstances wherever jointing work is carried out in the open, irrespective of the weather conditions. The joint shall be made in dust free, moisture free and clean atmosphere.

1.43 PRECAUTIONS BEFORE MAKING A JOINT

The cable end seals should not be opened until all necessary precautions have been taken to prevent circumstances arising out of rainy/ inclement weather conditions, which might become uncontrollable.

If the cable end seals or cable ends are found to have suffered damage the cables should not be jointed, without tests and rectification.

1.44 MEASUREMENT OF INSULATION RESISTANCE

Before jointing, the insulation resistance of both sections of cables shall be checked.

1.45 IDENTIFICATION

The identification of each phase, shall be clearly and properly noted. The cables shall be jointed as per the approved design. Each cable shall have identification for phase at joint bays.

1.46 MAKING A JOINT

Comprehensive jointing instructions should be obtained from the manufacture of jointing kits and meticulously followed.

The materials used in the joints like ferrules, screen/sheath continuity bonds, lugs etc., shall be of good quality and conform to standards.

The jointing tools shall be appropriate and as per the requirement of jointing EHV XLPE cables.

1.47 CABLE LAYING & TERMINATIONS

The preparation of the cable end for installing the terminations and the precautions to be taken before fixing the terminations shall be followed as in the case of the cable jointing procedures. The instructions furnished by the termination manufacturer shall be strictly followed.

At cable terminating end, the following provisions for supply and erections are to be included:

(viii) A sufficient length of spare cable shall be left in the ground, for future needs.
(ix) The rise of the cable immediately from the ground shall be enclosed in PVC/PE pipe of suitable diameter to protect against direct exposure to the sun.
(x) The cable shall be properly fastened using non-metallic clamps.
(xi) Appropriate labels shall be fixed identifying the phase circuit, voltage and date of commissioning etc., on the cable supporting structure.
(xii) The sealing end shall be mounted on pedestal insulators to isolate them from their supporting steel work.

(xiii) Protection from contact with the exposed metal work at the termination shall be provided by resin bonded glass fibre shroud.

(xiv) Providing earth stations with all required materials, like leads, connectors etc. Earth pits shall conform to IS–3043:1987 (Code of practice for earthing)/ or equivalent International standards.

1.48 BONDING OF SCREEN/ SHEATH

The screens/sheath shall be cross-bonded under each segment of specified route in accordance with IS-3043 (Code of practice for earthing) or applicable International codes & practices. The bidder shall offer complete cable system in order to limit maximum sheath voltage in accordance with relevant standards and furnish complete set of calculations in support of the same. The screen/sheath shall be connected to the earth stations/ earth pits through disconnecting type link boxes & through Sheath Voltage Limiter (SVL) as required.

All required materials used in the Cross bonding, termination of earth continuity cable, Link box, SVL etc to comply with specification/statutory requirements shall be in the scope of bidder and should be of good quality and compatible with the cable.

1.49 CONNECTION OF RADIAL WATER BARRIER AND CABLE SCREEN

If the metallic radial water barrier is insulated from the metallic wire screen, a connection suitable to carry the currents occurring during operation must be installed between metallic radial water barrier of the cable and metallic wire screen in joints and sealing ends.

1.50 CABLE TERMINATING STRUCTURES

1.50.1 The terminating structure being supplied, should be designed as per the project requirement for the cable end terminations i.e. for Standalone Outdoor AIS terminations, GIS end terminations as per requirement specified in BPS.

1.50.2 The mounting structure shall be fixed on the reinforced cement concrete foundation, the design & drawings of which shall be submitted to Employer for review & acceptance during detailed engineering.

1.50.3 The mounting structure includes the supports for cable end boxes, link boxes and any other item required for the intent of the contract. All steel sections used shall be free from all imperfections, mill scales, slag intrusions, laminations, fillings, rust etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Employer. The steel for mounting structure shall confirm to IS-2062 (latest).

1.50.4 In case of cable terminations on transmission line towers, the cable termination kit, LA, Link Box, SVL etc shall be fixed suitably on the tower for which necessary interface details shall be coordinated for Tower design during detailed engineering. After fixing the end terminations, the cable shall be suitably fixed to the tower members, with non-magnetic material clamps to the required height securely. The cable in air shall be suitably protected using HDPE pipes up to certain height.

1.50.5 In case of GIS end terminations, the structure & foundations shall be suitably designed in coordination with GIS terminations during detailed engineering.

1.51 MEASUREMENT (for Civil Works)

The buried cable trench shall be measured in the running meters including excavation, back filling, thermal back filling (if applicable), compaction, laying of concrete/ reinforcement, placing of warning tap markers, dewatering as required as per the drawing & specification & any other job required for successful completion of work.

1.52 Distributed ACOUSTIC SENSING monitoring system (DAS)

For the cable protection system, the bidder shall include and provide separate "Distributed Acoustic Sensing Monitoring System(DAS)" for entire route for EHV cables complete in all respects along with terminal coupling equipment, workstation and all required hardware & software for real time monitoring of acoustic fault location and detecting third party intrusion(TPI) such as digging, street breaking and anchor drag i.e. for cable protection system. The basic functional requirements of the offered system should include the following characteristics for proper monitoring.

(i) 2P Squared DAS System

(ii) Output Spatial Sampling Interval: 1.25m, 2.5m and 5m

(iii) Spatial Resolution: 5m, 10m, 20m and 40m

(iv) Laser Class: Class 1 laser product

The distributed acoustic sensing monitoring system shall be single mode optical fibre based, must be of proven technology and should be in operation for similar use along with EHV cables as per latest practices. The "terminal coupling equipment" and "workstation" shall preferably be microprocessor based with HMI, for displaying acoustic event along the length of the cable system. System shall provide signalling to SCADA. The bidder shall provide brochures and catalogues for offered distributed acoustic sensing monitoring system along with the bid.

Single mode Optical fibre cables along with all jointing accessories etc. required for DAS shall also be included in the scope of bidder and shall quote accordingly under cable protection, monitoring system. Optical fibre cables associated with DAS shall be laid in the same EHV cable trench. If the 48 core optical fiber cable (for communication purpose) can be used for DAS system as per design requirement, it can be proposed accordingly.

1.53 DISTRIBUTED TEMPERATURE MONITORING SYSTEM (DTS)

The bidder shall include and provide integrated or separate "Distributed Temperature Monitoring System (DTS)" for entire route for EHV cables complete in all respects along with terminal coupling equipment, workstation and all required hardware & software for real time monitoring of conductor temperature profile and to provide load predictions. The offered system should be able to provide maximum possible transmission capacity of the cable for each circuit. The distributed temperature monitoring system shall be optical fibre based, must be of proven technology and should be in operation for similar use along with EHV cables as per latest practices. The "terminal coupling equipment" and "workstation" shall preferably be microprocessor based with HMI, for displaying temperature along the length of the cable system. System shall provide potential free output contact for signalling to SCADA. The bidder shall provide brochures, methodology and catalogues for offered distributed temperature monitoring system along with the bid. Optical fibre cables along with all jointing accessories etc. required for DTS shall also be included in the scope of bidder and shall quote accordingly under cable protection, monitoring system. Optical fibre cables associated with DTS shall be laid attached to one of the EHV cable per circuit.

1.54 OPTICAL FIBRE CABLE (For Communication Equipments)

Optical fibre cable required for Communication Equipments shall also be laid in the same cable trench in separate pipe. If same cable can be used for DAS system as per design requirement, it can be proposed accordingly.

1.55 Option to include Optical Fibres in the Cable Construction

For Items 2 & 4, and as an optional inclusion in the power cable construction for all other items, the Tenderer shall offer the addition of multi-mode and single mode optical fibres to enable DAS and DTS. The Tenderer shall recommend the location for the placement of the OF cables within the cable construction. The Tenderer shall document the following details:

1. How it is proposed that the OF cable will be mechanically protected

2. How the integrity of the OF cable will be ensured during cable installation
3. How the integrity of the cable can be maintained where access to the OF cable is required for repair
4. How the OF joints will be incorporated into cable joints
5. How the water moisture proofing of the cable system will be ensured with the inclusion of the OF cable

The maximum operating temperature may range from 85°C continuously to 100°C under 2-hour emergency conditions.

The optical fibre cable shall have optic fibres in accordance with IEC.

The cable will be comprised of 2 multi mode and 2 single mode fibres shall be completely metal free and shall comply with IEC Publication 60793-2 with the following characteristics.

Multi Mode

The multi mode cable will be used for DAS/DTS. Alternative characteristics may be considered if the Tenderer can demonstrate better performance for DAS/DTS. The Tenderer must provide full details of any alternative offer in the tender submission.

 Transmission wavelength 850nm and suitable for 1,300nm

 Mode field diameter 50 + 3.0 um at a transmission wavelength of 850nm.

 Bandwidth >500Mhz at 850nm and >500Mhz at 1,300nm

 Numerical aperture 0.2 ± .015

 Attenuation Not greater than 2.4dB/km at an optical wavelength of 850nm and

0.6dB/km at 1,300nm

 Core Eccentricity Less than 6%

 Optical cladding diameter 125um ± 2.0um

 Life span Greater than 50 years

Single Mode

The characteristics of each single mode optical fibre in the optical fibre cable will adhere to

the IEC and as follows:

 Transmission wavelength 1,310nm and suitable for 1,550nm

 Mode field diameter 9.2 ±0.4 um at a transmission

wavelength of 1,310nm.

10.4±0.8um at a transmission

wavelength of 1,550nm.

 Attenuation Not greater than 0.40 dB/km at an

optical wavelength of 1310 nm

and 0.30 dB/km at 1,550nm

 Total dispersion Not greater than 6 ps/(nm . km) at

optical wavelength in the range

1,270nm to 1,360nm for a zero

dispersion wavelength of 1,310nm

and 20 ps/ (nm . km) at 1,550nm

 Optical cladding diameter 125 um ±2.0um

 Life span Greater than 50 years

CHAPTER 6: STRUCTURE

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1.0 GENERAL

The scope of specification covers design, fabrication, trial assembly, supply and erection of galvanized steel structures for equipment support structures and cable bridge structure. Structures shall be lattice or Pipe type structure fabricated from structural steel conforming to relevant British standard Codes (BS Codes)/ equivalent International Standards.

Line diagrams of cable bridge structure, equipment support structures for structures enclosed with the tender document are for information only. However, The line diagram of all structures required under this scope shall be prepared by the contractor based on their design during detailed engineering stage. The bidder shall mention in their bid for the type of proposed structure i.e. Pipe or lattice type structure. The fabrication drawings, proto corrected drawings along with Bill of Material (BOM) for all the structures (cable bridge structure, Gantry and Equipment support structures) shall be prepared by the contractor during detailed engineering for submission to NEA/Consultant for their approval.

It is the intent of the NEA/Consultant to provide structures which allow interchangeability of equipments at a later stage. Accordingly, Contractor is expected to design the equipment support structures with the provision of stool. Stools shall be provided by the Contractor between the equipment and its support structure to match the bus bar height. The top of stool shall be connected to the equipment and the bottom of the stool shall be connected to the Base support structure. -

The scope shall include supply and erection of all types of structures including bolts, nuts, washers, step bolts, inserts in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates, ground mounted marshalling boxes (AC/DC Marshalling box & equipment control cabinets), structure mounted marshalling boxes and any other items as required to complete the job.

The connection of all structures to their foundations shall be with base plates and embedded anchor/foundation bolts. All steel structures and anchor/foundation bolts, fasteners (Nuts, bolts, washers) shall be fully galvanized as per relevant British standard Codes (BS Codes) / equivalent International Standards. The weight of the zinc coating shall be at least 610 grammes /sq. m for anchor bolts/foundation bolts and for structural members. One additional nut shall be provided below the base plate which may be used for the purpose of leveling.

Contractor shall provide suitable arrangement on the equipment support structures wherever required to suit fixation of accessories such as marshalling boxes, MOM boxes, Control Cabinets, Junction box, surge counter, etc. in the equipment structure fabrication drawings. -

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2.0 DESIGN REQUIREMENTS FOR STRUCTURES

2.1 For design of steel structures loads such as dead loads, live loads, wind loads etc. shall be based on relevant British standard Codes (BS Codes) / equivalent International Standards.

2.2 For materials and permissible stresses, relevant British standard Codes (BS Codes) / equivalent International Standards. Shall be followed in general. However, additional requirements given in following paragraphs shall be also considered.

2.3 Minimum thickness of galvanized lattice structure member shall be as follows:

Members	Min Thickness (mm)
Leg members, Ground wire	5

Peak members\/Main members	5
Other members	4
Redundant members	4

2.4 Maximum slenderness ratios for leg members, other stressed members and redundant members for compression force shall be as per relevant British standard Codes (BS Codes) / equivalent International Standards.

2.5 Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.

2.6 All bolts shall be M16 or higher as per design requirement.

2.7 **Step Bolts**

In order to facilitate inspection and maintenance, the tower structures shall be provided with climbing devices. Each tower shall be provided with M16 step bolts 175mm long spaced not more than 450mm apart, staggered on faces on diagonally opposite legs extending from about 0.5 meters above plinth level to the top of the tower. The step bolt shall conform to relevant British standard Codes (BS Codes) / equivalent International Standards. Ladders along with safety guard shall be provided for the Lightning Mast Tower.

2.8 **Design Criteria**

a) All gantry structures, cable bridge, equipment support structures shall be designed for the worst combination of dead loads, live loads, wind loads and Seismic forces as per relevant British standard Codes (BS Codes) / equivalent International Standards. (latest) unbalanced vertical and horizontal forces, erection loads, short circuit forces including “snatch” in the case of cable etc. Short circuit forces shall be calculated considering a fault level of 40.0 kA for 220kV, 31.5KA for 132kV and 25KA for 33kV or as applicable. Relevant British standard Codes (BS Codes) / equivalent International Standards. May be followed for evaluation of short circuit forces.

b) Switchyard gantry structures, equipment support structures shall be designed for the two conditions i.e. normal condition and short circuit condition. In both conditions the design of all structures shall be based on the assumption that stringing is done only on one side i.e. all the three (phase) conductors broken on the other side.
Factor of safety of 2.0 under normal conditions and 1.5 under short circuit condition shall be considered on all external loads for the design of switchyard structures.

c) Vertical load/horizontal load of XLPE cable shall be taken into account for the purpose of design. Weight of man with tools shall be considered as 150 kgs. for the design of structures.

d) Terminal/line take off gantries shall be designed for a minimum conductor tension of 2 metric tonnes per phase for 220 kv, 1 Metric tonne per phase for 132 kV and 0.50 Metric Tonne for 33 kV or as per requirements whichever is higher. The distance between terminal gantry and dead end tower shall be taken as 200 meters for 220kV, 150m for 132kV and 80 m for 33 kV switch yard. The design of these terminal gantries shall also be checked considering +/- 30 deg deviation of conductor in both vertical and horizontal planes. For other gantries the structural layout requirements shall be adopted in design.

e) The girders / beams shall be connected with lattice/Tower columns by bolted joints.

f). All equipment support structures shall be designed for the worst combination of dead loads, erection load. Wind load/seismic forces, short circuit forces and operating forces acting n the equipment and associated bus bars as per relevant British standard Codes (BS Codes) / equivalent International Standards.

g) If luminaries are proposed to be fixed on gantries/towers, then the proper loading for the same shall be considered while designing. Also holes for fixing the brackets for luminaries should be provided wherever required.

h) Foundation bolts shall be designed for the loads for which the structures are designed.

3.0 DESIGN, DRAWINGS, BILL OF MATERIALS AND DOCUMENTS

3.1 The Contractor shall submit design and line diagram of each structure for approval of NEA/Consultant. Fabrication drawing based on approved line diagram shall be prepared by the contractor for approval of NEA/Consultant. The BOM (Bill Of Material) shall be prepared by the contractor based on approved fabrication drawing. The Line diagram should indicate not only profile, but section, numbers and sizes of bolts and details of typical joints. In case NEA/Consultant feels that any design or drawings are to be modified even after its approval, Contractor shall modify the designs & drawings and resubmit the same for approval.

3.2 The fabrication drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, lacing details, weld sizes and lengths. Bolt details and all customary details in accordance with standard structural engineering practice. The fabrication drawing and bill of material based on design/line diagram shall be submitted to NEA/Consultant for approval. Approved bill of materials prepared on the basis of fabrication drawing shall be the basis for payment.

3.3 Such approvals shall, however, not relieve the contractor of his responsibility for safety and durability of the structure and good connection and any loss occurring due to defective fabrication, design or workmanship shall be borne by the contractor.

3.4 The contractor shall submit editable soft copy of all designs preferably in Staad / excel form and drawings in AutoCAD to NEA/Consultant. The list of British standard codes relevant to steel structures have been given in Chapter-14-Civil section of technical specification This list is illustrative but not exhaustive. The contractor shall submit the copy of relevant portion of BS codes/equivalent International standard referred to NEA/Consultant for reference if necessary during detailed engineering stage.

4.0 FABRICATION AND ERECTION

4.1 The fabrication and erection works shall be carried out generally in accordance with relevant British standard Codes (BS Codes) / equivalent International Standards. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.

4.2 The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified camber, if any, is provided. In order to minimize distortion in member the component parts shall be positioned by using the clamps, clips, dogs, jigs and other suitable means and fasteners (bolts and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, paralleled and tapered drifts shall be used to align the part so that the bolts can be accurately positioned.

4.3 Sample towers, beams and lightning masts and equipment support structures may be trial assembled in the fabrication shop to ensure fitment of various members and to avoid problems during erection.

4.4 For all structures, BOM along with fabrication drawings in hard and editable soft copies shall be submitted to NEA/Consultant as document for information. The responsibility of correctness of such fabrication drawing and BOM shall be fully with the contractor.

4.5 Approval of fabrication drawings and BOM shall, however, not relieve the Contractor of his responsibility for the safety and durability of the structure and good connections and any loss or damage occurring due to defective fabrication, design or workmanship shall be borne by the Contractor.

4.6 The Contractor should arrange on his own all plant and equipment, welding set, tools and tackles, scaffolding, trestles equipments and all other accessories and ancillaries required for carrying out erection without causing any stresses in the members which may cause deformation and permanent damage. Minor modification if any, required during erection shall be done at site with the approval of NEA/Consultant.

5.0 BOLTING

i) Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.

ii) In case of fasteners, the galvanizing shall confirm to relevant British standard Codes (BS Codes) / equivalent International Standards. The spring washer shall be electro galvanized as per relevant British standard Codes (BS Codes) / equivalent International Standards.

6.0 WELDING

The work shall be done as per approved fabrication drawings which shall clearly indicate various details of joints to be welded, type of weld, length and size of weld, Symbols for welding on erection and shop drawings shall be according to relevant British standard Codes (BS Codes) / equivalent International Standards. Welding shall be carried out in accordance to relevant British standard Codes (BS Codes) / equivalent International Standards.

7.0 FOUNDATION BOLTS

7.1 Foundation bolts for the towers and equipment supporting structures and elsewhere shall be embedded in first stage concrete while the foundation is cast. The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate.

7.2 The Contractor shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the towers/structures are plumb.

7.3 All foundation bolts for lattice structure, pipe structure are to be supplied by the Contractor.

7.4 All foundation bolts shall be fully galvanised so as to achieve minimum 610 grams Per Sq.m. of Zinc Coating as per relevant British standard Codes (BS Codes) / equivalent International Standards.

7.5 All foundation bolts and its material shall conform to relevant British standard Codes (BS Codes) / equivalent International Standards. All foundation bolts shall be provided with two number standard nuts, one check nut, one plain washer and MS plate at the bottom of foundation bolt.

8.0 STABILITY OF STRUCTURE

The Supplier shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

9.0 GROUTING

The method of grouting the column bases shall be subject to approval of NEA/Consultant and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base. No additional payment for grouting shall be admissible.

10.0 GALVANISING

10.1 All structural steel works (Gantry structures, Equipment support structures) and foundation bolts shall be galvanized after fabrication. The galvanization shall be done as per requirement relevant British standard Codes (BS Codes) / equivalent International Standards.

10.2 Zinc required for galvanizing shall have to be arranged by the Contractor/manufacturer. Purity of zinc to be used shall be 99.95% as per relevant British Standard Codes (BS Codes) / equivalent International Standards.

10.3 The Contractor shall be required to make arrangement for frequent inspection by the employer as well as continuous inspection by a resident representative of the employer, if so desired for fabrication work.

11.0 TOUCH-UP PAINTING

Minor defects in hot dip galvanized members shall be repaired by applying zinc rich primer and two coats of enamel paint to the satisfaction of NEA/Consultant before erection.

12.0 INSPECTION BEFORE DISPATCH

Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by NEA/Consultant or his authorized representative as satisfactory before it is dispatched to the erection site. Such certification shall not relieve the Contractor of his responsibility regarding adequacy and completeness of fabrication.

13.0 TEST CERTIFICATE

Copies of all test certificates relating to material procured by the Contractor for the works shall be submitted to NEA/Consultant.

14.0 MODE OF MEASUREMENT

The measurement of the structure, fasteners (Nuts, Bolts, and Washers) and foundation bolts including its nuts washers and MS Plate at bottom shall be done as per Bid price schedule (BPS). The weight of all structural members and foundation bolts (Bolt, Nuts, washer and MS steel plates welded at bottom of bolt) shall be measured under one head in Metric Tonne. The weight of fasteners and step bolts (Nuts, bolts and washers) used to erect/complete structures shall be measured under another head in Metric tons.

15.0 SAFETY PRECAUTIONS

The Contractor shall strictly follow all precautions at all stages of fabrication, transportation and erection of steel structures. The stipulations contained in relevant

British standard Codes (BS Codes) / equivalent International Standards. for Safety during erection of structural steel work shall also be adhered to.

16.0 MANUFACTURING QUALITY PLAN

The material specification shall also be as per relevant British Standard Codes (BS Codes) / equivalent International Standards.
The Contractor shall prepare the manufacturing quality plan to accept/check the material, galvanization and welding as per relevant international standards/BS codes within 1 month after award of work and submit the same to NEA/ Consultant for approval.

CHAPTER 7: CIVIL WORKS

1 GENERAL

The intent of specification covers the following:

Design, engineering, drawing and construction of all civil works at sub-station, transmission line routes. All civil works shall also satisfy the general technical requirements specified in other Sections of Specification and as detailed below. They shall be designed to the required service conditions/loads as specified elsewhere in this Specification or implied as per relevant British standard codes (B S Codes)/ equivalent International Standards.

All civil works shall be carried out as per applicable Standards and Codes. All materials shall be of best quality conforming to relevant International Standards and Codes. In case of any conflict between Standards/ Code and Technical Specification, the provisions of Technical Specification shall prevail.

The Contractor shall furnish all design, drawings, labour, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with approved drawings, specifications and direction of NEA/Consultant.

The work shall be carried out according to the design/drawings to be developed by the Contractor and approved by the NEA/Consultant. For all structures, foundations etc. necessary layout and details shall be developed by the Contractor keeping in view the functional requirement of the substation facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this specification for guidance purposes only. However, the Contractor shall quote according to the complete requirements.

2 GEOTECHNICAL INVESTIGATIONS

2.1 Electrical Resistivity Test

This test shall be conducted to determine the Electrical resistivity of soil required for designing safety-grounding system for the entire station area. The specifications for the equipment and other accessories required for performing electrical resistivity test, the test procedure, and reporting of field observations shall confirm to relevant British standard codes (B S Codes)/ equivalent International Standards. The test shall be conducted using Wagner's four electrode method as specified in relevant British standard codes (B S Codes)/ equivalent International Standards.. Unless otherwise specified at each test location, the test shall be conducted along two perpendicular lines parallel to the coordinate axis. On each line a minimum of 8 to 10 readings shall be taken by changing the spacing of the electrodes from an initial small value of 1 m upto a distance of 50.0 m.

2.2 Soil Bearing Capacity Test

a. The contractor shall carry out soil tests to determine the ground bearing capacity by means of a Standard Penetrations Test and Auger Boring and tests shall be performed as per BS/IS/Equivalent international standards.
b. The Contractor shall perform soil investigation work according to the approved location plan preferably nearer to the locations of structures. Soil Investigations Works shall be

carried out in minimum three locations. Report on test results including various data collected during the investigation works and Contractor's recommendations, on which the design will be based, shall be approved Owner/Engineer.

c. Drilling of bore holes in accordance with the provisions of BS/IS/Equivalent standards upto 10 m depth or to refusal which ever occur earlier. However in case deep pile foundations are envisaged the depths have to be regulated as per codal provisions. In cases where rock is encountered, coring in one borehole per bay shall be carried out to 1.5 m in bedrock and continuous core recovery is achieved.
d. Performing Standard Penetration Tests at approximately 1.5 m interval in the borehole starting from 1.5 m below ground level onwards and at every change of stratum. The disturbed samples from the standard penetrometer shall also be collected for necessary tests. Collecting undisturbed samples of 100/75 mm diameter 450 mm long from the boreholes at intervals of 2.5 m and every change of stratum starting from 1.0 m below ground level onwards in clayey strata.
e. The depth of Water table shall be recorded in each borehole.
f. All samples, both disturbed and undisturbed, shall be identified properly with the borehole number and depth from which they have been taken.
g. The sample shall be sealed at both ends of the sampling tubes with wax immediately after the sampling and shall be packed properly and transported to the laboratory without any damage or loss.
h. The logging of the boreholes shall be compiled immediately after the boring is completed and a copy of the bore log shall be handed over to the Engineer-in-charge.
i. The Contractor shall provide all necessary equipment, materials and personnel to prepare conduct and report the tests.
j. Typical Soil Investigation report shall include but not limited to the following:

Cover Page:

i. Name of the Project
ii. Report document No. & revision
iii. Name of Soil consultant agency, e-mail address, telephone no. etc.
iv. Report shall be duly signed & stamped by Soil consultant & Vendor.

Index:

i. Page no. & Description.

Introduction :

i. Scope of the work
ii. Accessibility of the site
iii. Location of the site including colour copy of google maps & global co- ordinates.
iv. Seismic zone & wind zone, geology etc.
v. Type of foundation of the nearby buildings, if any.

Field Investigation:

i. Water table
ii. Water table in rainy season
iii. Chemical Nature of soil & ground water
iv. Deleterious effects of soil & ground water, if any.

Laboratory Test:

i. All the Lab-test shall be conducted as mentioned in TS-Civil works over the undisturbed sample and disturbed sample.
ii. Drained & Undrained Tri-axial Test shall be conducted as per the site condition.
iii. Laboratory test results indicating bore hole No. depth wise.
iv. Laboratory test shall be conducted in NEA approved lab & min 5 % tests shall be witnessed by NEA/ Consultant.

Bearing Capacity calculation:

i. By Shear & settlement Criteria.
ii. Bearing Capacity shall be calculated by analytical method (BIS code & SPT No.) and field method (Plate load test) at different exploration location. Proposed depth for plate load test shall be considered 2.0m to 3.0m below natural ground level.
iii. Min FOS 2.5 shall be taken. Allowable Settlement shall be as per relevant IS code for soil type and building type.
iv. In rocky strata, type of foundation & recommendation regarding Rock anchoring.

Observations & Recommendations:

i. Bearing capacity table for various footing size (Isolated & Raft) starting from 0.5m depth below EGL upto 3m depth i.e. 0.5m, 1.0m, 1.5m & so on.
ii. Recommendation of footing type for various types of structures.

Soil Improvement Technique:

iii. In case of low bearing capacity, Soil improvement technique for various types of structures shall be proposed with supporting calculation & necessary tests.
iv. In case of liquefaction, soil improvement techniques to be proposed with the tentative drawings.
v. In case of black cotton soil, consultant should give their recommendations for soil improvement.
vi. In case of Pile foundation, Different dia. & depth (Min 02 options) of pile shall be suggested for minor & major structures of the switchyard.

Annexure:

i. Mohr Circle graph, Bore Hole Log profile depth wise, Laboratory test summarized strata wise, Time Vs Settlement chart, Grain size analysis, results of the lab test.
ii. Plan showing the location of exploration work
iii. Sample calculations clearly showing the formula and Values.

2.3 Payment

Payment for the contract item Geological Investigation, will be made as per the price bid. Therefore, in the schedule, the price shall include compensation for all costs incurred in furnishing all materials and labor and other operations related to geological investigation.

3 EXCAVATION AND BACKFILL

a) The contractor shall excavate earth, rock, stumps and all the other materials encountered

as required for construction of the foundations, underground containments and trenches. The Contractor shall place all suitable excavated materials 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 own expense, and shall be backfilled with select borrowing material.

b) Excavation shall be maintained in a clean, safe and sound condition until completion of the foundation construction and shall be done to prevent flooding by surface runoff. Suitable pumping equipment shall be provided and used to dewater excavation 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 expenses.

c) In those excavation where the base is unstable, lies below groundwater level, or has been over excavated, the Contractor shall provide and place a layer of crushed stone, or selected backfill, or borrow to stabilize the base for placement of foundation.

d) 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 tempers shall be used on cohesive materials: vibratory compactors shall be used on non-cohesive materials. Compaction shall achieve a density at least 95% of the maximum dry density 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.

e) Rock particles larger than 10 cm shall not be in contact with the concrete.

f) Payment for the contract item Excavation and backfill, will be made as per the price bid. This shall include excavation in all kinds of soil including rock/concrete/road, all leads and lifts including back filling, shoring, compacting, dewatering (if required) and disposal of surplus earth/ rock to a suitable location decided by the employer. The quantity of excavation for all foundations/pits shall only be measured. The measurement of excavation for all concrete works shall be made considering dimension of the pit keeping 150mm gap around the base pad (concrete) or approved drawing or actually excavated pit, whichever is less.

4. FOUNDATION/CONCRETE DESIGN

4.1 General

The Contractor shall design all foundations required for completion of the project and as per the site requirement. The design shall be based on the recommendation of soil test report by soil consultant. In case of urgency, the design and drawings may be taken up with assumed soil parameters and after completion of the soil testing necessary modifications may needs to be taken care. There can be multiple varieties of foundations for the same equipment based on the recommended soil investigation report and existing underground services.

4.2 Submittals

The Contractor shall submit all the design calculations, detail drawings and reinforcement steel schedules to the Owner/Engineer for review and comment before construction commences, Review of the foundation design by the Owner/Engineer in no way relieves the Contractor of his responsibility for an adequate foundation design, even though this Specification sets forth the basis foundation design criteria. Upon receiving the Owner's /Engineer comments, the Contractor shall submit to the Owner/ Engineer final drawings of

all foundation details, including reinforcement steel schedules on drawing sheet sizes for record file.

4.3 Design Load

The structure design loads are defined on the structure outline drawings and the loads used to design the foundation shall be actual working loads applied to the foundations by the equipment and structures. The foundations shall be designed to resist all vertical and lateral forces, uplift forces and overturning moments with a minimum factor of safety of 1.5.

4.4 Uplift and Overturning Loads

The uplift and overturning resistance of concrete spread footing shall be assumed as the weight of a volume of earth in the form of an inverted frustum of cone or pyramid. The cone of pyramid height shall be 30cm less than the depth from finish grade to the top of the concrete mat, the base area shall be the top area of the mat and the top area shall be determined by the intersection of planes starting at the mat edges and sloping outward at a 20 degree cone angle from the vertical and the horizontal plane 30 cm below finish grade.

4.5 Unit weight for overturning resistance

The following unit weight shall be used for design:

a) Soil = 12,00kg/m3

b) Concrete = 16,00kg/m3

4.6 Payment

No separate or direct payment will be made to the Contractor for design works. All costs incurred in connection therewith shall be included in price of respective BPS item for the construction of various works.

5 FOUNDATION CONSTRUCTION / CONCRETE WORKS

5.1 General requirement

a. Work covered under this Clause of the Specification comprises the design, drawing and construction of foundations and other RCC constructions for switchyard bus supports, equipment supports, cable trenches, Joint Pits, Cable Bridges, RCC retaining wall, or for any other equipment or service and any other foundation required to complete the work. This clause is as well applicable to the other RCC constructions.

b. Concrete shall conform to the requirements mentioned in relevant British standard codes (B S Codes)/ equivalent International Standards. And all the tests shall be conducted as per relevant British standard codes (B S Codes)/ equivalent International Standards. However, M25 (design Mix) concrete shall be used for all structural members as per relevant British standard codes (B S Codes)/ equivalent International Standards.

c. The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof. The Spread footings foundation or pile foundation as may be required based

on soil/sub-soil conditions and superimposed loads shall be provided.

d. If pile foundations are adopted, the same shall be cast-in-situ driven/bored or pre-cast or under reamed type as per relevant parts of relevant British standard codes (B S Codes)/ equivalent International Standards. Only RCC piles shall be provided. Suitability of the adopted pile foundations shall be justified by way of full design calculations. Detailed design calculations shall be submitted by the contractor showing complete details of piles/pile groups proposed to be used. Necessary initial load test shall also be carried out by the bidder at their cost to establish the piles design capacity. Only after the design capacity of piles has been established, the Contractor shall take up the job of piling. Routine tests for the piles shall also be conducted. All the work (design & testing) shall be planned in such a way that these shall not cause any delay in project completion.

e. The Contractor will be required to remove and replace at his expenses any materials incorporated in the work that do not conform to these Specifications.

f. The Contractors shall provide without extra cost all materials, which may be required for testing. The cost of the tests shall be borne by the Contractor.

5.2 Reference to standard specifications

Standard referred to in these specifications are as follows.

a) BS/IS/ASTM/Equivalent international standards refers to the latest edition of publications for materials.
b) BS/IS/ACI/AISC/Equivalent international standards refers to the latest edition of publications for design of structures and foundations.

5.3 Concrete

At least on month prior to the placement of any concrete, the Contractor shall test cubes/cylinders for each trial mix under both field-cured and laboratory cured conditions. The test cubes/cylinders shall be made and tested in accordance with the applicable standards.

The concrete mixes be of such proportions as to produce a plastic and workable mix which will not separate during placing and will finish sell without using excessive quantities of mixing water.

After the test results are known for the test cubes/cylinders, the Contractor shall submit test result to Owner/Engineer then Owner/Engineer will notify the Contractor of the acceptable design mixes.

5.3.1 Cement, Coarse & Fine Aggregate

a) In locations where, in the opinion of the Owner/Engineer, the conditions required the use of high sulfate resistance cement, conforming to the requirements of ASTM C150 type V/Equivalent IS standard shall be used without any extra cost to the Owner.

b) The aggregates shall consist of clean, crushed materials or, subject to the approval of the Owner/Engineer, manufactured aggregate may be used.

c) Aggregates shall be separated into sand and coarse aggregate before being used. No pit or crusher run materials will be permitted without prior approval of the Owner/Engineer.

d) All cement, coarse and fine aggregates shall be as per the relevant codal and Field Quality Plan requirement.

5.3.2 Storage of materials

Cement and aggregate shall be stored at the site of the work in a clean condition and should not become contaminated with undesirable substances. Special care shall be taken in storing cement to keep it thoroughly dry at all times.

a) When reinforcing steel is procured to the store yard in advance of the Contractor's requirements, the Contractor shall provide suitable protection in order to prevent excessive rust developing on the reinforcing steel. It will be Contractor's responsibility to remove excessive rust.

b) Before starting of the foundation construction all screened aggregates and sand shall be collected and stockpiled near site. So that it is free from clay, dust and other foreign materials.

5.3.3 Concrete mixing

a) Before any concrete mixing is begun all equipment for mixing, transporting and placing the concrete 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.

b) All mechanical equipment shall be checked before starting a concrete placement to ascertain whether or not is in good operation condition, repaired or replaces to the satisfaction of the Owner/Engineer.

c) When a foundation location is ready for concrete placement, the Contractor shall inform Owner/Engineer before concrete placing time so that Owner/Engineer may inspect to assure that the excavation is free of water, mud and debris; that the bottom surface of the excavation is a well leveled and properly dressed; that the reinforcing steel is properly secured in place; and that the form-work is properly braced.

d) Rock surface shall be as flat as possible and projecting ridges shall be leveled off before the concrete is placed or space between the ridges shall have been filled with concrete to form a horizontal surface.

e) The Contractor shall ensure that all materials that is to be embedded in the concrete has been placed before pouring of concrete. The contractor shall be responsible for the accurate location of all embedded materials. Any work in accurately or improperly set shall be relocated and rest reset at the Contractor's expense.

f) All batching components of the concrete shall be accurately measured. In case of design mix concrete, all components of concrete shall be measured by weight. In case of nominal mix, the components of concrete are measured by volume. Volume measurements shall be made in standard measuring boxes.

g) A mechanically operated batch mixer shall be used for concrete mixing.

h) The re-tempering of concrete, which has partially hardened, that is remixing with or without additional cement, aggregate or water, will not be permitted.

i) 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 mixed concrete shall be rejected and replaced by fresh concrete at contractors own expense.

j) Equipment for chuting, pumping and pneumatically conveying concrete shall be of such size and design as to insured 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.

k) 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 cement slurry shall be evenly spread on the water- saturated surface and then normal concrete shall be deposited continuously and as rapidly as practicable.

l) The concreting shall be carried on at such a rate that the concrete is at all times plastic and flows readily into the spaces between the bars and so that each layer properly mixes with its predecessor. Successive layers shall be places within 15 minutes of the preceding layer.

m) When placing concrete with free drops over 1.5 meters, sufficient numbers of hoppers and trunk must be provided of a size to allow for proper placing. The trunk sections shall reach within 500mm of the bottom of the placement.

n) The concrete shall be consolidated during and after depositing by vibration, the concrete shall be thoroughly worked around reinforcement and embedded items and into corners of forms.

o) The Contractor shall always have at least two vibrators in operating condition at the location of the concrete placement.

p) Vibrators shall not be used to transport concrete inside the forms.

5.3.4 Concrete Testing

a) The contractor shall complete concrete testing as per the approved FQP (to be submitted and finalized before start of work). There shall be three cubes/cylinders to a set and the cubes/cylinders shall be made in accordance with relevant codes.

b) The Contractors shall deliver cubes/cylinders to a location of approved lab by the Owner/Engineer where they will be tested in accordance with BS/IS/ASTM C39/ Equivalent international standards.

c) The Owner/Engineer will determine what remedial measures are necessary and the Contractors shall perform the remedial measures at his own expenses. The remedial measurements may include, but are not limited to, the replacement of the entire foundation; The Contractor shall also pay for any additional concrete tests including core

drilling and the repairs or replacements which may result from same, which the Owner/Engineer deems necessary strength.

d) The cost of the tests for all materials, concrete cubes will be borne by the Contractor. No additional payment shall be made in this regards.

5.3.5 Concrete formwork

a) Forms shall be used, wherever necessary to confine the concrete for structures and shape it to the required lines or to avoid contamination of the concrete by materials caving or sloughing from adjacent surfaces by excavated material.

b) Forms shall be provided with tie rods and clamps to 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 shall be formed with plywood or steel sheathing. Unexposed surfaces may be formed with any materials of adequate strength and tightness to hold the plastic concrete in proper position and prevent the loss of mortar.

c) If plywood or steel forms are not available, the Contractor may substitute wood planking provided exposed surfaces to remove ridges.

d) Before concrete is placed, the surfaces of all forms shall be coated with a form oil that effectively prevents sticking and will not stain the concrete surfaces. For steel forms, form oil shall consist of refined mineral oil compound.

e) Forms shall be removed only after 48 hours of concreting or when the strength of the concrete is such that form removal will not result in cracking, spalling, or breaking of edges of surfaces, or other damage to the concrete. Any concrete damages by forms shall be repaired immediately.

5.3.6 Concrete finishing and curing

a) The exposed top surface of all concrete foundation piers shall be properly finished and shall be slightly sloped to prevent the accumulation of water.

b) Immediately after the removal of forms, the holes left by form tie rod fastener shall be filled with mortar and all damaged or defective concrete shall be repaired or removed and replaced to the satisfaction of the Owner/Engineer. Improperly consolidated concrete shall be removed by chipping and the clipped openings or recesses shall be of such depth and shape are required to insure that the patching materials 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 chipped recesses with small surface dimensions. Concrete will be required for the replacement of defective concrete where surface dimension of the shipped 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 a least ten (10) days. Burlap or and equivalent materials or a curing compound shall be applied over exposed concrete surfaces, the burlap shall be kept moist at all times.

5.3.7 Membrane curing compound

a) Where ever there is shortage of water for curing purpose, Membrane curing compound shall be applied (as per direction of employer) by uniform spraying, leaving no pinholes or gaps, at a rate not to exceed 4.91 square meters 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 placing the concrete, the uncovered surfaces shall be coated with the curing compound as specified herein.

b) Foundations shall not be backfilled before they have been inspected by Owner/Engineer to see that they are free from surface defects and voids, or that the defects and voids have been properly repaired.

c) The foundations shall not be subjected to any loads in addition to those existing at the time of placing of the foundation concrete until the curing period has elapsed.

5.3.8 Grouting

Grouting for seating structural steel members and equipment on foundations shall be non-shrink (not-setting) Portland cement mortar grout or a suitable commercially available grout, at the Contractor's option. Grouting shall be done under pressure by means of an expanding agent or by means of static head. Propositioning and missing of grout shall conform to the following:

a) Mortal grout containing aluminum powder as an expansive agent mixture of 1 part cement and 2 parts sand, by weight, with a water cement ratio not exceeding 0.55 the quantity of aluminum powder used shall be approximately. 0.005 percent of the weight of cement, the actual quantity to be determined from tests with materials to be used, and at the temperature and under the conditions of a placement. Aluminum powder shall be blended with cement in proportions of one part powder 10-50 parts cement, by weight and the blend shall be sprinkled over the dry batch. After all ingredients are added, the batch shall be missed 3 minutes. Grout, which has not been placed within 45 minutes, shall be wasted.

b) In lieu of use of an expensive agent. Settlement shall be reduced by extending the missing period or by delaying final mixture to minimize the interval between time to placement and initial set and placement the under static header pressure. The motor grout shall be mixture of one part cement and 2.5 parts sand, with a water cement ratio of approximately 0.50 slump shall be the minimum necessary to enable placement.

c) No separate or direct payment will be made to the Contractor for Grouting. The cost of Grouting is deemed to be included in the cost of foundation work.

5.3.9 Payment

Payment for the contract item concreting will be made as per the price bid. Measurement of concreting works at all locations shall be made and shall include all leads, lifts,

formworks, grouting of pockets and underpinning. This shall also include pre-cast RCC work and addition of water proofing compound & admixtures wherever required for which no additional payment shall be made. The quantity shall be measured in cubic meters as per lines and levels indicated in the approved drawings. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings having cross-sectional area up to 0.1 sq.m.

6 HYSD/TMT reinforcing bar

a) All steel reinforcing bar shall conform to the requirement of IS 1786 or equivalent international standard.

b) 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.

c) Reinforcing steel shall be accurately located and shall be secured in position by the use of binding wire 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 to supporting the reinforcing steel.

d) Payment for the contract item reinforcement steel, will be made as per the price bid. Reinforcement shall be measured in length (actual or theoretical as per drawing whichever is less) including hooks, if any, separately for different diameters as actually used in work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in tons on the basis of sectional weights as adopted by Indian Standards. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement

7 FIRST CLASS BRICK MASONRY WORK

a) All first class brick work shall be made with first class bricks built in 1:4 cement mortar (1 cement: 4 sand). All materials must be approved by the Employer/Engineer before using in the construction work.

b) All the bricks used for masonry construction shall be thoroughly burnt, deep cherry red or copper in colour, regular in standard shape and size, free from cracks, emit a clear ringing sound on tapping with a steel trowel and have a crushing strength as per the Nepal Standard Brick Masonry NS: 1/2035. A brick shall not absorb more water than 15 % of its weight after 24 hours of soaking in water at normal temperatures.

c) All brick work shall be laid with specified mortar of good workable consistency. Cement mortar shall be prepared by mixing cement and sand in the specified proportions the mixing shall be done in a mechanical mixer or by hand mixing as directed by Employer/ Engineer. Water shall be added as required during mixing. Care shall be taken not to add

more water than what is actually needed to bring the mortar to the consistency of a stiff paste. Only the quantity of mortar, which can be used within 2 hours of its mixing shall be prepared at a time. Mortar unused for more than 2 hours shall be rejected and removed from the site of work.

d) All bricks required for masonry in cement mortars shall be thoroughly soaked in clean water for at least one hour in tanks of sufficient size immediately before use. The cessation of bubbles when the bricks are immersed in water is an indication of through soaking of bricks.

e) Green work shall be protected from rain by suitable covering. Brick masonry with cement mortar shall be kept constantly moist on all faces for a minimum period of 7(seven) days.

f) Where exposed to weather, protect top of masonry with water tied material in such a way that it will protect the completed work. Masonry wall shall set for 48 hours before any load is applied on the completed work.

g) The measurements of work shall be the product of the length, height and thickness. Deductions for openings lintels shall be made to arrive at the net quantity of work. Nothing shall be paid extra for forming such openings. However, no deductions shall be made for areas less than 0.05 sq.m. Unless otherwise specified nothing extra shall be admissible for cutting in brickwork or brick to suit RCC structures, walls in any shape other than straight or any cutting necessary for shaping the walls to the structural design. Rate shall be inclusive of providing weep holes of PVC pipes (if any) and all necessary scaffolding, watering, cutting of bricks, curing, materials and labour.

8 STONE WORKS

8.1 Stone Masonry in substructure and superstructure

All stone work shall be made with random rubble stone from the best quarry and built in 1:4 cement mortar (1 cement: 4 sand) and fixing of required weep holes for substructures. The stones must be approved by the Employer/Engineer before using in the construction work.

a) The stone shall be hard, tough, sound and durable. Stone shall not be less than 15 cm and more than 45 cm. Face stones shall be larger and uniform in size and colour to give a good appearance. Breadth of face stones shall be greater than the height. Face stones should tail into wall to a sufficient depth to bond well. Stone shall be laid with broader face downwards to give good bedding. Face joints shall be broken and face of wall shall be truly in plumb. Corner stone or quoins should be of good stones and dressed correct to angle and laid as headers and stretchers. All stones shall be wetted thoroughly before laying.

b) The rubble stone shall be placed with 1:4 cement sand mortar after having joints thoroughly moistened. The surface joints shall be finished by flush pointing with 1:2 cement sand mortar. The ingredient shall be accurately gauged by measure and shall be well and evenly mixed together in a mechanical plant mixer care being taken not to add more water than is required. No mortar that has been set shall be used. River sand shall be used unless otherwise specified. If hand mixing is allowed then it shall be done in masonry tanks. The gauged materials shall be put on the platform and mixed dry. Water will be then added and whole mixed again until it is homogeneous and of uniform colour. Mortar shall be prepared in such quantity, at one time, which shall be consumed within half an hour of its mixing. The

work shall be well watered for a fortnight.

c) Joints shall not be thicker than 19 mm. Face joints shall be thinner. Interstices, if any may be filled with pieces of spalls of stones embedded in mortar. In the corners, the stones should be chiseled at both sides and also on the top of the stone walls where the wall is ending and such surfaces being built up. Not more than 60 cm height of masonry shall be constructed at one time.

d) Through bond stones of one piece shall be provided one for every 0.5 m2 (5sq.ft.) of face. For walls thicker than 75 cm bond stones may be of two pieces placed side by side over lapping at least 25 cm. Breadth of lap stones shall not be less than 1.5 times the height. All stones shall be thoroughly wetted before laying. At the end of day's work masonry shall be flooded with 2.5 cm water at the upper surface with the help of fillets of mortar about 38 mm high, made round in edges. The masonry shall be protected from sun, rain, frost and other weather effect.

e) Measurement for payment of stone masonry works shall be made on the basis of actual volume of stone masonry in cubic meters. The measurement of work shall be the product of the length, thickness and height. 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 labors, equipment, materials, fixing required weep holes, scaffolding and all other cost necessary for the performance and completion of the works.

9. CEMENT PLASTER WORKS

9.1 Cement Sand Plastering In Cement Sand (C/S) Mortar (1:4)

a) For plastering work, unless otherwise specified, proper scaffolding shall be provided. The Contractor shall be responsible for providing and maintaining sufficiently strong scaffolding so as to withstand all loads likely to come upon it.

b) The type of mortar mix to be used shall be as specified in the description of the item.

c) Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a minimum period of 7 days. The dates of plaster shall be legibly marked on the various sections of the wall so that curing for the specified period thereafter can be watched. Any cracks which appear in the surface and all portions, which sound hollow when tapped or are found to be soft or otherwise defective, shall be cut out in rectangular shape and redone as directed by the Employer/Engineer.

d) It shall be done in square metre of the surface over which the plaster has been done. The thickness of the plaster shall not be taken into account. Opening shall be deducted in full. Openings less than 0.5 sq.m shall not be deducted and nothing extra shall be paid for finishing jambs, soffits and the sides of such openings. Unless otherwise specified, nothing extra shall be allowed for plaster on independent columns and beams, short with or on curved surface.

9.2 Cement Pointing

This specification covers supplying materials and executing the pointing works on outside of stone work.

a) The joints of the brick work/stone work shall be raked out to a depth of 3/4" and the wall surface washed and cleaned and kept wet for two days before pointing.

b) Wooden ballies, planks, trestles, G.I. pipes, ply board and other scaffolding material shall be sound and erected in accordance with the specification given under Stone Work or as directed by the Construction Manager.

c) The materials for mortar-cement and sand as specified shall be of standard specifications as mentioned in the beginning, (see concrete works). The materials shall be first mixed by measuring with boxes to give the required proportion as specified (1:3); and then mixed by adding water slowly and gradually to give a working consistency.

d) The mortar shall be pressed into the raked, cleaned and wet joints and a groove of shape and size of 5 to 6 mm deep shall be formed running a forming tool of steel along the centre line of the joint. The vertical joints also shall be finished in a similar way at right angles to the horizontal lines. The finished work shall give a neat and clean appearance with straight edges.

e) The finished work surface shall be cured for seven days and shall be protected by hanging mattings or gunny bags on the pointing keeping them wet. Curing shall be done in a way to avoid or minimize overflow or seepage to the existing surface below.

f) Measurement and payment shall be done in square meter as in item. Measurement shall be done nearest to two decimal places separately for various mixes of the work for the net quantity executed. All openings shall be deducted and any jambs, soffits etc. measurements shall be allowed. The rate includes all labour, materials, erection and removal of scaffolding, preparation of background, finishing etc.

10 Hume Pipe Works

a) NP-3 Grade Hume pipe shall be designed and laid according to the norms of Department of Roads.

b) Hume pipe shall be measured diameter-wise and laid as per approved drawings and shall be measured in running meters. The item shall be inclusive of excavation, laying, back filling, jointing etc. but excluding concrete and reinforcement (if any)

FQP: FIELD QUALITY PLAN:

a) The material specification, workmanship and acceptance criteria and Contractor shall execute the work as per the approved Field Quality Plan.

b) The standards used may be BS/IS/ equivalent international standards.

c) Contractor shall submit the FQP for approval before commencement of works.

d) All testing required as per the approved FQP shall be arranged by the Contractor at his own cost including frequency tests also.

INTERFACING:

The proper coordination & execution of all interfacing civil works activities like fixing of foundation bolts, fixing of supports/embedment, provision of cut outs etc. shall be the sole responsibility of the Contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc. is reduced to minimum.

CHAPTER 8

TECHNICAL SPECIFICATION FOR HDPE PIPE AND FLEXIBLE PIPE

A. HDPE PIPE

A1. Scope

This Specification covers the fabrication and supply of HDPE Pipe(as per design requirement size minimum 200 mm outer diameter size) to be used for XLPE power cable in underground 132kV transmission system.

A2. Description

The HDPE pipes are black and should suitable for inserting cable. The flexible conduit pipe shall be plain pipe shall be used for installation of XLPE power cable. The pipe shall be buried before the cable installation and, then the cables shall be pulled in. The HDPE pipe material should be Fire Retardant or non-Flammable.

The HDPE pipes shall be fabricated and tested in accordance with BS: 3412 and IS 4984, Class N HDPE or any revision thereof or other equivalent national or international standard provided that ensure at least equal or better quality to the standard mentioned above will also be acceptable.

The conduit pipe shall be strong enough to withstand the compression force from heavy trucks or Lorries when it is buried more than 80 cm below the ground level and temperature rise up to 80 degree Celsius.

A3. Accessories

The flexible conduit pipe shall be provided with necessary accessories, such as joints and sealing material etc. The straight joint sleeve shall be made of high density polyethylene black colored and to be so designed as to be screwed on to flexible pipe.

Suitable accessories for connection of HDPE pipe with flexible HDPE pipe shall be used.

Bell mouth shall be fixed to the end of corrugated pipe to facilitate cable pulling in. The bell mouth shall be so designed as to screw into the pipe. It shall be made of hard density polyethylene and colored black.

Water proof materials for pipes in manhole shall be mounted to an outlet of duct to keep the water tightness. The waterproof materials shall be comprised the components such as sand-proof seal, sealing tape, neo seal compound, VUL-CO tape, PVC tape and other necessary materials to complete the specified scope of works.

HDPE PIPE 200 MM DIA or higher

Sl. No.	Item Description	Unit	Requirement
1.	M.F.R. (190°C, 5kg load)	gm/10 mins	0.20 to 1.10
2.	Specified base density	kg/mtr^3	940 to 958
3.	Material Grade		PE-80

4.	Pressure rating		PN6

A4. **Tests**

The type test and routine tests shall be carried out for the materials to be supplied according to the above mention technical specification in accordance with the governing standard.

Manufacturer shall conform to all Type, Routine and Acceptance tests listed in the relevant IEC & type test reports shall be submitted for Employer's approval.

B. FLEXIBLE PIPE

B1. General

The flexible conduit pipe of minimum 200 mm but higher diameter that may be required as per design suitable to work in conjunction with aforementioned HDPE pipe corrugated hard polyethylene pipe shall be used only at bends where bending of HDPE pipe is not possible taking approval from the Employer for installation of 132 kV XLPE power cable. The flexible pipe shall be buried before the cable installation and, then the cables shall be pulled in.

B2. Requirement

The flexible conduit pipe shall be of polyethylene and shall be strong enough to withstand the compression force from heavy trucks or lorries when it is buried more than 80 cm below the ground level.

The pipe's projected cross section shall be practically round.

The pipe shall be corrugated to get flexibility.

The colour of the pipes shall be black.

B3. Accessories

The flexible conduit pipe shall be provided with necessary accessories, such as joints and sealing material etc.

The straight joint sleeve shall be made of high density polyethylene colored black and to be so designed as to be screwed on to flexible pipe.

Bell mouth shall be fixed to the end of corrugated pipe to facilitate cable pulling in.

The bell mouth shall be so designed as to screwed into the pipe. It shall be made of hard density polyethylene and colored black.

Water proof materials for pipes in manhole shall be mounted to an outlet of duct to keep the water tightness.

The waterproof materials shall be comprised the components such as sand-proof seal, sealing tape, neo seal compound, VUL-CO tape, PVC tape and other necessary materials to complete the specified scope of works.

CHAPTER 9

TECHNICAL SPECIFICATION FOR FIBRE OPTIC CABLE AND PLB DUCT

Section 1A: Introduction, General Information and General Requirement

Section 1 : Technical Requirement for UGFO & associated hardware fittings

Section 2: Technical Requirement for ADSS

Section 3: Technical Requirement for FODP and FMS

Section 4: Type Testing, FAT and SAT requirement

Section-1A

Introduction, General Information and General Requirement

This Section of technical specifications describes Fibre Optic Cabling requirements which includes Under Ground Fibre Optic (UGFO) Cabling, ADSS (All Die-Electric Self Supporting) Fibre Optic Cable associated hardware & fittings including joint box, FODP and all the accessories as required for the successful completion of the work. This specification describes the functional, performance and type testing requirements of UGFO, ADSS and other associated items.

The purpose of this section of the specification is to provide introduction, general information, and general requirement and define the scope of the FO Cabling requirements along with specification for UGFO Cable & ADSS Cable.

A.1 Scope and General Requirements

The broad scope of the procurement of this specification include the survey, planning, design, engineering, manufacturing, supply, transportation, insurance, delivery at site, unloading, handling, storage, Supervision of erection/installation, installation, splicing, termination, testing, training, and demonstration for acceptance, commissioning and documentation for:

a) UGFO Cable including all associated hardware, accessories & fittings
b) ADSS Cable including all associated hardware, accessories & fittings (N/A)
c) Fibre Optic Distribution Panels (FODP) & Joint Box
d) Supply of spares
e) All other associated work/items described in the technical specifications.

The communication system comprises of Fibre Optic Cabling and communication equipment's, the technical specification of communication Equipment are given at separate section of this TS.

A.2 General Requirements

The Contractor is encouraged to offer standard products and designs. However, the Contractor must conform to the requirements and provide any special equipment necessary to meet the requirements stated herein.

It should be noted that preliminary design information and bill of quantity (BoQ) specified in price schedules are indicative only. The Contractor shall verify the design data during the site surveys & detail engineering and finalise the BoQ as required for optimum design & system performance.

The Bidder's proposal shall address all functional and performance requirements within this specification and shall include sufficient information and supporting documentation in order to determine compliance with this specification without further necessity for inquiries.

The Bidder's proposal shall clearly identify all features described in the specifications or in any supporting reference material that will not be implemented; otherwise, those features shall become binding as part of the final contract.

An analysis of the functional and performance requirements of this specification and/or site surveys, design, and engineering may lead the Contractor to conclude that additional items are required that are not specifically mentioned in this specification. The Contractor shall be responsible for providing at no added cost to the Employer, all such additional items such that a viable and fully functional Underground Fibre Optic Cable System is implemented that meets or exceeds the capacity and performance requirements specified. Such materials shall be considered to be within the scope of the contract. The Bidders shall identify and include all such additional items in their proposal.

The offered items shall be designed to operate in varying environments. Adequate measures shall be taken to provide protection against rodents, contaminants, pollutants, water & moisture and electro-magnetic interference etc.

The Contractor shall demonstrate a specified level of performance of the offered items during well structured factory and field tests.

The Bidders are advised to visit sites (at their own expense), prior to the submission of a proposal, and make surveys and assessments as deemed necessary for proposal submission. The successful bidder (Contractor) is required to visit all sites. The site visits after contract award shall include all necessary surveys to allow the contractor to perform the design and implementation functions. The Contractor shall inform their site survey schedule to the Employer well in advance. The site survey schedule shall be finalised in consultation with the Employer. The Employer shall also be associated with the Contractor during their site/route survey activities.

Section - 01

Specifications for Underground Fibre Optic Cabling and associated hardware & fittings

1.1 Under Ground FO Cable (UGFO)

1.1.1 General

This document describes the requirements of Metal free Optical fibre cable for underground installation in ducts. The cable shall have double HDPE jacketing anti-rodent & anti-termite with glass yarn in between as reinforcement. The optical fibre cable shall be suitably protected for the ingress of moisture by Flooding Jelly /WS yarn and WS tape. The raw material used in the cable shall meet the requirements as specified in the TEC GR for raw materials (GR No.TEC/GR/TX/ORM-01/04 SEP-09).

The underground fibre optic cable (UGFO) to be supplied shall be having 48 fibers count, unarmoured and shall be suitable for underground installation in pipes. The cable should be of low weight, small volume and high flexibility. The mechanical design and construction of each unit shall be inherently robust and rigid under all condition of operation, adjustment, replacement, storage and transport. UGFO shall be suitable for installation in trench and trenchless digging.

1.1.2 Applicable Standards

The cable shall conform to the standards named below and the technical specifications described in the following sections.

i) ITU-T Recommendations G.652

ii) Electronic Industries Association, EIA/TIA 455-78A, 455-3A, 455-62A, 455-164A/167A/174, 455-168A/169A/175A, 455-176, 455-59, EIA/TIA 598, EIA 455-104.

iii) International Electro technical Commission standards, IEC60304, IEC60794-1-2, IEC60811-5-1.

iv) Bellcore GR-20 with latest revision

v) GR/OFT-01/03. APR 2006 Tools for installation & Operating the OFC & for assembly of the OF Splice Closures.

vi) The raw material used in the cable shall meet the requirements as specified in TEC GR: TEC/GR/TX/ORM-01/04 SEP-09 or latest amendments.

vii) Splice Enclosure shall comply as per TEC GR TEC/GR/TX/OJC-002/03/APR-2010 or latest amendments, if any.

1.1.3 Fibre Type(s) and Counts

The cable shall consist of Dual Window Single Mode (DWSM) fibres conforming to G.652D and the Technical parameters stipulated in the Table –1 below:

Table 1

DWSM Optical Fibre Characteristics

Fibre Description:	Dual-Window Single-Mode
Mode Field Diameter:	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 ITU-T G.652 D
Proof Test Level	≥ 0.69 Gpa
Attenuation Coefficient:	@ 1310 nm ≤ 0.34 dB/km @ 1550 nm ≤ 0.21 dB/km
Chromatic Dispersion; Maximum: **Zero Dispersion Wavelength:** **Zero Dispersion Slope:**	18 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) 1288-1339nm 5.3 ps/(nm x km) 1271-1360nm 1300 to 1324nm 0.092 ps/(nm^{2}xkm) maximum
Polarization mode dispersion coefficient	≤ 0.2 ps/km^½
Temperature Dependence:	Induced attenuation ≤ 0.05 dB (-60°C - +85°C)
Bend Performance:	@ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (30±1 mm radius Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (32±0.5 mm dia Mandrel, 1 turn; Attenuation Rise ≤ 0.50 dB

1.1.4 Functional Requirement:

The design and construction of Optical fibre cable shall be inherently robust and rigid under all conditions of installation, operation, adjustment, replacement, storage and transport.

i. The Optical fibre cable shall be able to work in a saline atmosphere and should be protected

against corrosion.

ii. Life of cable shall be at least 25 years. Necessary statistical calculations shall be submitted by the manufacturer, based upon life of the fibre and other component parts of the cable. The cable shall meet the cable aging test requirement.

iii. It shall be possible to operate and handle the Optical fibre cable with tools as per GR No. GR/OFT-01/03 APR 2006 and subsequent amendment, if any. If any special tool is required for operating and handling the optical fibre cable, the same shall be provided along with the cable.

iv. The Optical fibre cable supplied shall be suitable and compatible to match with the dimensions, fixing, terminating & splicing arrangement of the splice closure. The cable supplied shall also meet other requirement of splice closure (GR No.TEC/GR/TX/OJC-002/03/APR-2010) and subsequent amendments, if any.

v. The manufacturer shall submit an undertaking that the optical and mechanical fibre characteristics shall not change during the lifetime of the cable against the manufacturing defects.

vi. It is mandatory that the Optical fibre cable supplied in a particular route is manufactured from a single source of optical fibres.

vii. The Optical fibre cable shall be manufactured so as to protect the cable from rodent and termite.

1.2 Optical Fibre Cable Construction Specifications for Wet core (Type-I)

General: The Metal Free optical fibre cable shall be designed to the parameters mentioned in Annexure-I. The manufacturer shall submit designed calculations and the same shall be studied and checked.

TYPICAL STRUCTURAL DRAWING OF WET CORE CABLE

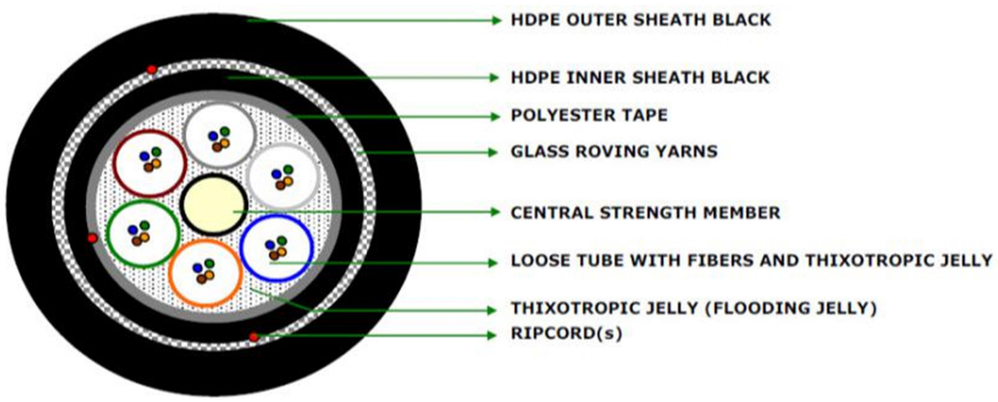


Fig: Under Ground Fibre Optic Cable

1.2.1 Secondary Protection: The primary coated fibres may be protected by loose packaging within tube, which shall be filled with thixotropic jelly. The dimensions of tube shall be as per Annexure-I.

1.2.2 Number of fibres in cable: 48

1.2.3 Strength Member: Solid FRP non - metallic strength member shall be used in the center of the cable core. The strength member in the cable shall be for strength and flexibility of the cable and shall have anti buckling properties. The FRP shall keep the fibre strain within permissible values. The size of FRP shall be as per Annexure – I.

1.2.4 Cable Core Assembly: Primary coated fibres in loose tubes stranded together around a central strength member using helical or reverse lay techniques shall form the cable core. The dimensions of FRP and stranding pitch shall be as per annexure - I.

1.2.5 Core Wrapping: The main cable core containing fibres shall be wrapped by a layer / layers of Polyester foil/ tape. The nylon/polyester binder thread shall be used to hold the tape, if required. The core wrapping shall not adhere to the secondary fibre coating and shall not leave any kink marks over the loose tube.

1.2.6 Moisture barrier (protection): The main cable core (containing fibres & core wrapping) shall by be protected by thixotropic flooding compound (jelly) having properties of non hygroscopic dielectric material.

1.2.7 Filling and Flooding compound: The filling/flooding compound used in the loose tube and in the cable core shall be compatible to fibre, secondary protection of fibre, core wrapping and other component part of the cable. The drip point shall not be lower than +70°C. The fibre movement shall not be constrained by stickiness & shall be removable easily for splicing. Reference test method to measure drop point shall be as per ASTM D 566**.** The thixotropic filling/flooding compound (jelly) shall be as per the GR No. TEC/GR/TX/ORM-01/04/SEP-09 and subsequent amendment issued, if any.

1.2.8 Inner Sheath: A non-metallic moisture barrier sheath may be applied over and above the cable core. The core shall be covered with tough weather resistant High Density Polyethylene (HDPE) sheath, black in colour (UV Stabilized) and colour shall conform to Munsell colour standards. Thickness of the sheath shall be uniform & shall not be less than **1.2 mm.** The sheath shall be circular, smooth, free from pin holes, joints, mended pieces and other defects. Reference test method to measure thickness shall be as per IEC 189 para 2.2.1 and para 2.2.2.

Note: HDPE material, black in colour, from the finished cable shall be subjected to following tests (on sample basis) and shall confirm to the requirement of the material as per GR No. TEC/GR/TX/ORM-01/04 SEP.09.

i) Density
ii) Melt flow index
iii) Oxidative Induction time
iv) Carbon black content
v) Carbon black dispersion

vi) ESCR
vii) Moisture content
viii) Tensile strength and elongation at break
ix) Absorption Coefficient
x) Brittleness Temperature

1.2.9 Glass Reinforcement: Impregnated Glass Fibre Reinforcement are used to achieve the required tensile strength of the optic fibre cables over the cable inner sheath to provide peripheral reinforcement along with Solid Rigid FRP Rod in the centre at cable core. These flexible strength members shall be **Non-water blocking type.** The use of Solid Rigid FRP Rod(s) is mandatory in Optical Fibre cable design. Impregnated Colour Coated Glass Fibre Reinforcement used shall be equally distributed over the periphery of the cable inner sheath. It shall be applied **helically** and shall provide full coverage to inner sheath to provide rodent protection. The quantity of the Impregnated Glass fibre Reinforcement used 20 Kg per km length of the cable along with its dimensions shall be as per Annexure-I. The specification of the glass roving shall be as per Section XII of GR No. TEC/GR/TX/ORM-01/04 SEP.09 and as per other details given in the Annexure –I.

1.2.10 Outer Sheath: A non-metallic moisture barrier sheath (black in colour) shall be applied over the inner sheath, which shall consist of tough weather resistant made High Density Polyethylene compound (HDPE) which is Anti-termite. The outer sheath shall be UV stabilized and the colour shall confirm to Munsell colour standards. The thickness of the outer sheath shall not be less than **1.6mm** .The outer sheath shall be uniform, circular, smooth, free from pin holes, joints mended pieces and other defects The reference test method to measure thickness shall be as per IEC 811-5-1. Anti termite dopant shall be added in the outer sheath to resist termite attack on the cable.

Note: HDPE material from finished product shall be subjected to following tests (on sample basis) and shall confirm to the requirement of the material as per the GR no. TEC/GR/TX/ORM-01/04/SEP-09 (Section-III):

i) Density
ii) Melt flow index
iii) Oxidative Induction time
iv) Carbon black content
v) Carbon black dispersion
vi) ESCR
vii) Moisture content
viii) Tensile strength and elongation at break
ix) Absorption Coefficient
x) Brittleness Temperature

Note: The outer jacket of HDPE shall be able to protect the cable from attack by termites.

Manufacturer shall provide the details of doping material used and same shall be verified during bulk testing. The outer sheath shall be termite protected. The surface of the sheath shall be smooth and free of defects such as cracks, blisters, etc. The cable shall be rodent protected. As specified in various clauses of the Technical specifications of the OF cable, the HDPE Outer Jacket shall be anti-termite. The tests as per clause 1.1.20 of Annex-III to Section 4 shall be carried out as applicable.

1.2.11 Cable diameter: The finished cable diameter shall be as per Annexure – I.

1.2.12 Cable Weight: The nominal cable weight shall be as per Annexure – I.

1.2.13 RIP Cord:

a) Three suitable ripcords shall be provided in the cable, which shall be used to open both HDPE sheath of the cable. Two ripcords shall be placed diametrically opposite each other below the outer Jacket & one ripcord shall be placed below inner sheath. It shall be capable of consistently slitting the sheath without breaking for a length of 1meter at the installation temperature. The ripcords (3ply & twisted) shall be properly waxed to avoid wicking action and shall not work as water carrier.

b) The ripcords used in the cable shall be readily distinguishable from any other components utilized in the cable construction.

1.2.14 Colour coding in OF Cables

1.2.14.1 The colorant applied to individual fibres shall be readily identifiable throughout the lifetime of the cable and shall match and conform to the Munsell Colour Standards (EIA-359-A) and also IEC Publication 304 (4).

1.2.14.2 Colour Coding Scheme

When the loose tubes are placed in circular format, the marking to indicate the loose tube no. "1" shall be in blue colour followed by loose tube no.2 of orange and so on for other tubes as per the colour scheme given below and complete the circular format by placing the dummy /fillers at the end.

Depending upon the number of fibres in a loose tube (which depends on the cable capacity), the fibres are serially chosen from the column no. II of the following table-1. Last fibre in a tube shall be of natural color, while the rest of fibres are colored.

Table -1 : Colour Coding scheme of the Optical Fibre & Loose tube

No. of Fibers/Buffer tube I	Fiber identification II	Loose tube identification III
1	Blue	Blue
2	Orange	Orange
3	Green	Green
4	Brown	Brown
5	Slate	Slate
6	White	White
7	Red	Red
8	Black	Black
9	Yellow	Yellow
10	Violet	Violet
11	Rose/Pink	Rose/Pink
12	Natural	Aqua

1.3 Cable drums, Marking, Packaging and Transport

All optical fibre cable shall be supplied on strong wooden drums provided with lagging with adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation. The cable drum shall be suitable to carry underground fibre optic cable of length 2 km ±10% (and can be customized based on the requirement). The Contractor may offer higher cable drum length in straight routes subject to transportation, handling and installation limitations. However, the exact lengths for drums to be supplied for each link shall be determined by the Contractor during detailed engineering/survey. Drum schedule shall be approved by the Employer before manufacturing the FO cable. Both cable ends in the drum shall be sealed and shall be readily accessible. The drum shall be marked with arrows to indicate the direction of rotation. Both the ends of the cable shall be provided with pulling eye. The pulling eye and its coupling system should withstand the same tensile load as applicable to the cable. The following marking shall be done on each side of the cable drums.

i) Drum number
ii) Consignee's name and address
iii) Contractor's name and address
iv) Type of cable
v) Number of fibres
vi) Type of fibres
vii) Year of manufacturing, month & batch no
viii) Name of manufacturer
ix) Total cable length
x) Inner end marking and Outer end marking

Packing list supplied with each drum shall have all the information provided on marking on the respective cable drum and following additional information: OTDR length measurement of each fibre and Ratio of fibre and cable length.

1.3.1 Fibre Optic Link lengths

The fiber optic route lengths are as specified in appendices. The lengths specified in appendices are route lengths; however the actual fiber cable length shall exceed the route lengths on account of extra cable requirement due to loop, jointing & splicing.

The exact cable lengths shall be determined by the Contractor during the survey. The same shall be used by the Contractor for final link design during the detailed engineering of the project.

The payment will be made for installation on the executed route length only. Upto 3% wastages of OFC shall be is allowed for specified service loops, lengths for wastage, installation/working for FO cable, joints, terminations etc during material reconciliation.

1.3.2 Operating Instructions

Complete technical literature in English with detailed cable construction diagram of various sub-component with dimensions and test data of the cable shall be provided. All aspects of installation shall also be covered in the handbook.

1.4 PLB HDPE pipe and ACCESSORIES

The following paragraphs describe the functional requirements, major technical parameters and Type and Factory Acceptance Testing requirements for Permanently Lubricant High Density Polyethylene (PLB HDPE) Pipe. PLB HDPE pipe shall be suitable for underground fibre optic cable installation by blowing as well as conventional pulling. The PLB HDPE pipe shall be suitable for laying in trenches by directly burying, laying through G.I./RCC Hume pipe, HDPE pipes and laying through trench less digging. The expected service life of HDPE pipe and accessories shall not be less than 50 years. Documentary evidence in support of guaranteed life span shall be submitted by the Contractor during detailed engineering.

The unit rates quoted in the price schedule shall be the composite price of PLB HDPE pipe along with all accessories.

1.4.1 Construction of PLB HDPE pipe

The PLB HDPE pipe shall have two concentric layers viz. outer layer and inner layer. The outer layer shall be made of HDPE material and the inner layer of solid permanent lubricant. These concentric layers shall be co-extruded and distinctively visible in cross-section under normal lighting conditions and generally conform to IS-9938. The colour of the PLB HDPE pipe shall be finalized during detail engineering. In the finished PLB HDPE pipe, the co-extruded inner layer of solid permanent lubricant shall be continuous and integral part with HDPE outer layer and preferably be white in colour. The inner layer of solid permanent lubricant shall not come out during storage, usage and throughout the life of the pipe. The pipe shall be supplied in a continuous length of 1000 (one thousand) meter in coil form, suitable for transportation, installation and handling purposes.

The finished pipe shall be of good workmanship such that the pipe is free from blisters, shrink holes, flaking, chips, scratches, roughness, break and other defects. The pipe shall be smooth, clean and in round shape, without eccentricity. The ends shall be cleanly cut and shall be square with axis of the pipe.

1.4.2 General

The HDPE pipe shall conform to the following standard and the technical specifications described in the following sections.

a) IS: 4984 / IS: 2530/IS:14151/(part1)/ IS:9938/IS:7328/IS12235(Part-9)/IS:5175
b) ASTM D 1693/ ASTM D 638/ ASTM D 648/ ASTM D 790 / ASTM D 1712/ ASTM D 2240/ ASTM D 4565 / ASTM F 2160/ ASTM G 154
c) TEC GR: TEC/GR/TX/CDS-008/03/MAR-11 or Latest relevant TEC GR for HDPE pipe for use as duct for optical fibre cable

1.4.3 Material

The raw material used for the PLB HDPE pipe shall meet the following requirements:

(i) The anti-oxidant establishers, color master batch and other additive used shall be physiologically harmless and shall be used only to minimum extent necessary to meet the specification.

(ii) Usage of any additives used separately or together, should not impair the long-term physical and chemical properties of the PLB HDPE pipe.

(iii) Suitable Ultra Violet stabilizers may be used for manufacture of the PLB HDPE pipe to protect against UV degradation when stored in open for a minimum period of 8 months.

(iv) The ash content of the colour master batch shall not be more than 12% when tested as per method detailed below:
Test Method for ash content: About one gram of the sample under test shall be taken and dried at 105°C for two hours in a plantinum or glazed porcelain or silica or quartz crucible. The weight of the sample shall be noted. Subsequently, the sample with the crucible shall be transferred to a muffle furnace maintained at 600±50°C and allowed to remain there for three hours. The ash content may be calculated as a percentage of the weight of the original sample.

(v) The base HDPE resin used for manufacturing outer layer of pipe shall conform to any grade of IS-7328 or to any equivalent standard meeting the following requirement when tested as per standards referred in this Section below.

a) Density (outer and inner layer): 940 to 958kg/m^3 at 27°C. The density of completed PLB HDPE shall not be differ by more than 0.003gms/cc by this value when tested as per IS:2530 or IS:7328.

b) Melt Flow Rate (MFR): 0.2 to 1.1 g/10 minutes at 190°C & 5 kg load: when tested as per IS:2530. The MFR of the outer layer of the completed PLB HDPE pipe shall not differ by more than 30% of this value.

c) Tensile Strength at Yield: 20 N/mm2 minimum, when tested As per ASTM D 638, Type-IV specimens

d) Elongation at break: >600%, when tested as per ASTM D638, Type-IV specimens

e) Flexural Modulus at 1% strain: 690 N/mm^2 minimum, when tested as per ASTM D 790.

f) Hardness, Shore-D: Between 60 and 65 units, when tested as per ASTM D 2240

g) Heat Deflection Temperature at 45 g/mm^2: 65ºC minimum, when tested as per ASTM D 648.

h) Environmental Stress Crack resistance, When tested with 10% Igepal, CO 0630 Solution 50ºC: 96 hrs., when tested as per ASTM D 1693, No cracks.

i) Weathering in artificial (UV) light (Specimens shall be as per ASTM D 638 Type-IV) and cut from compression moulded sheet. After exposure for 720 hrs., Tensile strength shall be tested. The variation shall not be greater than 20% compared to tensile strength obtained at above.

j) OIT (in Aluminium Pan): 30 minutes minimum, when tested as per Annexure-I.

k) UV Stabliser Content: Hindered Amine Light Stabliser minimum 0.15%, when analysed as per FT-IR method.

(vi) In the inner layer of PLB HDPE pipe, the friction reducing, polymeric material to be used as the inner layer lubrication material shall be integral with HDPE layer. The lubricant materials shall have no toxic or dermatic hazards for safe handling.

1.4.4 Dimension of pipe

The nominal size of the pipe shall be 40mm and shall meet the following requirements.

(i) Outside diameter	40 mm + 0.4 mm
(ii) Wall thickness	3.5 mm (+0.2 mm/ -0.00 mm)
(iii) Standard length	1000 meters ± 100 meter
(iv) Thickness of permanent lubricant,	≥ 0.4 mm
(v) Maximum outer diameter of FO cable that can be installed by blowing technique	16 ±0.5 mm or cable dia whichever is higher

1.4.5 Accessories of PLB HDPE pipe

The following accessories are required for jointing the pipe and shall be supplied along with the pipe. The manufacturers shall provide complete design details, procedure for method of installation and type of the material used for the accessories. No part of the accessories shall contain metal part and minimum pulling force of the coupler shall be 330kgf. The accessories shall pass the ageing test at 70+2ºC and there shall be no leakage when tested for 168 hours.

i) Plastic coupler: The coupler shall be used to join two PLB HDPE pipes. The coupling shall be able to provide a durable airtight and watertight joint between two pipes without deteriorating the strength of the pipes. The strength of coupler shall match the primary strength of the PLB HDPE pipe and threaded coupler is not acceptable. The jointing shall meet the air pressure test of 15 kg/cm^2 for a minimum period of 2 hours without any leakage.
ii) End plug: This shall be used for sealing the ends of empty pipe, prior to installation of FO cable and shall be fitted immediately after laying of the PLB HDPE pipe, to prevent entry of any unwanted elements such as dirt, water, moisture, insects/rodents etc.
iii) Cable sealing plug: This is used to hold the cable and prevent entry of any unwanted elements, as specified above.
iv) End cap: This cap is made of hard rubber, shall be fitted with both ends of PLB HDPE pipe to prevent the entry of any unwanted elements such as dirt, water, moisture, insects/rodents during transportation and storage.
v) Set of installation/maintenance accessories comprising of C-Spanners for tightening plastic coupler (4 nos.), Rotary duct cutter (2 nos.), spare cutting wheel (4 nos. per Rotary Duct cutter), Chamfering tool for giving slight chamfer to the ends of PLB HDPE pipe shall be

used during maintenance of the PLB HDPE pipes and these items (1set) shall be supplied along with the pipe.

1.4.6 Workmanship

The pipe shall be free of blisters, shrink holes, break and other defects. The PLB HDPE pipe ends shall be cut as square as possible to longitudinal aspects. The internal and external PLB HDPE pipe surfaces shall be smooth. The color should be uniform throughout.

1.4.7 Marking

All the pipe, shall be clearly marked at intervals of 1 meter with the following data which is not less than 5 mm height. The details of marking on pipe shall be approved by Employer before commencement of manufacturing.

i) Employer name with logo
ii) Manufacture's name or trade mark
iii) Year of manufacturing
iv) Type of PLB HDPE pipe and size
v) Running length marking

1.5 Installation of Underground Fibre Optic Cable System

This section describes the installation procedures and methods including survey, clearances, excavation of trenches and pits, trenchless digging, installation of PLB HDPE pipes, installation of RCC hume pipes and GI Pipes, marking, backfilling, installation of underground cable, construction of manholes, splicing, termination and site acceptance testing requirements of the underground fibre optic cabling system.

This specification is applicable for underground optical fibre installation work and some miscellaneous works to be executed inside city/town. The quantities indicated in the BoQ are indicative only and the final quantities against individual items will be approved by the Employer after detailed survey and depending upon the site condition.

1.5.1 Survey

The choice of route is most important aspect in planning an underground cable system. The correct choice is essential to reduce the cost of laying pipes, keeping the pipes safe from damage and to attain their maximum utilization when they have been laid.

The survey shall be conducted for underground fibre optic cable routes as described below to finalise the route and paths for the underground fibre optic cable. For underground fibre optic cable links, location of customers such as: Telecom service providers (NTC/NCELL, other basic operator, Cellular, Pager, ISPs etc), Major business centres, Bulk data users (Corporate Houses, universities, colleges etc) shall be identified by the Contractor and submitted to Employer by suitably marking the locations on a city map of proper scale.

In certain cases there will be routes where the Employer has finalized the route for the installation of PLB HDPE pipe vis-à-vis the underground OFC, or PLB HDPE pipe is already installed by Employer or other agency. In such cases, the Employer shall provide the details of the finalised route or existing PLB HDPE pipes routes to the extent possible. However, to carry out the fibre optic cable installation, the Contractor shall carry out the required survey of the routes.

1.5.1.1 Identification of under ground fibre cable route:

The Contractor shall propose preferably two most suitable routes (unless availability of a single route is obvious) for each link keeping in view the following broad criteria:

a. The route shall be as straight and as short as possible.
b. The route shall have minimum obstacles in order to minimise reinstatement cost.
c. Clearances required from other authorities/bodies are minimum and that the clearances can be obtained expeditiously.
d. Wet or unstable ground shall be avoided to the extent possible.
e. The route for the pipes shall be away from the carriage-way of the road to the extent possible.
f. The route shall be suitable for placing manholes wherever required.

g. Future expansion of roads shall be taken into consideration.
h. Road, rail, river, nallah crossings shall be minimum.
i. Underground fibre optic cable route shall be so chosen that it would be possible maintain sufficient distance from existing underground cables and to do excavation and backfilling along the route without disturbing the existing cables laid by other operators/utilities during installation of PLB HDPE pipe or future maintenance, to the extent possible subjected to ROW clearance.

1.5.1.2 Survey Report

The Contractor shall submit the survey report with the most suitable two alternate routes for all the fibre optic links along with details described above. The Employer shall choose one of the two alternatives. On finalisation the Contractor shall carry out detail survey for the selected routes and submit the final survey report for approval before implementation. The final survey report shall include at least the following:

a. A drawing of the proposed route indicating all details of the route including name of the road, GIS co-ordinates at every 25 mtrs, relevant details of soil strata, bridges, culverts, causeways, rail over/under bridges, defence area, underground gas / oil / water pipe line, power and communication cables routes, other important landmarks etc.
b. The distance of the fibre optic cable route from the centre of the road/rail/river//bridge/culvert etc. shall be indicated on the route maps as well as documented in tables.
c. Sections of the links where Horizontal Direction drilling, Moiling and Manual auguring may be required.
d. Sections where GI or RCC Hume pipe may be required.
e. Location and number of permanent and temporary manholes.
f. Location of all turns, bends and major landmarks.
g. Type, quantity and location of all the joint boxes. Care must be taken to minimise the number of splicing and joint boxes.
h. Section lengths of the underground fibre optic cable, total length of each link and drum scheduling for all the link.
i. List of authorities from which clearance shall be required to be obtained for each relevant section.

The final survey report shall have to be approved by the Employer and requisite clearances (as indicated below in this section) need to be obtained before the cable installation work is commenced.

For the routes where the Employer has finalised the route for installation of PLB HDPE pipe vis-à-vis the underground OFC or where PLB HDPE pipe is already installed by the Employer/Owner or other agency, the Contractor will survey the route to facilitate installation of optical fibre cable, and submit the final survey report as per above description.

The scope of survey shall also include the route and tentative Bill of Materials (pipes, couplers, manholes, G.I. pipes, RCC pipes, Joint box, conduits, bends, trays, warning bricks, Warning tape etc. and any other items required for successful implementation of the links) for the interconnection of optical fibre cable from the nearest manhole to the fibre termination box (FODP/FMS). It may be noted that routing of optical fibre cable inside the building may require installation on the walls and floors using suitable pipes, conduits, bends, trays etc and minor civil works (e.g. making holes on the walls, cutting grooves on walls/floor and making good etc.). The Contractor will also indicate sections where the OFC may be required to be installed overhead using poles/other supports and guide wires, because of non-feasibility in installation underground or lack of clearance from authorities.

1.5.2 Installation of PLB HDPE Pipe

PLB HDPE pipe shall be laid at bottom of the trench after making the surface smooth and stone free sand bedding or inside HDPE pipe.

After laying the pipe (where it is not laid inside HDPE pipe) additional sieved sand shall be added to increase the height of the sand layer to a total of 200 mm hence positioning the PLB HDPE pipe in the middle of the layer. Other important steps are described as under:

a. PLB HDPE Pipe shall be laid in a flat bottom trench free from stones, sharp edged debris.
b. The Pipe shall be placed in trenches as straight as possible. Minimum bending radius of pipe and fibre optic cable shall always to be taken into account.
c. The ends of pipes shall always be closed with end plugs to avoid ingress of mud, water or dust i.e. all pipe opening shall be sealed to avoid entry of foreign material.
d. The pipes shall be joined tightly & properly through plastic couplers and the joint shall be smooth and free from steps. The joints shall be made properly so that it passes the duct integrity test specified in this section. All joints shall be assembled with proper tools only.

e. Coupler shall not be placed along the bend portion of the pipe
f. Cable sealing plugs shall be provided at all manhole locations and at locations cable is coming out of the pipe and empty pipe ends i.e. all pipe openings shall be sealed to avoid entry of foreign objects.
g. PLB HDPE pipes shall be installed in a manner that fibre optic cable can be pulled, blown, de-blown without damaging the fibre optic cable due to stresses.

The Contractor shall inspect all joints before carrying out the backfilling along with representative of Owner/Employer. Joints shall be visually inspected and checked for tightness.

Unit rate for installation of PLB HDPE pipes shall interalia include all related works/activities including installation of all accessories/hardware described in this section. Accordingly the unit rate quoted shall include all wastages, working length etc. and all other items/works required for PLB HDPE pipe installation. The Owner/Employer shall not entertain any claims or payment towards installation of hardware/accessories, installation of additional lengths of PLB HDPE pipe required to be taken for working lengths and wastages etc.

Manhole are marked at every 200m or at bends or turns for installing UGFO cable through HDPE duct. HDPE end caps used for sealing the PLB HDPE Ducts, to avoid entry of rodents/mud etc.

1.5.2.1 Acceptance Testing of PLB HDPE pipes

After installation of PLB HDPE pipes, the PLB HDPE pipes shall be checked over the whole lengths in order to ensure integrity and its suitability during fibre optic cable blowing/pulling. The installed PLB HDPE pipes shall be checked as per the requirements specified in this section. In case of any problem, the Contractor shall rectify the same and re-digging and/or re-installing of PLB HDPE pipes shall be carried out by the Contractor at no additional cost to the Employer. After acceptance test, both ends of each PLB HDPE pipe shall be again properly sealed.

The Contractor shall submit the exact method/procedure for the above tests for Employer's approval.

1.5.3 Manholes

Manholes shall be provided at around 200m and at proposed future joint location to house Joint Box and Optical Fibre cable service loops. The location for Joint boxes shall be decided during survey and detailed engineering. At RMU and GO switch locations joint box Manhole are proposed. For the other Manhole where joint box is not proposed fibre loop to be provided.

There can be three types of construction of manholes depending upon the location of the manhole. Each type of construction of manhole can be of two sizes (heights) depending upon the utility. Where the manholes are placed on the footpath or where heavy vehicular movement is not expected, manhole with brick masonry wall (wall thickness min. 225mm and inside dimension 1000mmx1000mm square, inside wall 12mm cement plaster with 1:4 mix) can be constructed. However, in case the manhole is required to be constructed at the middle of the road or where heavy vehicular movement is expected, the manhole shall necessarily be of RCC construction. Such manhole shall be pre cast RCC Cylindrical pipe (spun concrete) with minimum wall thickness of 80mm and shall include Φ8mm or more steel reinforcement. The base of manhole in all types shall be minimum 80mm thick PCC and minimum internal diameter shall be 1000 mm. In case the base is constructed as integral part of the pre cast RCC cylinder, the base shall also be RCC. Height of the manhole, where joint boxes are to be kept, shall be of 1100 mm height. Manhole for keeping service loops of OFC shall be of minimum 400mm height. The cover shall be pre cast RCC, minimum 50mm thick. However, for easy handling purpose, the cover is to be constructed with suitable arrangement for lifting. The top of manhole should be flushed with the ground level. Manholes type approved by the Employer shall only be acceptable. Manhole shall be designed as per the typical drawing enclosed at Annexure-I. The manhole shall have two holes in each four perpendicular directions for PLB HDPE/HDPE pipe entries and exits. Fixtures for placing cable and spliced Joint Box inside the manhole shall be provisioned. The joint box shall be mounted vertically on the wall of the manhole. The contractor shall carry out the required excavation and backfilling for the construction of the manhole. All PLB HDPE pipe entries, cable entries and holes shall be properly sealed.

The Contractor may propose double walled "Annual ring shaped conical manholes" meeting all the requirements of the manhole specified above. The assembly of conical manhole shall be made by using pre-cast steel (rod or wire-mesh) reinforced Concrete elements, which consists of annular rings different height and diameter (within permissible diameter range of conventional manhole as specified above)

placed over each other. Manholes type approved by the Employer shall only be acceptable. For installation of PLB HDPE pipe or trenchless digging or blowing of OFC, at times there might be requirement of providing temporary manhole or hand holes. No separate payment shall be admissible for such manholes or handholes and shall be deemed to be inclusive in the overall scope of work by the Contractor.

If required, as per the advice of the Employer, manholes shall also be installed along the existing installed PLB HDPE pipe routes to house joint boxes and cable service loops. Due care is to be taken so that the existing PLB HDPE pipe and OFC does not get damaged while placement of new manhole.

Unit rate for the manholes shall interalia include all related works/activities including RCC cylindrical pipe, Brick masonry work, PCC base, pre cast cover, excavation, backfilling, supply, transportation and installation of all material & accessories required for construction of manhole as per specification. Provisional quantity for all types of manholes (viz. manhole for service loops and for joint box, RCC and Brick Masonry Construction) manholes has been identified in the appendices, payment shall be made based on actual quantities executed.

1.5.4 Installation of GI Pipe

The GI pipe of nominal bore of minimum 150 mm shall be laid wherever road crossings, bridge crossings, railway crossings are encountered on the route as well as on wall/floor crossings in a building. PLB HDPE pipe shall be inserted into GI pipe. Whenever it is not possible to install the FO cable underground due to non availability of the right of way or any other unavoidable reasons, the HDPE ducts along with FO cable shall be installed in GI pipe on the existing rock/concrete/brick wall/surface with suitable fixing arrangement and concreting, if necessary, with specific approval of the Employer in case to case basis. The GI pipe shall conform to at least medium class and conform to IS: 1239 (Part –I). In regard to bridge and culvert crossing, GI pipe may be installed by concreting the GI pipe along the bridge or by using supporting brackets or by laying underneath the existing footpath etc. The PLB HDPE pipes shall be installed through this GI pipe. Wherever underground fibre optic cable is required to be spliced to overhead fibre optic cable using the outdoor FODPs/Joint Boxes installed on towers, GI pipes shall be used to protect the portion of the cable/duct upto a height of about 6 to 10 meters and shall be extended in the ground up to suitable depth of the trench so that minimum bending radius of the cable is maintained. The GI pipe shall be properly clamped/ fixed on the tower leg. The Contractor shall supply and install all necessary accessories as part of the installation work.

The Contractor shall propose the exact methods and procedures for implementation of crossings taking into consideration the following guidelines, for approval by the Employer:

a. The GI pipe shall be extended at least 5 meters on each side of crossing subject to availability of space and approval of the Employer.
b. Two GI pipes shall be joined using proper tools, sockets and accessories etc.
c. Proper arrangements shall be made to seal the ends of GI pipe after installation of PLB HDPE pipes.
d. Minimum bending radius of optical fibre cable shall always be taken into consideration.
e. 1:2:4 concrete shall be used for encasing of the GI pipe, wherever required.
f. The floor of the trench shall be levelled by laying at least 50 mm of soft soil or sieved sand before installing the GI pipe.
g. The GI pipes shall be supplied in standard lengths of 6m or as approved by Employer.
h. The GI pipe shall be sealed at both ends.
i. The GI pipe of suitable length shall be provided at road crossings, bridge crossings, railway crossings encountered on the route as well as on wall/floor crossings in a building and also for protection of fibre optic cable at tower/pole mounted joint boxes.

The quoted unit rate for the supply of GI pipe shall interalia include all required accessories (sockets, joints, brackets, clamps etc) and material (cement, sand, chips etc). The quoted unit rate for the installation of GI pipe shall interalia include all related works/activities including installation of hardware and accessories (sockets, joints, brackets, clamps etc), fixing arrangement and concreting required for GI Pipe installation at road crossings, bridge crossing, railway crossing encountered on the route as well as on wall/floor crossings in a building. PLB HDPE Pipe shall be laid in the GI pipe, accordingly the quoted unit price shall take into account working lengths and wastages. The Owner/Employer shall not entertain any claims or payments towards installation hardware, accessories, concreting, cementing, working length and wastage etc. The Payment shall be made based on actual fibre optic route length executed inside GI pipe.

1.5.5 Underground Fibre Optic Cable Installation

The cable shall be installed inside one of the 40mm diameter PLB HDPE pipe installed under this package along the route(s). Generally, the cable shall be installed by compressed air blowing technique. However, for spans upto 150 meters, the Contractor can use pulling method for installation of OFC in HDPE pipe. If any temporary manhole or handhole is required for installation of OFC, the same will be done by the Contractor without any additional cost implication. Adopting pulling method for installation of OFC for spans more than 150 meter, shall be subjected to approval of the Employer and shall be substantiated by proper justification. Contractor shall take into consideration the following guidelines, for installation of OFC approval by the Employer.

a. The Optical Fibre Cable Drums shall be handled with utmost care. The drum shall not be subjected to shocks by dropping etc. They shall not be normally rolled along the ground for long distance and when rolled, shall in the direction indicated by the arrow. The battens shall be removed only at the time of actual laying.
b. A blowing machine in association with an appropriate compressor shall be used for blowing.
c. Temporary blowing chambers (if required) shall be constructed and then backfilled after blowing operation is completed.
d. Locations along the route, which provide easy access points for blowing machine and compressor, shall be determined.
e. Before starting the cable blowing, PLB HDPE pipe shall be checked for obstacles or damage. Checking shall be done by using a proper sized mandrel.
f. Always blow downhill wherever possible.
g. Multiple blowing machines may be used in tandem if so required.
h. Care must be taken not to violate the minimum bending radius applicable for the fibre optic cable. Tension in the cable during laying shall not exceed tension limit of the OFC.

Installation by pulling may be permitted by the Employer only in specific cases where installation by blowing is not feasible on specific approval from the Employer. In case pulling is used, the pulling speed shall be determined considering the site condition.

While installing the cable, excess length of about 10 meters shall be stored at each joint location for each side. Excess length of 10 m shall be kept at one ends of a road crossing, culvert crossing and 20 meters at one end of bridges, However, exact excess lengths and manhole locations shall be finalised during detailed engineering depending upon the site requirement.

Unit rate for installation of fibre optic cable shall interalia include all related works/activities including associated accessories, tools & tackles, machinery etc. The BoQ in the appendices indicates the total fibre optic route length where fibre optic cable shall be installed. Accordingly, unit rate shall include all working allowances and wastages, hardware and accessories required for installation of optical fibre cable. The Owner/Employer shall not entertain any claims or payment towards installation of hardware/accessories, any additional length of cable for working allowances and wastages etc. The payment shall be made on prorata based on actual fibre optic route length executed including cable service loops/excess cable as stipulated above.

1.6 As Built Drawings/details

The Contractor shall submit the as built drawings for the whole route indicating the route, depth of digging and manhole locations for easy maintenance of the installed system.

1.6.1 List of Drawings/documents required to be submitted for Employer's approval

The Contractor shall ensure that the required drawings and documents are submitted well in time to avoid any delay in approval and project execution. The following minimum drawings and documents are required to be submitted by the Contractor for approval of the Employer:

a. Final Route Survey Report including manhole locations
b. The methods/procedures and the equipment/machines to be used for different types of trenchless digging techniques
c. Bill of quantities for various items as per contract
d. SAT Reports
e. As built drawings

1.7 Documentation

Apart from survey reports as mentioned above, the Contractor will submit the following documents after completion of the job and acceptance by the Employer:

(a) As built drawing of the route indicating the distance from road centre, location of other utilities, link BoQ, OFC loop length, name of the road, sections and positions of PLB HDPE pipes, couplers, warning bricks/stone, manholes, G.I. pipes, RCC pipes, joint box, conduits, bends, trays, optical fibre cable loop lengths in manholes etc.

(b) Depth of PLB HDPE pipe in various sections of the route executed through open trenching.

(c) Sections of trenching digging executed through various methods.

(d) Splicing/termination details of each joint box/FODP. Attenuation and splicing loss measurement data shall be submitted for each fibre.

(e) Specific deviation w.r.t. the installation and supply items, if any, from the technical specification. If there is no deviation, either explicit or implicit, the Contractor will provide a certification to this effect.

(f) Without submission of the above documentations, the Site Acceptance Testing of various items as described above will be deemed to be incomplete.

1.8 Interconnection

The contractor shall also interconnect their Fibre Optic Cable system at both ends with existing Fibre Optic cable through splicing in Joint boxes or through connection by patch cords at FODPs, as required. The exact method of interconnection shall be finalized during project execution.

1.9 Miscellaneous Works

In order to provide end-to-end connectivity, it may be required to execute some miscellaneous jobs as detailed below.

1.9.1 Routing of Cables inside building.

In order to route the OFC (Optical Fibre Cable) from the underground trench to the FODPs it may be necessary to install the cable on walls inside PLB HDPE pipe over the existing cable tray/raceways inside the building.

1.9.2 Installation of PLB HDPE pipe on wall

The PLB HDPE pipe may be required to be installed on the wall using steel or G.I clamps. The contractor will provide the required clamps and other consumables sufficient for such installation. The contractor will take care of aesthetics while installation. The OFC will be pulled through the PLB HDPE pipe with due care as described in relevant Para of this specification.

Annexure-I

The following parameters of the component parts of the cable are to be taken in to account while designing and manufacturing the optical fibre cables of the required fibre count. These parameters shall be checked during evaluation of the OF cables.

SN	Parameter	Unit	12 Fibre OF cable(NA)	24 Fibre OF cable(NA)	48 Fibre OF cable	96 Fibre OF cable (NA)
2	Tube ID (min)	mm	1.2	1.2	1.2	1.4
3	Tube OD	mm	1.9+ 0.1	1.9+ 0.1	1.9+ 0.1	2.0 + 0.1
4	No of fibre /tube	No	4	4	8	12
5	Color of fibre		BL,OR,GR, NAT	BL,OR,GR, NAT	BL,OR,GR,BR, SL, WH, RED, NAT	BL,OR,GR,BR, SL, WH, RED, BK, YL,V, PK, NAT
6	No of loose tubes	No	3	6	6	8
7	Colour of loose tubes		BL,OR,GR	BL, OR, GR, BR, SL, WH	BL,OR,GR,BR, SL,WH	BL,OR,GR,BR,SL, WH, RD, BK
8	No of dummy cord	No	3	0	0	0
9	Tube stranding lay over length	mm	90-110	90-110	90-110	100-120
10	Inner Sheath Thickness (Min.)	mm	1.2	1.2	1.2	1.2
11	Qty. of Impregnated Glass roving (min.)	Kg	20	20	20	20
12	Outer Sheath Thickness (Min.)	mm	1.6	1.6	1.6	1.6
13	Cable diameter	mm	12.8+0.5	13.2+1.0	13.2+1.0	14.5+0.5
14	Nominal cable weight	Kg/km	140	140	140	175
15	Cable to be designed to Fibre strain value of	%	0.1	0.1	0.1	0.1
16	Excess fibre	%	0.65	0.65	0.70	0.70

	length					
17	Cable to be tested at defined load for fibre strain value of	%	0.25	0.25	0.25	0.25

The drawing above is for reference only and shall be finalized during detail engineering.

Annexure-II

DRY DRY CORE CABLE DESIGN

The following parameters of the component parts of the cable are to be taken in to account while designing and manufacturing the optical fibre cables of the required fibre count. These parameters shall be checked during evaluation of the OF cables:

S N	Parameter	Unit	12 Fiber OF Cable	24 Fiber OF Cable	48 Fiber OF Cable	96 Fibre OF Cable
1	FRP Rod EAA Coated	mm	2.3+0.1/-0.0	2.3+0.1/-0.0	2.5+0.1/-0.0	3.0+0.1/-0.0
2	FRP up jacketing thickness	mm	0	0	0	0.6
3	Tube ID (min)	mm	1.4	1.4	1.7	1.7
4	Tube OD	mm	2.2 ± 0.1	2.3 ± 0.1	2.4 ± 0.1	2.4 ± 0.1
5	No of fibre / tube	No	4	4	12	12
6	Color of fibre		BL, OR, GR, NAT	BL, OR, GR, NAT	BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, PK, NAT	BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, PK, NAT
7	No of loose tubes	No	3	6	4	8
8	Color of loose tubes		BL, OR, GR	BL, OR, GR, BR, SL, WH	BL, OR, GR, BR	BL, OR, GR, BR, SL, WH, RD, BK
9	No of dummy cord	No	3	0	2	0
10	Tube stranding lay over length	mm	90-110	90-110	90-110	100-120
11	Aramid Yarns-Min	Kg/Km	10	10	10	13

12	Cable diameter	mm	14.5 ± 0.5	14.5 ± 0.5	15.0 ± 0.5	16.5 ± 0.5
13	Nominal cable weight	Kg/Km	145-175	145-175	150-180	190-220
14	Cable to be designed to Fiber strain value of.	%	0.1	0.1	0.1	0.1
15	Excess fibre length	%	0.70	0.70	0.70	0.70
16	Cable to be tested at defined load for fiber strain value of	%	0.25	0.25	0.25	0.25

** In case of 96F, use of FRP with 4.2mm± 0.1mm diameter can also be allowed in place of up coating option.

Section-03 (As applicable)

Specifications for FMS, FODP and Splice Enclosure

This Section describes the functional & technical specifications of Fibre Management System (FMS), Fibre Optic Distribution Panel (FODP) and Joint Box (Splice Enclosure). All items shall be included with the cost of fiber optics indicated in the price schedule.

3.1 FMS

Fibre Management System (FMS) or Line Interface Unit (LIU) shall be used at RMU & GO switch locations. These FMS shall be used to connect fibre optic cable from Manhole / Splice enclosure to the communication equipment.

Indoor FMS Shall be 1U/2U/3U/4U size and rack mountable through sliding into panel. It shall be as per relevant TEC GR. Outdoor FMS shall be wall mountable or shall be mountable to Ground/Footpath. Outdoor FMS shall also conform IP68 protection and latest TEC GR.

Indoor type FMS shall be installed into the existing Cabinet/Panel of RMU panel. However for outdoor FMS cabinet to be provided alongwith cabinet and locking arrangement.

TEC GR Reference: GR/FDM-01/02/APR-2007 (Type-I) with latest amendment No. TEC/T/OFC-FDMS/149/2012.

FMS should have following features:

1. Metal base material with powder coating for light mounting.

2. Connectivity available for all type of connector available e.g. SC, LC, FC, ST, E2000 Terminations. There should be arrangement of termination of 96/48/24/12/6 Nos. of fibers

3. It should be mountable in standard 19” rack and of slider type.

4. Shall supplied with all accessories e.g. Cable Ties, mounting ear screw, sleeves, Tissue, Fiber cleaner liquid etc.

The FMS shall be manufactured as per latest state of art technology. Body should be of MS steel; powder coating painting (min. 70 micrometer thickness) shall be provided with rust resistance paint.

3.1.1 Specifications of Patch Cords

The Patch cords should be confirming to TEC NO.: TEC/GR/TX OFJ-01/05/NOV-09 with latest amendment No. TEC/T/OFC-OFJ/155/2013.

3.2 Joint Box

3.2.1 Joint Box (Splice Enclosure) and Splicing:

The UGFO and ADSS cables would be required to be spliced at every joint, normally at a distance of every 2 km. Splicing to be for underground cable at Manhole and for ADSS cable on the 11 kV poles. For the ADSS Joint Box, pole mounting structure to be provided alongwith joint box. Joint box shall be as per TEC GR TEC/GR/TX/OJC-002/03/APR-2010 or latest amendments, if any. Joint Box shall be universal type that can be placed on underground and overhead locations.

Joint Box shall be suitable to both straight joint and branch joints. Maximum 12 fibres shall be splices in one splice tray. In the Price Schedule different type of joint box mentioned 12F, 24F and 96F. 12F & 24F Joint Box shall be used for branch joints and for straight joint between branching cables.

For the joint between UGFO and ADSS it will be done preferably on O/H (on the poles).

Manhole shall be placed at around 200m for installation/pulling of UGFO. At these manhole where splicing is not to be done UGFO cable shall kept with 15 meter additional loop for future Telecom purpose.

3.2.2 Methodology for splicing at RMU locations:

96F UGFO and ADSS shall be used as main feeder FO cable and 12F & 24F cable (UGFO/ADSS) shall be used as branching cable to connect 6 fibres from main 96F to FMS.

At RMU / GO switch location, 6 fibre from 1 tube of UGFO /ADSS cable of multitube cable shall be cut and spliced inside joint box and other tubes shall be bypassed to save splice losses of remaining fibres. At the location where UGFO/ADSS drum to be terminated, all the 96Fibers shall be spliced. The methodology in this regard shall be finalized during detailed engineering.

3.2.3 Cable Entry and Sealing Arrangements:

The base shall have a minimum 4 single cable entry ports and one port for express (looped) cable entry. The arrangement shall be provided for terminating looped or express cable by making a suitable necessary provision. All ports shall be sealed and entry ports (sealed) shall be opened as per the requirement. The opening of any port shall not cause any interference to any existing cable. No heat shrink of any type shall be allowed on the cable for sealing. No screws or nut & bolts of any type shall be allowed. The sealing material shall be termite proof. No consumable items shall be required for sealing. The sealing components must be reusable and shall have unlimited shelf life. The sealing arrangements shall be specified along with opening and closing arrangement by the manufacturer and the same shall be tested.

It shall be possible to terminate all cables having outer diameter of 20mm (Max.).

The joint enclosures shall contain fibre organizer system where the extra length of fibres and splices are stored in systematic & secured manner. The method or device for safely routing and securing buffer tube and bare fibre shall be provided.

The joint enclosures shall allow an easy opening and re-closing without degradation in the performance of joint enclosure. Access to the inner junctions shall be possible without damaging the existing cables. The closure must be designed such that no installed cable is disturbed or require re-sealing of the existing cables during installation of additional cables.

3.2.4 Holding Arrangements

The box shall provide the following:

(i) Holding arrangement and framework for properly securing cable organizers with splice trays.
(ii) Securing arrangement for holding fibres.
(iii) Holding device to hold strength member of fibre optic cable securely.
(iv) Any other extra component required for providing strength and reliability to the Joint Box.

3.2.5 Compatibility

All the component and parts used shall be compatible with the optical fibre cable, fibre splices and cable components. Their use for long should not result in increase in transmission loss or deterioration in other properties.

3.2.6 Marking on body of the Joint box

The following information by marking on Joint box shall be provided:

(i) Manufacturer's name & date
(ii) Type of Joint box
(iii) Number of Splice organiser cassettes
(iv) Number of splices per cassette
(v) Batch number and serial number.

3.3 Fibre Optic Distribution Panel

This section describes the general requirements, type and factory testing requirements of Joint Box for underground optical fibre cables. At locations requiring the termination of at least one pair fibre within a cable, all fibres within that cable shall be connectorised and terminated in FODPs in a manner consistent with the following.

a. FODP shall be provided to accommodate rack mountable 1U (24F) & 2U (48F) FODP Subrack with Splicing & Patching Trays, with suitable patch cord & Adaptors in 2200x600x600 Cabinet.
b. All fibre optic terminations shall be housed using FODPs provisioned with splice organisers and splice trays. All fibres within a cable shall be fusion spliced to pre-connectorised pigtails and fitted to the backside of the provided couplings. The pigtails and the fibres shall be stored and dressed neatly in the provided trays and holders. The pigtails/fibres shall be numbered using suitable ferrules.
c. Ground lugs shall be provided on all FODPs and the contractor shall properly ground all FODPs. The FODPs shall be properly fixed/grouted to the floor and or with wall with better support. Necessary installation material for fixing the FODP on wall or ground shall be provided by the Contractor.
d. The location of FODPs rack shall be fixed by the contractor, with the Employer's approval.
e. Flexible protection shall be provided to the patch cord bunches going out from FODP to another equipments.

3.3.1 Optical Fibre Connectors

FC-PC type connectors shall be used. Average loss of the FC-PC connectors shall not exceed 0.5dB.

3.3.2 Optical Fibre Splices

Splicing of the optical fibre cabling shall be minimized through careful planning. It is important that all splicing work be done under clean conditions. All required splices shall be planned to occur at Joint location/manhole. All optical fibre splicing shall comply with the following:

a. All fibre splices shall be accomplished through fusion splicing.
b. Each fibre splice shall be fitted with a splice protection sheath fitted over the final splice.
c. For splicing of each fibre, every effort shall be made to minimise the bidirectional average splice loss.
d. All splices and bare fibre shall be neatly installed in covered splice trays.
e. Average bi-directional splice loss at any particular splice shall not exceed **0.1dB** but total bi-directional average of all splices in a link shall not exceed **0.05dB.**
f. Fibre optic cable service loops as indicated in technical specifications shall be provided.

3.4 Splicing of fibres in existing Joint Box or FODP

In case it is required to do re-splicing for rectification or splice new cable in an existing Joint Box, above stipulations for splicing shall be applicable. In such conditions, splicing of only few fibres of the existing cables in the Joint Box with the new cable shall be done. For working in existing Join Box/FODP, the Contractor shall take due care so that the traffic in the balance fibres is not affected**.**

3.5 Service Loops

For purposes of this specification, cable and fibre service loops are defined as slack (excess) cable and fibre provided for facilitating the installation, maintenance and repair of the optical fibre cable system.

a. Outdoor Cable Service Loops: At manhole chambers splices are installed with sufficient fibre optic cable service loops (as mentioned in Technical Specification) such that the recommended minimum bend radius is maintained while allowing for installation or maintenance of the cable to be performed in a controlled environment at ground level. Optical cable service loops (excess cable) shall also be provided at all crossings in manholes (as mentioned in Technical Specification).

b. Indoor Cable Service Loops: At FODPs, Contractor shall provide at least three (3) metres of cable service loop. Service loops shall be neatly secured and stored, coiled such that the minimum recommended bend radius is maintained.

c. Fibre Units Service Loops: For all fibre optic cable splicing, the cable shall be stripped back a sufficient length such that the fan-out of fibre units shall provide for at least one (1) metre of fibre unit service loop between the stripped cable and the bare fibre fan-out.

d. Pigtail Service Loops: Connectorised pigtails spliced to bare fibres shall provide at least 0.5 metre of service loop installed in the FODP fibre organizer and at least one (1) metre of service loop to the couplings neatly stored behind the FODP coupling panels.

e. Fibre Service Loops: At least 0.5 metre of bare fibre service loop shall be provided on each side of all fibre splices. The bare fibre service loops shall be neatly and safely installed inside covered splice trays.

Section - 04

Inspection & Testing Requirement

All materials furnished and all work performed under this Contract shall be inspected and tested. Deliverables shall not be shipped until all required inspections and tests have been completed, and all deficiencies have been corrected to comply with this Specification and approved for shipment by the Employer.

Except where otherwise specified, the Contractor shall provide all manpower and materials for tests, including testing facilities, logistics, power and instrumentation, and replacement of damaged parts. The costs shall be borne by the Contractor and shall be deemed to be included in the contract price.

The entire cost of testing for factory, production tests and other test during manufacture specified herein shall be treated as included in the quoted unit price of materials, except for the expenses of Inspector/Employer's representative.

Acceptance or waiver of tests shall not relieve the Contractor from the responsibility to furnish material in accordance with the specifications.

All tests shall be witnessed by the Employer and/or its authorized representative (hereinafter referred to as the Employer) unless the Employer authorizes testing to proceed without witness. The Employer representative shall sign the test form indicating approval of successful tests.

Should any inspections or tests indicate that specific item does not meet Specification requirements, the appropriate items shall be replaced, upgraded, or added by the Contractor as necessary to correct the noted deficiencies at no cost to the Employer. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The Employer reserves the right to require the Contractor to perform, at the Employer's expense, any other reasonable test(s) at the Contractor's premises, on site, or elsewhere in addition to the specified Type, Acceptance, Routine, or Manufacturing tests to assure the Employer of specification compliance.

4.1 Testing Requirements

Following are the requirements of testing:

1. **Type Testing**
2. **Factory Acceptance Testing**
3. **Site Acceptance Testing**

4.1.1 Type Testing

The Contractor shall submit along with their bid the earlier carried out type test reports for the offered fibre optic cable, HDPE Duct etc. meeting the requirement. The Contractor shall submit the previously carried out type test report for the same design of cable for the tests listed in this section. All items should have been type tested as per relevant standards for the tests listed in this section and the Contractor shall submit the test reports and certificates along with the bid. Type Testing shall comply with the following:

(a) All items being supplied shall conform to type tests as per technical specification.

(b) The reports submitted shall be of type tests conducted within below mentioned periods from the date of bid opening:

(i) seven (7) years for UGFO, ADSS Cable and other items

In case the test reports are older than aforementioned time duration, the Contractor shall repeat these tests at no extra cost to the purchaser.

(c) The Contractor shall submit previous type test reports. These reports may be accepted by the Employer only if they apply to materials and equipment that are essentially identical to those due to be delivered under the Contract and only if test procedures and parameter values are identical

to those specified in this specifications carried out at accredited labs and witnessed by third party / customer's representatives.

In the event of any discrepancy in the test reports or any type tests not carried out, same shall be carried out by Contractor without any additional cost implication to the Employer.

(d) Type Tests shall be certified or performed by reputed laboratories using material and equipment data sheets as per procedures provided in this technical specification. The Contractor shall provide the Employer at least 30 days written notice of the planned commencement of each type test.

(e) The Contractor shall provide a detailed schedule for performing all specified type tests. These tests shall be performed in the presence of a representative of the Employer.

(f) The Contractor shall ensure that all type tests can be completed within the time schedule offered in his Technical Proposal.

(g) In case of failure during any type test, the Supplier is either required to manufacture a fresh sample lot and repeat all type tests successfully or repeat that particular type test(s) at least three times successfully on the samples selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

4.1.1.1 Type Test Samples

The Contractor shall supply equipment/material for sample selection only after the Quality Assurance Plan has been approved by the Employer. The sample material shall be manufactured strictly in accordance with the approved Quality Assurance Plan. The Contractor shall submit for Employer approval, the type test sample selection procedure. The selection process for conducting the type tests shall ensure that samples are selected at random. For optical fibres/ Fibre Optic cables, at least three reels/ drums of each type of fibre/cable proposed shall be offered for selection. For FO cable installation hardware & fittings at least ten (10) samples shall be offered for selection. For Splice enclosures at least three samples shall be offered for selection.

4.1.2 List of Type Tests

The type testing shall be conducted on the following items

(a) Optical fibres
(b) UGFO Cable
(c) ADSS Cable (NA)
(d) Splice Enclosure (Joint Box)
(g) ADSS Fibre Optic Cable fittings (NA)

4.1.2.1 Type Tests for Optical Fibres

The type tests listed below in Table 4-1 shall be conducted on DWSM fibres to be supplied as part of underground and overhead cables. The tests specific to the cable type are listed in this section.

Table 4-1

Type Tests For Optical Fibres

S. No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation	As per Section-01 of TS	IEC 60793-1-40 Or EIA/TIA 455-78A
2	Attenuation Variation with Wavelength		IEC 60793-1-40 Or EIA/TIA 455-78A
3	Attenuation at Water Peak		IEC 60793-1-40 Or EIA/TIA 455-78A
4	Temp. Cycling (Temp dependence of Attenuation)		IEC 60793-1-52 Or EIA/TIA 455-3A, 2 cycles
5	Attenuation With Bending (Bend Performance)		IEC 60793-1-47 Or EIA/TIA 455-62A
6	Mode Field dia.		IEC 60793-1-45 Or EIA/TIA 455-164A/167A/174
7	Chromatic Dispersion		IEC 60793-1-42 Or EIA/TIA 455-168A/169A/175A
8	Cladding Diameter		IEC 60793-1-20 Or EIA/TIA 455-176
9	Point Discontinuities of attenuation		IEC 60793-1-40 Or EIA/TIA 455-59
10	Core -Clad concentricity error		IEC 60793-1-20 Or EIA/TIA 455-176
11	Fibre Tensile Proof Testing		IEC 60793-1-30 Or EIA/TIA 455-31B
-End Of table-			

4.1.2.2 **Type Test for Underground Fibre Optic Cable**

Table- 1.7.2 **Type tests for Underground Fibre Optic Cable**	
1.	Tensile Strength Test
2.	Abrasion Test
3.	Crush Test (Compressive Test)
4.	Impact Test
5.	Repeated Bending Test
6.	Torsion Test
7.	Kink Test
8.	Cable Bend Test
9.	Temperature Cycling
10.	Cable Aging Test
11.	Water penetration Test
12.	Test of Figure of 8 (Eight) on the cable
13.	Flexural Rigidity Test on the optical fibre cable
14.	Static Bend test
15.	Cable Jacket yield strength and ultimate elongation
16.	16.1 Embrittlement Test on loose tube
	16.2 Kink Resistance on loose tube
17.	17.1 Drainage Test for loose Tube
	17.2 Drip Test on the cable
18.	Check of easy removal of sheath
19.	Check of effect of aggressive media on the cable surface (Acidic and Alkaline behaviour
20.	Termite & Rodent Test

The detailed procedure for type test are given at Annexure -III.

4.1.2.3 Type Test for PLB-HDPE Pipe

The PLB HDPE pipes & accessories offered to be supplied should have been type tested as per requirement specified in TEC/GR/TX/CDS-008/03 MAR-11 with latest revisions or equivalent standard. The contractor shall enclose the previous type test report according to relevant international standard for the proposed PLB HDPE duct meeting the specified requirement.

4.1.2.4 Type tests for Joint Box:

The Joint Box offered to be supplied should have been type tested as per requirement specified in TEC/GR/TX/OJC-002/03 APR-10 with latest revisions or equivalent standard. The contractor shall submit the earlier carried out type test reports for the offered joint box meeting the requirement.

List of type tests on joint box are given below:

(i). Water Ingress Test.

(ii). Drop and Topple Test.

(iii). Air Tightness Test.

(iv). Static Load Test.

(v). Impact Test.

(vi). Vibration Test.

(vii). Environmental Cycle Test.

(viii). Salt Spray (Mist) Test.

(ix)(a). Resistance to Aggressive Media Test.

(ix)(b). Resistance to Stress Cracking Test.

(x). Variation in Attenuation.

(xi). Torsion Test.

(xii). Flexure Test.

(xiii). Clamping Test.

(xiv). Thermal Aging.

(xv). Current Surge Test.

(xvi). UV Test.

4.1.2.5 Type Testing on ADSS Optical Fibre Cable (Not Applicable)

The type test on the ADSS Cable shall be as per procedure mentioned in TEC GR:TEC/GR/TX/OFC-022/02/MAR-17 or equivalent standard.

The contractor shall submit earlier carried out type test reports for the offered ADSS Optical Fibre Cable meeting the requirement. The Contractor shall submit the previously carried out type test report for the same design of cable for the tests listed in Table 4-4 below. The fibre should have been type tested as per relevant International standards for the tests listed in Table-2-1.

Table 4-4

S.N.	Name of Test
1	Tensile strength Test
2	Abrasion Test
3	Crush Test (Compressive Test)
4	Impact Test
5	Repeated Bending
6	Torsion Test
7	Kink Test
8	Cable Bend Test
9	Snatch Test
10	Cable Bend Test at High & Low Temperature

S.N.	Name of Test
11	Temperature Cycling
12	Cable Aging Test
13	Cable Freezing Test
14	Water Penetration Test
15	Test of Figure of Eight on the cable
16	Flexural Rigidity Test on the optical fibre cable
17	Static Bend Test
18	Cable Jacket Yield Strength and Ultimate Elongation
19	Drip Test
20	ECSR Test
21	UV Resistance Test
22	Embrittlement Test of Loose Tube
23	Kink Resistance Test on the Loose Tube
24	Drainage Test for Loose Tube
25	Check of Easy removal of Sheath
26	Check of the effect of Aggressive Media on the Cable
27	Electrical Test
28	Aeolian Vibration Test (Type Test)
29	Galloping Test
30	Sheave Test
31	Creep Test
32	Tracking & Erosion Test

The detailed procedure for type test are given at Annexure -III.

4.1.2.6 Type Tests for ADSS FO cable Accessories & fixtures

The type test on the ADSS Cable shall be as per procedure mentioned in TEC GR: TEC/GR/TX/OAF-001/03/MAR-17 (latest amendments) or equivalent standard, if any.

The contractor shall submit earlier carried out type test reports for the offered Hardware Fittings of ADSS Optical Fibre Cable meeting the requirement. The Contractor shall submit the previously carried out type test report for the same design of hardware fittings for the tests listed below. The type tests of offered hardware fittings shall be conducted along with offered ADSS Optical Fibre Cable.

The applicability of the tests for the particular type of accessories and fixtures shall be as given below:

4.1.2.6.1 Visual examination : Applicable to all fittings

Objective: To check the quality and the workmanship.

Visual examination shall be carried out for all the accessories and fixtures for quality and workmanship which is required to be of the high order with super quality finish without any manufacturing defects.

4.1.2.6.1.1 Verification of dimensions : Applicable to all fittings

Objective: To check the dimensions of the accessories and fixtures: shall be checked as per approved DRS/drawings.

4.1.2.6.1.2 Tensile strength test : Applicable to tension & suspension clamp assemblies

Objective: To assess the mechanical performance of fixtures under ultimate tensile strength.

Requirement: Cable UTS with factor of safety 1.5

All the load bearing metal fittings except those of elastomer pads and helically formed fittings shall be tested to meet the above requirement.

4.1.2.6.1.3 Tensile strength test for helically formed product

This test shall be applicable to terminating Helix, Protective Helix and Armour grip suspension helix.

Objective: To check the tensile strength for the helically formed items.

Requirement: The tensile strength test shall be carried out to the method specified in the respective standards for wires and shall meet the requirements listed in earlier clauses.

4.1.2.6.1.4 Slip Strength Test

This test shall be applicable to the Terminating helix and Armoured grip suspension fittings.

Objective: To check the tensile load strength of the formed fittings to assess the performance for withstanding the guaranteed load.

Requirement: The helically formed terminating fittings shall not slip up to 90 % of the Cable UTS. The helically formed suspension fittings shall withstand the load up to a minimum of 25 % of cable UTS and shall slip before 50 % of cable UTS.

4.1.2.6.1.5 Resilience Test

This test shall be applicable to terminating Helix.

Objective: To check the resilience of the helically formed fittings (Terminating Helix)

Requirement: The helically formed fittings shall pass the resilience test while helically formed fittings are wrapped and unwrapped on a piece of optical fibre cable three times successfully. The helical fittings should not loose its resilience even after three applications and shall be able to pass the slip strength test after third application.

4.1.2.6.1.6 Galloping / Fatigue test

This shall be applicable to a complete assembly of one set of tension fittings together with one set of suspension fittings and spiral damper.

Objective: To assess the fatigue performance of fixtures and accessories and the performance of optical characteristics of the optical fibre cable under galloping conditions.

Requirement of test methods:

Length of the span	:	100 meters
Minimum vibration cycles	:	1 million
Frequency	:	> 30 Hz to 100 Hz.
Amplitude	:	Amplitude of vibration at antinodal points shall not be less than 100 % of the cable diameter.

Requirement: The accessories and fixtures shall pass the test when tested for the test conditions as above and shall meet the requirement given below:

1. Change in attenuation shall not exceed more than 0.1 dB after the recovery period.
2. No damage on the accessories and fixtures.
3. No physical damage to optical fibre cable.

4.1.2.6.1.7 Aeolian Vibration Test

Objective: To assess the fatigue performance of accessories and fixtures and the optical characteristics of the optical fibre cable under Aeolian vibration.

Requirement of test method:

Minimum length of span: 100 meters.

Minimum vibration cycles: 1 million

Frequency: 10 Hz to 100 Hz.

Amplitude: Free loop peak to peak antinode amplitude shall be maintained at a level equal to one half of the cable diameter.

Requirement:

1. Change in attenuation shall not exceed more than 0.1 dB after the recovery period.
2. No visual damage observed on the accessories and fixtures.
3. No physical damage to optical fibre cable.

4.1.2.6.1.8 Tension and Attenuation Test (Dead End Assembly)

Objective : To assess the attenuation and the optical characteristics of the optical fibre cable after fixing and installing dead end assembly on the optical fibre cable.

Requirement of test method:

Minimum length of span: 100 meters

The test shall meet the following:

a. Change is attenuation shall not exceed more than 0.1 dB after the recovery period.

b. Any visual damage observed on the accessories and fixtures.

c. No physical damage to optical fibre cables.

4.1.2.6.1.9 Wrapping Test

Objective: To check quality of the aluminum alloy wires.

Test Method: The formed fittings made of aluminum alloy wires shall by wrapped on a wire of its own diameter to form a close helix.

Requirement: The wires should not break or show fracture and shall meet the requirement specified above.

4.1.2.6.1.10 Galvanising Test

Objective: To check galvanized coating and the quality of galvanizing on accessories and fixtures

Test method: IS 2633-1972 for uniformity.

Requirement: The fittings shall meet the requirement of the specifications.

4.1.2.6.1.11 Hardness Test of Elastomer pad

Objective: To check the Ploychloroprene compounded elastomer pads of the suspension and cable jumper clamp.

Requirement: The Ploychloroprene compounded elastomer pads of the suspension unit shall be subjected for the test parameters as listed earlier in this specifications. The compounded material should meet the minimum properties specified therein.

4.2 Factory Acceptance Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Factory acceptance testing shall be carried out on UGFO Cable and associated hardware & fittings, ADSS Cable and associated hardware & fittings, Joint Box, FODP, FMS etc. and all other items for which price has been identified separately in the Bid Price Schedules.

Material shall not be shipped to the Employer until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the Employer, and the Employer has issued dispatch clearance. Successful completion of the factory tests and the Employer approval to ship, shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the Employer's authorized representatives unless waiver for witnessing by Employer’s representatives is intimated to the contractor.

Factory acceptance tests shall not proceed without the prior delivery to and approval of all test documentation by the Employer.

The factory acceptance tests for the supplied items shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's / supplier's) standard FAT testing program. In general the FAT for other items shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces etc.

Test equipment used for FAT shall include supply of proper calibration certificates, demonstration of satisfactory performance, evidence of correct equipment configuration and manufacturer's final inspection certificate/ report.

4.2.1 Sampling for FAT

From each batch of equipment presented by the Contractor for Factory acceptance testing, the Employer shall select random sample(s) to be tested for acceptance. Unless otherwise agreed, all required FAT tests in the approved FAT procedures, shall be performed on all samples. The Sampling rate for the Factory acceptance tests shall be minimum 10% of the batch size (minimum 1) for all items. The physical verification shall be carried out on 100% of the offered quantities as per the approved FAT procedure. In case any of the selected samples fail, the failed sample is rejected and additional 20% samples shall be selected randomly and tested. In case any sample from the additional 20% also fails the entire batch may be rejected.

The Sampling rate for the Factory acceptance tests shall be 10% of the batch size (minimum 2) for FO cable drums, FODPs, Joint box and other similar items.

Since FAT testing provides a measure of assurance that the Quality Control objectives are being met during all phases of production, the Employer reserves the right to require the Contractor to investigate and report on the cause of FAT failures and to suspend further testing/ approvals until such a report is made and remedial actions taken, as applicable.

4.2.2 Production Testing

Production testing shall mean those tests which are to be carried out during the process of production by the Contractor to ensure the desired quality of end product to be supplied by him. The production tests to be carried out at each stage of production shall be based on the Contractor's standard quality assurance procedures. The production tests to be carried out shall be listed in the Manufacturing Quality Plan (MQP), along with information such as sampling frequency, applicable standards, acceptance criteria etc.

The production tests would normally not be witnessed by the Employer. However, the Employer reserves the right to do so or inspect the production testing records in accordance with Inspection rights specified for this contract.

4.2.3 Factory Acceptance Testing for Underground Fibre Optic Cable

The tests listed in Table 4.2.3 shall be carried out as Factory Acceptance Test for Underground fibre optic cable meeting the requirements specified in this section.

Table 4.2.3

Factory Acceptance Tests on Underground Fibre Optic Cable

S. No.	Factory Acceptance Test
1	Attenuation Coefficient (1310, 1550): By EIA/TIA 455-78A or OTDR
2	Point discontinuities of attenuation: By EIA/TIA 455-78A or OTDR
3	Visual Material verification and dimensional checks as per approved drawings
4	Water Penetration test

5	Tensile strength test
6	Impact test
7	Kink test
8	Environmental test (Temp Cycling Test)
9	Crush Test

4.2.4 Factory Acceptance Testing for PLB-HDPE Pipe : The following tests shall be carried out during Factory Acceptance Testing (FAT) in Table 4.2.4.

Table 4.2.4

Factory Acceptance Test on PLB HDPE pipe & Accessories

S.No.	**Name of the test**
1	Visual Inspection
2	Dimension Check
3	Hydraulic Characteristics
4	Reversion Test
5	Tensile Strength and Elongation Test
6	Environmental Stress Crack Test
7	Impact Strength Test
8	Crush Resistance
9	Mandrel Test
10	Ovality Test
11	Coil Set Test
12	Internal Co-efficient of Friction
13	Ash content
14	Colour fading
15	Optical Fiber Cable Blowing Test
16	Air Pressure test on plastic coupler
17	Ageing test on accessories

The air pressure test of plastic coupler shall be carried out for at least two joints made together with the offered PLB HDPE pipe. Each of the offered PLB HDPE pipe reels shall be weighed which should not be less than as specified in the DRS.

4.2.5 **Factory Acceptance Test for Joint Box**

Table 4.2.5

Factory Acceptance Tests on Splice Enclosures (Joint Box)

FAT for Joint Box	
Sr.No.	**Name of test**
1	Visual Inspection
2	Tightness (Sealing) Test
3	Static Load test
4	Impact test
5	Axial pull out test
6	Bending test
7	Water ingress test
8	Reopening test

4.2.6 **Factory Acceptance Test for FODP**

Table 4.2.6

Factory Acceptance Tests on FODP

Visual check of Quantities and Specific Component Number for each component of FODP and dimensional checks against the approved drawings.

4.2.7 Factory Acceptance Test for FMS

Table 4.2.7

Factory Acceptance Tests on FMS

Visual check of Quantities and Specific Component Number for each component of FMS and dimensional checks against the approved drawings.

4.2.8 Factory Acceptance Tests on ADSS optical fibre cable

The tests listed in Table 4.2.8 shall be carried out as Factory Acceptance Test for ADSS optical fibre cable meeting the requirements specified in this Chapter.

Table 4.2.8

Factory Acceptance Tests on ADSS Fibre Optic Cable

S. No.	**Factory Acceptance Test**
1	Attenuation Coefficient (1310, 1550): By EIA/TIA 455- 78A or OTDR
2	Point discontinuities of attenuation: By EIA/TIA 455- 78A or OTDR
3	Visual Material verification and dimensional checks as per approved drawings
4	Water Ingress test
5	Tensile strength test / Strain test

S. No.	Factory Acceptance Test
6	Impact test
7	Kink test
8	Environmental test
9	**Crush Test**
10	Drip test

4.2.9 Factory Acceptance Tests on ADSS cable accessories & fixtures (Not Applicable)

The FAT on accessories & fixtures of ADSS optical fibre cable shall be carried out as specified in Table 4.2.9.

Table 4.2.9

Factory Acceptance Tests on Fittings for ADSS FO Cable

S. No.	Factory Acceptance Test
1	Visual and dimensional checks of all components
2	Tensile test
3	Slip test
4	Galvanising test
5	Wrapping test
6	Hardness test

4.2.10 Factory Acceptance Test on Test Equipment & other items

As per technical specification and approved DRS/Documents.

4.3 Site Acceptance Testing (SAT)

The tests, checks, adjustments etc conducted by the Contractor prior to offering the equipment/material for SAT shall be called Pre-SAT activities. During installation the Contractor shall maintain proper record of measurements in approved format and shall be given to the Owner/Employer (along with As Built drawing of the routes) for cross checking during SAT.

4.3.1 SAT for Excavation, Backfilling, Installation of Pipes, Manholes.

The tests shall include but shall not be limited to the following:

a. Depth Check: One sample every 200 mtrs, Contractor shall prepare a sample pit at a location identified by the Employer. Depth of each item, warning tape, no. of warning bricks (if applicable), pipes, cable etc. shall be measured. Depth shall be as per technical specifications and shall correspond to recorded measurements.

b. Crossings: 10% of each type, visual inspection for checking conformance with drawings, thickness of Concrete, RCC Hume Pipe and GI pipe.

c. Manholes: As per technical specifications.

After inspection the Contractor shall backfill and carry out other restoration work at no additional cost to the Owner/Employer.

4.3.2 SAT for UGFO & ADSS Fibre Optic Cable

SAT for optical fibre cable shall be carried out link by link from FODP to FODP.

Prior to installation, every fibre optic cable segment shall be tested for continuity and attenuation and measurements shall be recorded.

Any discontinuity or attenuation beyond permissible limits in any of the fibres has to be recorded and brought to the notice of Employer.

Upon completion of a continuous cable path (FODP to FODP locations), all fibres within the cable path shall be demonstrated for acceptance of the cable path. Test requirements are indicated in table 4.3.2-2 and in no case losses attributed due to other factors viz. extra splice, kinks, will be acceptable to the limit determine by the following formula:

Max attenuation @ 1550nm: 0.21dB/km + 0.05dB x total no of splices + 0.5dB x connector

Max attenuation @ 1310nm: 0.35dB/km + 0.05dB x total no of Splices + 0.5dB x connector

Any increase in attenuation or step discontinuity in attenuation shall not be acceptable and shall constitute a cable failure during installation. The Contractor shall have to either replace the concerned cable span at its own cost or provide additional splicing, joint box and manholes required to rectify the fault at its own cost. The fibre attenuation shall be tested again after replacement or rectification of fault.

In case it is found that the splices are bad (loss is unacceptable as per approved test procedures), the Contractor shall have to do re-splicing and provide new Joint Box wherever required at no additional cost to the Owner/Employer. After re-splicing the end to end testing shall be repeated. The splice testing requirements are indicated in table 4.3.2-1-3

Table 4.3.2-1

Fibre Optic Cable Pre-Installation Testing

Item:	Description:
1.	Physical Inspection of the cable assembly for damage
2.	Optical fibre continuity and fibre attenuation with OTDR at 1550 nm

Table 4.3.2-2

Fibre Optic Cable Splice Testing

Item:	**Description:**
1.	Per splice attenuation with OTDR (bi-directional average) at 1550 nm
2.	Physical inspection of Joint Box for proper fibre routing techniques
3.	Physical inspection of sealing techniques, weatherproofing, etc.

Table 4.3.2-3

Fibre Optic Cable Commissioning Testing

Item:	**Description:**
1.	Fibre continuity and link attenuation (bi-directional) between FODP connectors at two ends for each fibre at 1310 &1550 nm by OTDR
2.	Fibre continuity and link attenuation (bi-directional) between FODP connectors at two ends for each fibre at 1310 &1550 nm by Power Meter & Laser Source
3.	Average splice loss (bi-directional) for each splices and average splice loss for the link by OTDR at 1550 nm.
-End of Table-	

4.3.3 SAT for Joint Box (Splice Enclosure)

All the joint boxes shall be physically inspected (visual) tightness checking of clamps and bolts, heat shrink sleeves and proper installation in the manholes. In case the Employer finds the workmanship of the installation of joint box to be poor, the Contractor shall make good the same. Consumable, if any e.g. joint box sealing, heat shrink sleeves, required for rectification work shall be provide by the Contractor at no extra cost to Employer/Owner.

4.3.4 SAT for PLB HDPE pipe

For PLB HDPE pipes, duct integrity tests shall be carried out as described below. The **Duct cleaning (Sponge test)** test shall be carried out on all the ducts before blowing/pulling of the cable between two consecutive manholes on the PLB HDPE pipes.

b. Duct cleaning (Sponge test)

Compressed air should be blown through the PLB HDPE pipe in order to remove dirt and water, if any, with the help of suitable Air Compressor. A short blast of air about 2-3 Bar shall be blown through the PLB HDPE pipe for about 2 minutes. Sponge shall be blown through the duct to thoroughly clean the duct from inside.

c. Crush and deformity test

Place a shuttle of length <15cm and O.D. 80% of the inner diameter of the offered PLB HDPE pipe. Connect the compressor pipe with a suitable flexible wire grip at the other end to catch the shuttle and start blowing operation to the pipe and check if shuttle reaches at the other end. If shuttle gets stuck the Contractor shall adopt suitable arrangement at site to locate the deformity/damage in the HDPE pipe, repair the pipe and ensure end-to-end continuity of the duct in sound condition

4.3.5 SAT for other items

Tests for other components such as FODP etc. shall be done as per the direction of Employer

Annexure-III (a)

Type Test Procedure for UGFO Cable

1.1 Mechanical Characteristics and Tests on Optical Fibre Cable:

(**Note:** All observations are to be taken at 1310nm and 1550nm wavelengths)

1.1.1 Tensile strength Test:

Objective: This measuring method applies to optical fibre cables which are tested at a particular tensile strength in order to examine the behaviour of the attenuation as a function of the load on a cable which may occur during installation.

Method: IEC 60794-1-2-E1.

Test Specs: The cable shall have sufficient strength to withstand a load of value T (N) = 9.81 x 2.5 W Newton or 2670 N whichever is higher (Where W-mass of 1 Km of cable in Kg). The load shall be sustained for 10 minutes and the strain of the fibre monitored.

Requirement: The load shall not produce a strain exceeding 0.25% in the fibre and shall not cause any permanent physical and optical damage to any component of the cable. The attenuation shall be noted before strain and after the release of strain. The change in attenuation of each fibre after the test shall be ≤ 0.05 dB both for 1310 nm and 1550 nm wavelength.

1.1.2 Abrasion Test:

Objective: To test the abrasion resistance of the sheath and the marking printed on the surface of the cable.

Method: IEC-60794-1-2-E2 or by any other international test method

Test Specs: The cable surface shall be abraded with needle (wt. 150 gm) having diameter of 1 mm with 500 grams weight (Total weight more than 650 gms)

No. of cycles : 100

Duration : One minute (Nominal)

Requirement: There shall be no perforation & loss of eligibility of the marking on the sheath.

1.1.3 Crush Test (Compressive Test):

Objective: The purpose of this test is to determine the ability of an optical fibre cable to withstand crushing.

Method: IEC 60794-1-2-E3.

Test Specs: The fibres and component parts of the cable shall not suffer permanent damage when subjected to a compressive load of 2000 Newton applied between the plates of dimension 100 x 100 mm. The load shall be applied for 60 Secs. The attenuation shall be noted before and after the completion of the test.

Requirement: The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for l310 nm and 1550 nm wavelength.

1.1.4 Impact Test:

Objective: The purpose of this test is to determine the ability of an optical fibre cable to withstand impact.

Method: IEC 60794-1-2-E4.

Test Specs: The cable shall have sufficient strength to withstand an impact caused by a mass weight of 50 Newton, when falls freely from a height of 0.5 meters. The radius R of the surface causing impact shall be 300 mm. 10 such impacts shall be applied at the same place. The attenuation shall be noted before and after the completion of the test.

Requirement: The change in attenuation of the fibre after the test shall be ≤ 0.05dB both for 1310 nm and 1550 nm wavelength.

1.1.5 Repeated Bending:

Objective: The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated bending.

Method: IEC 60794-1-2-E6.

Test Specs: The cable sample shall be of sufficient length (5 m minimum) to permit radiant power measurements as required by this test. Longer lengths may be used if required.

Parameters:

Weight	:	5 Kg
Minimum distance from Pulley centre to holding device	:	216mm
Minimum distance from Wt. to Pulley centre	:	457mm
Pulley Diameter	:	20 D (D - cable diameter)
Angle of Turning	:	90^{o}
No. of cycles	:	30
Time Required for 30 cycles	:	2 min

Requirement: During the test no fibre shall break and the attenuation shall be noted before and after the completion of the test. The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310 nm and 1550 nm wavelength.

1.1.6 Torsion Test:

Objective: The purpose of this test is to determine the ability of an optical fibre cable to withstand torsion.

Method: IEC 60794-1-2-E7.

Test Specs: The length of the specimen under rest shall be 2 meters and the load shall be 100 N. The sample shall be mounted in the test apparatus with cable clamped in the fixed clamp sufficiently tight to prevent the movement of cable sheath during the test. One end of the cable shall be fixed to the rotating clamp which shall be rotated in a clock wise direction for one turn. The sample shall then be returned to the starting position and then rotated in an anti-clock wise direction for one turn and returned to the starting position. This complete movement constitutes one cycle. The cable shall withstand 10 such complete cycles. The attenuation shall be noted before and after the completion of the test.

Requirement: The cable shall be examined physically for any cracks tearing on the outer sheath and for the damage to other component ports of the cable. The twist mark shall not be taken as damage. The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310 nm and 1550 nm wavelength.

1.1.7 Kink Test:

Objective: The purpose of this test is to verify whether kinking of an optical fibre cable results in breakage of any fibre, when a loop is formed of dimension small enough to induce a kink on the sheath.

Method: IEC 60794-1-2-E10.

Test Specs.: The sample length shall be 10 times the minimum bending radius of the cable The sample is held in both hands, a loop is made of a bigger diameter and by stretching both the ends of the cable in opposite direction, the loop is made to the minimum bend radius so that no kink shall form. After the cable comes in normal condition, the attenuation reading is taken.

Requirement: The kink should disappear after the cable comes in normal condition. The change in attenuation of the fibre after test shall be ≤ 0.05 dB both for 1310 nm & 1550 nm wavelength.

1.1.8 Cable Bend Test:

Objective: The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated flexing. The procedure is designed to measure optical transmittance changes and requires an assessment of any damage occurring to other cable components.

Method: IEC 60794-1-2-E11 (Procedure-I).

Test Specs: The fibre and the component parts of the cable shall not suffer permanent damage when the cable is repeatedly wrapped and unwrapped 4 complete turns of 10 complete cycles around a mandrel of 20 D, where D is the diameter of the cable. The attenuation shall be noted before and after the completion of the test.

Requirement: The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310 nm and 1550 nm wavelength. Sheath shall not show any cracks visible to the naked eye when examined whilst still wrapped on the mandrel.

1.1.9 Temperature Cycling (Type Test):

Objective: To determine the stability behaviour of the attenuation of a cable subjected to temperature changes which may occur during storage, transportation and usage.

Method: IEC 794-1-2-F1 (To be tested on Standard cable length & drum i.e 2Km. ± 5%)

Test Specs: The permissible temperature range for storage and operation will be from -20°C to +70°C. The rate of change of temperature during the test shall be 1°C per minute approx. The cable shall be subjected to temperature cycling for 12 Hrs. at each temperature as given below:

TA2 temp. : - 20°C

TA1 temp. : - 10°C.

TB1 temp. : + 60°C.

TB2 temp. : + 70°C.

The test shall be conducted for 2 cycles at the above temperatures.

Requirement: The change in attenuation of the fibre under test shall be ≤ 0.05 dB for 1310 nm and 1550 nm wave length respectively for the entire range of temperature.

1.1.10 Cable aging Test (Type Test):

Objective: To check the cable material change dimensionally as the cable ages.

Method: At the completion of temperature cycle test, the test cable shall be exposed to 85 ± 2 degree C for 168 hours. The attenuation measurement at 1310 & 1550 nm wave length to be made after stabilization of the test cable at ambient temperature for 24 hours.

Requirement: The increase in attenuation allowed: ≤ 0.05 dB at 1310 and 1550 nm.

Note: The attenuation changes are to be calculated with respect to the base line attenuation values measured at room temperature before temperature cycling.

1.1.11 Water Penetration Test (Type Test):

Objective: The aim of this test is to ensure that installed jelly filled Optical Fibre cable will not allow water passage along its length.

Method: IEC 60794-1-2-F5 (Fig. B) 1992.

Test Specs. A circumferential portion of the cable end (with inner HDPE sheath) shall face the water head. The water tight sleeve shall be applied over the cable. The cable shall be supported horizontally and two meter head of water, containing a sufficient quantity of water soluble fluorescent dye for the detection of seepage, shall be applied on the inner HDPE sheath for a period of 7 days at ambient temperature. No other coloured dye is permitted.

Requirement: No dye shall be detected when the end of the 3m length of the cable is examined with ultraviolet light detector. The cable sample under test shall be ripped open after the test and then it shall be examined for seepage of water into the cable and the distance to be noted. It shall not be more than 20 cm.

1.1.12 Test of Figure of 8 (Eight) on the cable (Type Test):

Objective: Check of easiness in formation of figure of 8 of the cable during installation in the field.

Test Method: 1000 meter of the cable shall be uncoiled from the cable reel and shall be arranged in figure of 8 (eight) shape. The diameter of each loop of the figure of 8 shall be maximum 2 meters.

Requirement: It shall be possible to make figure of 8 of minimum 1000 meters of the cable uncoiled from the cable reel without any difficulty. No visible damage shall occur.

1.1.13 Flexural Rigidity Test on the optical fibre cable (Type Test):

Objective: To check the Flexural Rigidity of the metal free optical fibre cable.

Method: To be tested as per ASTM D –790

Test Specs: The fibre and the component parts of the cable shall not suffer permanent damage in the cable subjected to Flexural Rigidity Test as per the above method. The attenuation shall be noted after and before the completion of the test.

Requirement: The change in attenuation of the fibre after the test shall be $\leq$ 0.05 dB at 1310, 1550 nm and 1625nm wavelengths. The sheath shall not show any cracks visible to the naked eye.

1.1.14 Static Bend test (Type Test):

Objective: To check the cable under Static bend.

Method: As per the clause no 4.8 of the GR alternatively as per ASTM D790.

Test Specs: The cable shall be subjected to static bend test. The optical fibre cable shall be bend on a mandrel having a Diameter of 10 D (D is diameter of the cable).

Requirement: The change in attenuation of the fibre after the test shall be $\leq$0.05 dB for 1310, 1550 nm and 1625nm wavelengths. Sheath shall not show any cracks visible to the naked eye when examined whilst still wrapped on the mandrel.

1.1.15 Cable Jacket Yield Strength And Ultimate Elongation:

Objective: To determine the yield strength and elongation of the polyethylene (HDPE) cable sheath (jacket).

Test Method: FOTP-89 or ASTM 1248 Type III class

Test Condition: 1. Sample shall be taken from a completed cable. The aged sample shall be conditioned at 100 ± 2°C for 120 hours before testing.

2. The cross-head speed shall be 50 mm per minute.

Requirement:

Jacket Material	Minimum Yield Strength		Minimum Elongation (%)
	(MPa)	(psi)	
HDPE un-aged	16.5	2400	400
HDPE aged	12.4	1800	375

1.1.16 To Check of the quality of the loose tube (containing optical fibre) (Type Test):

a. Embrittlement Test

This test method is based on bending by compression and reflects embrittlement much better than the other tensile tests. This test is independent of wall thickness of the loose tube.

Sample: The minimum length of the test sample depends on the outside diameter of the loose tube and should be 85 mm for tubes up to 2.5 mm outside dia. The length of the bigger tubes should be calculated by using the following equation:

$$Lo > 100 \times \frac{[(D^2 + d^2)]^{1/2}}{4}$$ where

Lo = Length of tube under test.
D = Outside dia of loose tube.
d = Inside dia of loose tube.

Procedure: Both the ends of a buffer tube test sample may be mounted in a tool, which is clamped in jaws of a tensile machine which exerts a constant rate of movement. The movable jaw may move at a rate of 50 mm per minute toward the fixed jaw. Under load, the tube will bend so that it is subjected to tensile and compressive stresses. The fixture for holding the tube should be designed in a manner that the tube might bend in all directions without further loading.

Requirement: The tube should not get embrittled. No kink should appear on the tube up to the safe bend diameter of tube (15 D), where D is the outside diameter of the loose

tube. There should also not be any physical damage or mark on the tube surface.

b. Kink Resistance Test on the Loose Tube

Objective: To safeguard the delicate optical fibers, the quality of the loose tube material should be such that no kink or damage to the tube occur while it is being handled during installation and in splicing operations.

Procedure: To check the kink resistance of the loose tube, a longer length of the loose tube is taken (with fiber and gel), a loop is made and loop is reduced to the minimum bend radius of loose tube i.e. 15 D (where D is the outside diameter of the loose tube). This test is to be repeated 4 times on the same sample length of the loose tube.

Requirement: No damage or kink should appear on the surface of the tube.

1.1.17 Drainage Test for Loose Tube and Drip test on the cable (Type Test):

a. Drainage Test for loose Tube

Sample Size: 30 cm tube length.

Test procedure:

1. Cut the tube length to 40 cm.
2. Fill the tube with the tube filling gel ensuring that there are no air bubbles and the tube is completely full.
3. Place the filled tube in a horizontal position on a clean worktop and cut 5 cm from either end so that the finished length of the sample is 30 cm.
4. Leave the filled tube in a horizontal position at an ambient temperature for 24 hrs. (This is necessary because the gel has been sheared and the viscosity has been reduced during the filling process).
5. The sample tube is then suspended vertically in an environment heat oven over a weighed beaker. It is left in the oven at a temperature of 70°C for a period of 24 Hrs.
6. At the end of the 24 hours period the beaker is checked and weighed to see if there is any gel in the beaker.

Results:

1. If there is no gel or oil in the beaker the tube has PASSED the drainage test.
2. If there is gel or oil in the beaker the tube has FAILED the drainage test.

b. Drip test on the cable

Objective: The purpose of this test is to determine the ability of jelly in the O.F. cable to withstand a temperature of 70 degree C.

Method: Take a sample of 30 cm. length of the cable with one end sealed by end cap. Remove outer black sheath, binder tapes for 5 cm from open end of the sample. Clean the jelly. Then the sample is kept vertically with open end downwards in the oven for 24 hours at 70^{o} C with a paper under the sample.

Test Specs: Examine the paper placed below the cable inside the oven for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.

1.1.18 Check of easy removal of sheath:

Objective: Check of the easy removal of sheath of the fiber optic cable by using normal sheath removal tool.

Procedure: To check easy removal, the sheath shall be cut in circular way and the about 300 mm length of the sheath should be removed in one operation. It should be observed during sheath removal process that no undue extra force is applied and no component part of the cable is damaged. One should be able to remove the sheath easily.

1.1.19 Check of the effect of aggressive media on the cable (Acidic and Alkaline Behavior) (Type Test):

Procedure: To check the effect of aggressive media, solution of PH4 and PH10 shall be made. The two test samples of the finished cable, each of 600 mm in length, are taken and the ends of the samples are sealed. These test samples are put in the PH4 and PH10 solutions separately. After 30 days these samples are taken out from the solutions and examined for any corrosion etc. on the sheath and other markings of the cables. (Test method no. ISO175).

Requirement: The sample should not show any effect of these solution on the sheath and other marking of the cable.

1.1.20 Termite & Rodent Test (Type Test):

Termite & Rodent test shall be carried out at any NABL accredited /Government lab on finished cable samples. The reports shall be submitted by the manufacturers. Termite resistance shall be provided with an additive/without additive in outer sheath and rodent protection shall be provided with Glass roving yarns around the periphery of inner sheath and these yarns should be spread uniformly around the periphery of inner sheath.

The following minimum parametric tests on Anti termite / Anti rodent dopants shall be carried out during the Type testing

1. Non-toxicity
2. Thermal Stability
3. Long life Span / half-life
4. Compatibility
5. Efficacy

The thermal stability of the dopant should not deteriorate during cable execution process. The life of the dopant should be equal or better than the life of the cable specified in the technical specification herein. Appropriate certificate in this regard from any neutral lab accredited with NABL / Government Laboratory / Institute should be produced.

Similarly other parameters such as non toxicity, efficacy and compatibility shall be certified in any neutral lab accredited with NABL / Government Laboratory / Institute and test report is to be submitted.

The above tests mentioned here are the minimum test requirements. NEA can specify any other test / changes in parametric values which shall be deemed necessary at a later stage and these will have to be mandatorily complied with.

All fibre optic cable shall have a minimum service life span of 25 years. Documentary evidence in support of guaranteed life span of cable & fibre shall be submitted by the Contractor during detailed engineering.

Annexure-III(b)

Type Test Procedure for ADSS Cable (Not Applicable)

2.1 Tensile strength Test:

Objective:

To test the tensile strength of Self Supporting Metal Free ADSS Optical Fibre Cable, in order to examine the behavior of the attenuation as a function of the load on a cable. This load occurs during installation, while the ADSS optical fibre cable encounters the excess ice loading and the winds at high speed.

Test Method: IEC 60794-1-2-EI

Test Specs. :

The cable shall have sufficient strength to withstand a load of value T(N) = 9.81 x

W Newtons for ADSS cable without ice loading & T(N) = 9.81 x 6 W Newtons for ADSS cable with ice loading(where —W is the mass of 1 Km of cable in Kg.). The load shall be sustained for 10 minutes and the strain on the fibre and the attenuation shall be monitored.

Requirement:

The load shall not produce a strain exceeding 0.25 % in the fibre and shall not cause any permanent physical or optical damage to any component of the cable. The attenuation shall be noted before strain and after the release of strain. The change in attenuation of each fibre after the test shall be < 0.05 dB, both for 1310 nm and 1550 nm wavelengths.

2.2 Abrasion Test:

Objective: To test the abrasion resistance of the sheath and the marking printed on the surface of the cable.

Method: IEC-60794-1-2-E2

The cable surface shall be abraded with needle (wt. 150 gm) having diameter of 1 mm with 500 grams weight (Total weight more than equal 650 gms.)

No. of cycles: 100

Duration: One minute (Nominal)

Requirement: There shall be no perforation and loss of legibility of the marking on the sheath.

2.3 Crush Test (Compressive Test):

Objective:

The purpose of this test is to determine the ability of an optical fibre cable to withstand crushing. Test Method: IEC 60794-1-2-E3

Test Specs. : The fibres and component parts of the cable shall not suffer permanent damage when subjected to a compressive load of 2200 Newtons applied, between the plates of dimension 100 x 100 mm. The load shall be applied for 10 minutes. The attenuation shall be noted before and after the completion of the test.

Requirement: The change in attenuation of the fibre after the test shall be <0.05 dB, both for1310nm and 1550nm wavelengths.

2.4 Impact Test:

Object:

The purpose of this test is to determine the ability of an optical fibre cable to withstand impact.

Method: IEC 60794-1-2-E4

Test Specs: The cable shall have sufficient strength to withstand an impact caused by a mass weight of 50 Newton, when falls freely from a height of 0.5 meters. The radius R of the surface causing impact shall be 300 mm. Ten such impacts shall be applied at the same place. The attenuation shall be noted before and after the completion of the test.

Requirement: The change in attenuation of the fibre after the test shall be <0.05 dB both for 1310 nm and 1550 nm wavelengths.

2.5 Repeated Bending (Cable cyclic flexing):

Objective: The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated bending.

Method: IEC-60794-1-2-E6/ IEEE - 1222

Test Specs. : The cable sample shall be of sufficient length (5m minimum) to permit radiant power measurements as required by this test. Longer lengths may be used, if required. The sheave diameter shall be maximum of 20 times the cable outside diameter. The cable shall be flexed at 30 cycle/minute for 25 cycles.

Parameters:

Minimum distance from Pulley centre to holding device	216 mm
Minimum distance from Wt. to Pulley centre	457 mm
Pulley Diameter	20D(D- cable diameter)
Angle of Turning	90^0
No. of cycles	30
Time Required for 30 cycles	1 min

Requirement:

During the test no fibre shall break and the attenuation shall be noted before and after the completion of the test. The change in attenuation of the fibre after the test shall be < 0.05 dB, both for 1310 nm and 1550 nm wavelengths.**2.6 Torsion Test/Cable twist:**

Object:

The purpose of this test is to determine the ability of an optical fibre cable to withstand torsion.

Method: IEC 60794-1-2-E7 [IEEE - 1222

Test Specs. :

The length of the specimen under test shall be 2 meters and the load shall be 100 N. The sample shall be mounted in the test apparatus with cable clamped in the fixed clamp, sufficiently tight, to prevent the movement of cable sheath during the test. One end of the cable shall be fixed to the rotating clamp, which shall be rotated in a clockwise direction for one turn. The sample shall then be returned to the starting position and then rotated in an anti-clock wise direction for one turn and returned to the starting position. This complete movement constitutes one cycle. The cable shall withstand ten such complete cycles. The attenuation shall be noted before and after the completion of the test.

Requirement:

The cable shall be examined physically for any cracks, tearing on the outer sheath and for the damage to other component ports of the cable. The twist mark shall not be taken as damage. The change in attenuation of the fibre after the test shall be < 0.05 dB, both for 1310 nm and 1550 nm wavelengths.

2.7 Kink Test:

Object:

The purpose of this test is to verify whether kinking of an optical fibre cable results in breakage of any fibre, when a loop is formed of dimension small enough to induce a kink on the sheath.

Method: IEC 60794-1-2-EIO.

Test Specs. :

The sample length shall be 10 times the minimum bending radius of the cable. The sample is held in both hands, a loop is made of a bigger diameter and by stretching both the ends of the cable in opposite direction, the loop is made to the minimum bend radius so that no kink shall form. After the cable comes in normal condition, the attenuation reading is taken.

Requirement:

The kink should disappear after the cable is brought to normal position. The change in attenuation of the fibre after test shall be < 0.05 dB, both for 1310 nm & 1550 nm wavelengths.

2.8 Cable Bend Test:

Objective:

The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated flexing. The procedure is designed to measure optical transmittance changes and requires an assessment of any damage occurring to other cable components.

Method :

IEC 60794-1-2-EII (Procedure-I).

Test Specs. : The fibre and the component parts of the cable shall not suffer permanent damage when the cable is repeatedly wrapped and unwrapped 4 complete turns of 10 complete cycles around a mandrel having diameter of 20 D, where D is the diameter of the cable. The attenuation shall be noted before and after the completion of the test.

Requirement:

The change in attenuation of the fibre after the test shall be <0.05 dB, both for 1310 nm and 1550 nm wavelengths. Sheath shall not show any cracks visible to the naked eye, when examined whilst still wrapped on the mandrel.

2.9 Snatch Test (Type Test):

Object:

This test is to determine the ability of the cable to withstand a sudden snatch load.

Method: IEC 60794-1-2-E9

Test Specs.

The sample is terminated in a manner that the fibres, sheathing and any strength member/ members are clamped together firmly. A hook has a shaft capable of bearing variable loads applied to it. The cable of 4.5 meters length is taken and firmly clamped at the two ends so that a sag of 300 mm. is formed. The attenuation is then measured.

Testing load shall be 300 N and the radius of impacting surface of the crown of the hook shall be 12.5 mm. The hook with the mass attached, is held or supported over the cable so that the crown of the hook is centered over the lowest point of the cable at a height of 100 mm. The hook is then released so as to catch the cable after dropping from the height of 100 mm. It shall be repeated ten times. The load is then removed from the cable and attenuation is noted.

Requirement:

There shall be no permanent physical damage to the cable and the change in attenuation of the fibre after the test shall be < 0.05 dB, both for 1310 and 1550 nm wavelengths.

2.10 Cable bend Test at High & Low Temp (Type Test):

Object :

To determine the ability of a optical fibre cable to withstand bending at low and high temperatures, which might be encountered during cable placement.

Method : EIA RS-455-37.

Test Specs. :

Test Temperature: - 40^0 to + 70^0 C

Mandrel Diameter: 20D (D- Diameter of cable).

No. of turns: 4

Conditioning Time Duration	24 hours at each temperature.
Acceptance	Visual test for the damage of the sheath.

Requirement :

The change in attenuation of the fibre after the test, shall be < 0.05 dB both for 1310 nm & 1550 nm wave lengths. The attenuation shall be noted before and after the completion of the cycle.

2.11 Temperature Cycling (Type Test):

Objective :

To determine the stability behavior of the attenuation of a cable subjected to temperature changes, which may occur during storage, transportation and usage.

Method : IEC 60794-1-2-FI/ IEEE - 1222 (Annexure E)

(To be tested on Standard cable length of drum i.e. 2Km + 5 %)

Test Specs. .

The permissible temperature range of the cable for storage shall be from -50 ^{0}C to +70 ^{0}C and for operation -40 ^{0}C to +70 ^{0}C. The rate of change of temperature during the test shall be 1 ^{0} per minute approx. The cable shall be subjected to temperature cycling for 24 hrs at each temperature as given below:

TA2 temp. . - 400C

TAI temp. : - 10^0 C.

TBI temp. . + 600 C.

TB2 temp. . + 700 C.

The test shall be conducted for 2 cycles at the above temperatures.

Requirement:

The change in attenuation of the fibre under test shall be < 0.05 dB, both for1310 nm and 1550 nm wavelengths for the entire range of temperature.

2.12 Cable Aging test (Type Test):

Objective:

To check the cable material change dimensionally as the cable ages.

Method : IEEE -1222 (Annexure F)

Test Specs. :

At the completion of temperature cycle test, the test cable shall be exposed to 85 +2 degree C for 168 hours. The attenuation measurement at 1310 & 1550 nm wave length to be made after stabilization of the test cable at ambient temperature for 24 hours.

Requirement:

The increase in attenuation allowed is < 0.05dB at 1310nm & 1550nm

Note: The attenuation changes are to be calculated with respect to the base line attenuation values measured at room temperature before temperature cycling.

2.13 Cable Freezing Test (Type Test):

Objective:

To determine that installed optical fibre cable jacket shall not show the evidence of cracking or splitting.

Test Method: FOTP - 98.

Requirement:

The attenuation change shall be < 0.05dB at 1310nm & 1550nm. The magnitude of the maximum attenuation change of each individual fibre shall not be greater than 0.15dB and cable shall not show the evidence of cracking or splitting.

2.14 Water Penetration/Blocking Test (Type Test):

Objective:

The aim of this test is to ensure that installed optical fibre cable will not allow water passage in the cable.

Method: IEC 60794-1-2-F5 (Fig. B) 1999

Test Specs. :

A circumferential portion of the cable end shall face the water head. The water tight sleeve shall be applied over the core of cable. The cable shall be supported horizontally and two meter water head, containing sufficient quantity of water soluble fluorescent dye for the detection of seepage, shall be applied over the inner sheath of cable for seven days, at ambient temperature. No other colored dye is permitted.

Requirement:

No dye shall be detected when the end of the 3m length is examined with ultraviolet light detector. The cable sample under test shall be ripped open after the test and then it shall be examined for seepage of water into the cable and the distance to be noted. It shall not be more than 20 cm. For Semi Dry core cable and Dry Dry cable, it shall not be more than 1 meter.

Note: For bulk testing, test should be conducted for 24 hours.

2.15 Test of Figure of 8 (Eight) on the cable (Type Test):

Objective:

Check of easiness in formation of figure of 8 of the cable during installation in the field.

Test Method :

1000 meter (approximate) length of the cable shall be uncoiled from the cable reel and shall be arranged in figure of 8 (eight). The diameter of each loop of the figure of 8 shall be maximum 2 meters.

Requirement :

It shall be possible to make figure of 8 of minimum 1000 meter length of the cable uncoiled from the cable reel, without any difficulty. No visible damage shall occur.

2.16 Flexural Rigidity Test on the optical fibre cable (Type Test):

Objective: To check the Flexural Rigidity of the metal free optical fibre cable.

Method: ASTM D 790

Test Specs: The fibre and the component parts of the cable shall not suffer permanent damage in the cable subjected to Flexural Rigidity Test as per the above method. The attenuation shall be noted after and before the completion of the test.

Requirement: The change in attenuation of the fibre after the test shall be < 0.05 dB at both 1310 nm and 1550 nm wavelengths. The sheath shall not show any cracks visible to the naked eye.

2.17 Static Bend test (Type Test):

Objective: To check the cable under Static bend.

Method: ASTM D 790.

Test Specs: The cable shall be subjected to static bend test. The optical fibre cable shall be bend on a mandrel having a Diameter of 10 D (D is diameter of the cable).

Requirement: The change in attenuation of the fibre after the test shall be <0.05 dB for both 1310 nm and 1550 nm wavelengths. Sheath shall not show any cracks visible to the naked eye when examined whilst still wrapped on the mandrel.

2.18 Cable Jacket Yield Strength And Ultimate Elongation (Type Test):

Objective:

To check the yield strength and elongation of polyethylene (HDPE) cable sheath.

Test Method: FOTP-89 or ASTM D 1248 Type III class.

Condition:

1) Sample shall be taken from a completed cable. The aged sample shall be conditioned at 100 + 2^0 C for 120 hours before testing.
2) The cross-head speed shall be 50 mm per minute.

Requirement:

Jacket Material	Minimum Yield Strength		Minimum Elongation
	(Mpa)	(psi)	
HDPE unaged	16.5	2400	400
HDPE aged	12.4	1800	375

2.19 Drip Test on the cable (Seepage of filling/flooding compound Test):

Objective :

The purpose of this test is to determine the ability of jelly in the Optical Fibre cable to withstand a temperature of 70^0 C.

Test Method: TIA/EIA-455-81-A-1992 [B9]

Method:

Take a sample of 30 cm length of the cable with one end sealed by the end cap. Remove outer jacket, black sheath binder tapes for 5 cm from open end of the sample. Clean the jelly. Then the sample is kept vertically with open end downwards in the oven for 24 hours at 70^0 C with a paper under the sample.

Specs. :

Examine the paper placed below the cable inside the over for dripping of the jelly after 24 hours.

Requirement :

There should be no jelly drip or oil impression on the paper.

Note: The test is applicable for only Wet Core and Semi Dry cable.

2.20 ESCR (Environmental Stress Cracking Resistance) Test(Type Test):

Objective:

The outer sheath of the ADSS optical fibre cable shall be checked and tested for

ECSR.

Test Method: ASTM D 1693

Requirement •

There should not be any visible cracks on the surface of the outer sheath, when examined with the help of a magnifying glass at the end of 1000 hours for Type

Test in a 10% lgepal solution.

2.21 UV radiation Test (Type Test)

Objective •

To check the effect of UV radiation on the following:

i) On the Outer Sheath material (ATPE).

ii) On the meter and other legend markings.

Method: IEC 60068-2-1/ASTM G-154-12a

Type of Lamp: 40 Watt UV-B lamp with a peak emission at 313nm.

Duration: 1000 hours.

Test procedure:

Four test samples of the finished cable of the required length (as per the test chamber specifications) are to be prepared and 2 samples are to be kept inside. These test samples are to be compared after test with the other 2 samples kept outside.

Requirement:

There should not be any fading or change in the colour of the markings and that of sheath.

2.22 Check of the quality of the loose tube (containing optical fibre) (Type Test):

a) Embrittlement Test of loose Tube

This test method is based on bending by compression and reflects embrittlement much better than the other tensile tests. This test is independent of wall thickness of the loose tube.

Test Sample:

The minimum length of the test sample depends on the outside diameter of the loose tube and should be 85 mm for tubes up to 2.5 mm outside dia. The length of the bigger tubes should be calculated by using the following equation:

$$Lo > 100 \times \frac{[(D^2 + d^2)]^{1/2}}{4} \text{ where}$$

Lo = Length of tube under test.
D = Outside dia of loose tube.
d = Inside dia of loose tube.

Test Method:

Both the ends of a buffer tube test sample may be mounted in a tool, which is clamped in jaws of a tensile machine which exerts a constant rate of movement. The movable jaw may move at a rate of 50 mm per minute toward the fixed jaw. Under load, the tube will bend so that it is subjected to tensile and compressive stresses. The fixture for holding the tube should be designed in a manner that the tube might bend in all directions without further loading.

Requirement:

The tube should not get embrittled. No ink should appear on the tube up to the safe bend dia of tube (15 D), where D is the outside diameter of the loose tube. There should also not be any physical damage or mark on the tube surface.

b) Kink resistance Test on the loose Tube

To safeguard the delicate optical fibres, the quality of the loose tube material should be such that no kink or damage to the tube occur while it is being handled during installation and in splicing operations.

To check the kink resistance of the loose tube, a longer length of the loose tube is taken (with fibre and gel), a loop is made and loop is reduced to the minimum bend radius of loose tube i.e. 15 D. (where D is the outside dia of the loose tube). This test is to be repeated 4 times on the same sample length of the loose tube.

Requirement:

No damage or kink should appear on the surface of the tube.

2.23 Drainage Test for loose Tube (Type Test):

Sample Size: 30 cm tube length.

Test Method:

1. Cut the tube length to 40 cm.
2. Fill the tube with the tube filling gel ensuring that there are no air bubbles and the tube is completely full.
3. Place the filled tube in a horizontal position on a clean worktop and cut 5 cm from either end so that the finished length of the sample is 30 cm.
4. Leave the filled tube in a horizontal position at an ambient temperature for 24 hrs.
5. The sample tube is then suspended vertically in an environment heat oven over a weighed beaker. It is left in the oven at a temperature of 70 ^{0} C for a period of 24 Hrs.
6. At the end of the 24 Hrs period the beaker is checked and weighed to see if there is any gel in the beaker.

Requirement:

1. If there is no gel or oil in the beaker the tube has PASSED the drainage test.
2. If there is gel or oil in the beaker the tube has FAILED the drainage test.

Note: This test is applicable for only Wet Core and Semi Dry cable.

2.24 Check of easy removal of sheath:

Objective :

Check of the easy removal of sheath of the optical fibre cable by using normal sheath removal tool.

Test Method:

To check easy removal, the sheath shall be cut in circular way and the about 300 mm length of the sheath should be removed in one operation. It should be observed during sheath removal process that no undue extra force is applied and no component part of the cable is damaged. One should be able to remove the sheath easily.

Note :

Easy removal of both the outer jacket and the inner sheath shall be checked separately.

2.25 Check of the effect of aggressive media on the cable (Type Test) :

Test Method:

To check the effect of aggressive media, solution of PH4 and PH 10 shall be made. The two test samples of the finished cable, each of 600mm in length, are taken and the ends of the samples are sealed. These test samples are put in the PH4 and PH 10 solutions separately. After 30 days these samples are taken out from the solutions and examined for any corrosion etc on the sheath and other markings of the cables. (Test method no. IS0175).

Requirement:

The sample should not show any effect of these solution on the sheath and other marking of the cable.

2.26 Electrical Test (Type Test):

Objective:

The objective of this test is to demonstrate the resistance of the cable sheath to erosion and tracking under combined electrical and mechanical stresses.

Test Method: IEEE Std 1222-2003 (Annexure A)

Requirement:

Tracking on the outside of sheath shall not result in erosion at any point of sheath.

2.27 Aeolian Vibration Test (Type Test):

Objective:

The objective of this test is to assess the fatigue performance of ADSS cable and the optical characteristics of the fibers under typical Aeolian vibrations.

Test Method: IEC 60794-1-2 (E19) / IEEE Std 1222-2003 (Annexure B)

B). The cable shall be subjected to a minimum of 100 million vibration cycles. The frequency of the test span shall be equal to and maintained at the nearest resonant frequency produced by a 16.1 km/hr wind (i.e., frequency = 82.92, diameter of cable in centimeters). The free loop peak-to-peak antinode amplitude shall be maintained at a level equal to one-half the diameter of the cable.

In the initial stages, the test span requires continuous attention and recordings shall be taken approximately every 15 minutes until the test span has stabilized. After the span has stabilized, readings shall be taken a minimum of two times per day, typically at the start and end of the working day. The test shall be performed on a minimum 95 meter sample of ADSS cable. About 45 meter section of the cable is placed in a test span at a 2 deg static sag angle with the use of ADSS dead ends and suspension clamps.

Requirement:

The change in attenuation of the fibre after the test shall be 0.05 dB measured at both 1310 nm & 1550 nm wavelengths. The cable shall be examined physically for any cracks, tearing of the outer sheath and for the damage to other component parts of the cable.

2.28 Galloping Test (Type Test):

Objective:

The objective of this test is to assess the fatigue performance of ADSS cable and the optical characteristics of the fibers under typical galloping motions.

Test Method: IEEE Std 1222-2003 (Annexure C)

The cable shall be subjected to a minimum of 100000 galloping cycles. The test frequency shall be the single-loop resonant frequency. The minimum peak to-peak antinode amplitude/loop length ratio shall be maintained at a value of 1/25, as measured in the active span.

Mechanical and optical data shall be read and recorded approximately every 2000 cycles.

The optical power meters shall be continuously monitored beginning at least one hour before the test and ending at least two hours after the test.

Requirement:

The change in attenuation of the fibre after the test shall be 0.05 dB measured at both 1310 nm & 1550 nm wavelengths. The cable shall be examined physically for any cracks, tearing of the outer sheath and for the damage to other component parts of the cable.

2.29 Sheave Test (Type Test):

Objective :

The objective of this test is to verify that the installation of the ADSS cable will not damage or degrade their performance.

Test Method: IEC 60794 -1-2 (E9) / IEEE std 1222-2003 (Annexure D)

Test Spec:

The Cable test set up is as shown in Figure D.1 of IEEE std. 1222-2003 (Annexure-D). A 2m minimum length of the ADSS test sample shall be pulled 120 times forward and backward through the sheave (60 times in each direction).

The 120 passes shall be distributed as mentioned below:

Angle of Pull (Degrees) -- 70

Number of passes -- 120

The diameter of the sheave for the angle of pull shall be determined by the ADSS cable manufacturer. Before the first pull, the beginning, midpoint, and end of this length shall be marked. Micrometer readings of the diameter shall be taken and recorded before the first pass through the sheave and thereafter every tenth cycle. The output of the optical power meter shall be monitored continuously during the test. After the test is completed, the ADSS cable shall be removed in the test section and the cable shall be visually examined for any surface damage. The ADSS cable shall be dissected to observe for any signs of damage to the inner structure.

Requirement:

The change in attenuation of the fibre after the test shall be ≤ 0.05 dB measured at both 1310 nm & 1550 nm wavelengths. The cable shall be examined physically for any cracks, tearing of the outer sheath and for the damage to other component parts of the cable.

2.30 Creep Test (Type Test):

Test Method: IEC 61395

A creep test shall be performed on an ADSS sample approximately 10 m long. The cable shall be terminated at each end, and a tension of at least 50% of the maximum rated cable loads shall be applied and sustained for duration of at least 1000 hrs. The elongation of the cable versus time shall be measured at suitable intervals and recorded.

Requirement:

The change in attenuation of the fibre after the test shall be ≤ 0.05 dB measured at both 1310 nm & 1550 nm wavelengths. The cable shall be examined physically for any cracks, tearing of the outer sheath and for the damage to other component parts of the cable.

2.31 Tracking & Erosion Test (Type Test):

Test Method: ASTM D 2303-97

Note: Type test is conducted during product approval and Bulk test are conducted during Bulk production.

CHAPTER 10

TECHNICAL DATA SHEET

(To Be Completed By the Tenderer)

Item No 1 TECHNICAL DATA FOR 132kV SINGLE CORE 800 SQMM XLPE INSULATED, ARMOURED CABLE:

Sl. No	Name of the Particulars	NEA REQ	Data to be filled
		800 sq mm	
1	No. of cores	1(Single)	
2	Size (in mm2)	800	
3	Voltage Grade(in kV)	76/132(145) kV	
4	Type of cable		
5	Standard according to which cable has been manufactured and tested	IEC- 62067, Testing as per IEC-60840.	
6	Permissible Voltage & Frequency variation for satisfactory operation.		
	Voltage	±10%	
	Frequency	±5%	
7	Maximum rated conductor temperature	90^0C	
8	Max. allowable conductor temperature during short circuit	250^0C	
9	Conductor Details		
	(a) Normal Cross-Sectional Area	800 mm^2	
	(b) Material and Grade	Copper as per Specs	
	(c) Shape of Conductor	Compacted stranded circular	
10	**Conductor Screen**		
	(a)Material	Extruded Semi-Conducting XLPE	
	(b)Nominal Thickness	1.5mm(Approx.)	
11	**Insulation**		
	(a) Material	Cross linked Polyethyle	
	(b) Nominal Thickness		
12	**Insulation Screen**		
	(a) Material	Extruded Semi-Conducting XLPE (SC) layer followed by water	
	(b) Min. Thickness	1.0 mm followed by water swellable SC tapes	
	(c) Longitudinal Water Sealing	Semiconducting water blocking tape(s) with 50% over lap	
13	**Metallic Sheath**		
	(a) Material	Seam Welded/ Corrugated Extruded Aluminum sheath with anti corrosion	
	(b) Thickness	3.0 mm	
	(c) Short Circuit current of metallic screen for 1 sec (kA)	>=31.5	

14	**Outer Sheath**			
	(a) Material	Extruded HDPE		
	(b) Colour	Black		
	(c) Thickness (Nom/Min)	4.0 mm		
	(d) Conducting layer over outer sheath	Graphite Coating		
15	Standard Drum Length with Tolerance			
16	Minimum Bending Radius allowable during installation	20 x OD		
17	Safe Pulling force	5kg/mm^2 of CU area.		
20	(a) Impulse Withstand	650kVp		
21	(b) One minute Power Frequency Withstand Voltage (kV)	190kV for 30 sec		
22	Short circuit current for one second (kA)			
	Max conductor DC resistance at 20^{0}C			
	Approx. AC resistance at 90^{0}C			
	Max. capacitance			
23	Continuous Current Rating for in flat/trefoil formation	BEB	SPB/CB	
	(i) In ground at 30^{0}C ground temp, Depth of laying 1.5 m, Thermal Resistivity of soil 150°C Cm/W			
	(ii) In free air at 40^0 C Ambient Air Temperature			
	BEB: Sheath both end bonded **SPB:** Sheath single point/ Cross bonded			
	1. The following details shall be embossed/ Printed on outer sheath at regular interval not exceeding one metre. (a) Manufacturer□s Name or Trade name (b) Year of Manufacture (c) Voltage grade of Cable i.e. (d) Cable Code i.e. (e) Number of cores & cable size e.g. 800 Sqmm (Cu) 1 core			

Item no 2 : OPTICAL FIBRE CABLE

Description	NEA REQ	Manufacturer's Particulars Data to be filled
Manufacturer name and address		
Optical fibre cable designation & type		
Reference standard		
No. of fibre	48	
Central strength member	FRP	
Luse tube Material		
Diameter	Nom. 2.5mm	
Filling compound in tube	Jelly	
Strength element	Aramid yarn	
Inner sheath Material	HDPE	
Thickness	Nom. 1.0mm	
Armouring Material		
Thickness	mm	
Outer sheath Material	HDPE	
Thickness	mm	
Anti-termite layer		
Cable diameter	mm	
Weight of cable	kg/km	
Mode field diameter at 1310nm	9.0um±0.5um	
Mode field concentricity error	Max. 0.8um	
Cladding diameter	125.0±1.0um	
Cladding non-circularity	Max. 1%	
Attenuation at 1310nm	dB/km	
at 1550nm	dB/km	
Dispersion at range 1285-1300nm	ps/nm・km	
At1550nm	ps/nm・km	
Zero dispersion wavelength	≤ 1310 nm	
Zero dispersion slope	ps/nm・km	
Cable cut-off wavelength	≤ 1270 nm	

Item No 3: 132kV GIS Cable Sealing End

Item	Description	Unit	Requirement	Manufacturer's Particulars Data to be filled
1	Manufacturer name and address			
2	Voltage rating	kV	132	
3	Current rating	amp	As per cable	
4	Type		Elastomeric stress cone	
5	Insulator material		Epoxy bushing	
6	Pollution severity levels		Heavy	
7	Pitch circle diameter	mm		
8	Overall length of insulator	mm		
9	Weight of bushing including sealing compound	kg		
10	Total creepage distance of shedding	mm	450mm (approx)	
11	Impulse withstand voltage (External)			
12	(a) Positive	kV	650	
	(b) negative	kV	650	
	Standards		IEC 60840	

Item no 4: 132 kV Straight Through Joint

Item	Description	Unit	Requirement	Manufacturer's Particulars Data to be filled
1	Manufacturer name and address			
2	Voltage rating	kV	132	
3	Current rating	amp	As per cable	
4	Type		Pre-molded (One piece)	
5	Stress relief cone			
	Material		EPDM/EPR/ Silicone Rubber	
6	The Interface pressure between cable insulation and joint rubber block insulator		Min. 0.2MPa	
7	Conductor connecting method			
8	Impulse withstand voltage			
	(a) Positive	kV	650	
	(b) negative	kV	650	
	Standards		IEC 60840	

Item No 5 : 132 kV Insulated Joint

Item	Description	Unit	Requirement	Manufacturer's Particulars Data to be filled
1	Manufacturer name and address			
2	Voltage rating	kV	132	
3	Current rating	amp	As per cable	
4	Type		Pre-molded (One piece)	
5	Stress relief cone			
	Material		EPDM/EPR/ Silicone Rubber	
6	The Interface pressure between cable insulation and joint rubber block insulator		Min. 0.2MPa	
7	Conductor connecting method			
8	DC voltage withstand of the insulation flange	kV		
9	Impulse withstand voltage			
	(a) Positive	kV	650	
	(b) negative	kV	650	
	Standards		IEC 60840	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.6: HDPE PIPE **Sheet 1 of 1**

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
1	**Manufacturer and Country of Origin**			
2	**Year of manufacturing experience**	Years		
3	**Applicable Standard**			
4	**Type**		HDPE PN6	
5	**PE Grade**		PE 80	
6	**Diameter of pipe**	mm	>=200 as per design requirement	
7	**Wall Thickness**	mm		
8	**Weight**	kg/mtr		
9	**Technical Literature Submitted**	Yes/No		
10	**Type Test Certificate Submitted**	Yes/No		
11	**Technical literature/drawings Submitted**	Yes/No		

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.7: 132 kV LIGHTNING ARRESTOR **Sheet 1 of 1**

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
			132kV	132kV
1	**Manufacturer and Country of Origin**			
2	**Year of manufacturing experience**	Years	7	
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC	
5	**Type**		Outdoor, gapless, Zinc-Oxide	
6	**Voltage rating of L.A**	kV	120	
7	**Nominal discharge current**	kA	10	
8	**Surge counter with insulating base furnished**	Yes/No	Yes	
9	**Minimum power frequency sparkover voltage**	kV		
10	**Maximum 1/50 impulse sparkover voltage**	kV		
11	**Maximum front wave sparkover voltage**	kV		
12	**Maximum switching surge sparkover voltage**	kV		
13	**Number of section per Pole**		1	
14	**Insulation level**			
	a)Impulse withstand voltage(peak)	kV	650	
	b)Power frequency withstand voltage (1min, rms)	kV	275	
15	**Porcelain creepage distance**	mm	3300	
16	**Earth terminal with accessories provided**	Yes/No	Yes	
17	**Delivery of equipment in months** following award of contract (Allowing time for approval of drawing)	month		
18	Is manufacturer is ISO 9001 holder?	Yes/No	Yes	
20	Has manufacturer exported units?	Yes/No	Yes	
21	Technical literature/drawings submitted?	Yes/No	Yes	

GUARANTEED TECHNICAL PARTICULARS FOR 132 KV CABLE:

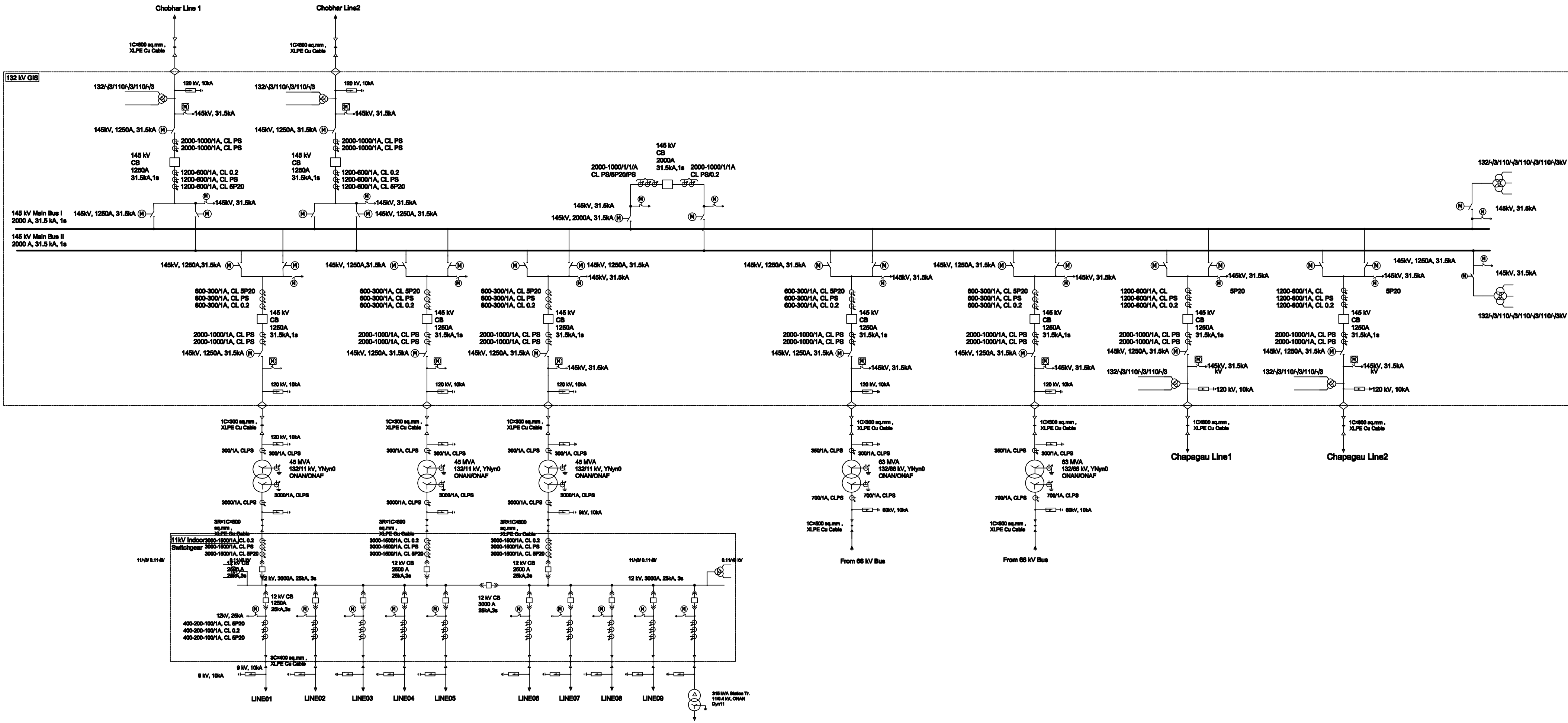
Sl. No.	Name of the Particulars	Data to be filled
1	Type of cable	1CX800 SQMM
2	Standard according to which cable has been manufactured and tested	
3	Rated Voltage (Uo/U}	
4	Highest System Voltage which the cable can withstand	
5	Maximum Conductor temperature for continuous operation	
6	(a) Maximum short time conductor temperature with duration	
	(b) Maximum allowable conductor temp. during overload	
7	Conductor Details	
	Normal Cross-Sectional Area	
	Material and Grade	
	Shape of Conductor	
	Diameter of Conductor	
	No. of Strands and Diameter of each Strand	
	Water swellable powder/yarn provided	
	Conducting water swellable tape with 50% overlap over compacted conductor provided	
8	Extruded Conductor Screen	
	Material	
	Nominal Thickness	
	Diameter over Conductor screen	
	Designed maximum stress at conductor screen	
9	Insulation	
	Material	
	Nominal Thickness	
	Minimum thickness at any point	
	Diameter over insulation	
	Designed maximum stress	
	Detail of vulcanization process	
	Extrusion method	
	Curing method	
	Cooling method	
	CO/ or VOI Line	
10	Extruded Insulation Screen	
	Material	
	Thickness	
	Diameter over insulation screen	
	Strippable/ Bonded	
11	Conducting Longitudinal Water Sealing	
	Material	
	Thickness	
12	Metallic Sheath/ Screen	
	Material	
	No. of strands	
	Diameter of each Strand (Nom/Min)	
	Diameter of Cable after stranding	
	Armour coverage	
13	Non-conducting Longitudinal Water Sealing	
	Material	
	Thickness	

14	HDPE Outer Sheath	
	Type	
	Colour	
	Thickness (Nom/Min)	
	Conductive Coating Provided	
15	Nominal overall Diameter of cable	
16	Nominal OVerall Weight of Cable per Meter	
17	Standard Drum Length with Tolerance	
18	Minimum Bending Radius allowable during installation	
19	Short Circuit Current Rating of Conductor with maximum conductor temperature (90°C) at the commencement of fault 1Sec. Duration	
20	Maximum Continuous Current Rating of a Circuit Comprising of 3 nos. Single Core Cable laid in trefoil/flat formation at a depth of 1.05 M.	
	Soil Temperature	
	Ambient Temperature	
	Soil Thermal Resistivity	
	System of Bonding	
	Laid in ground (at a depth of 1.05 m)	
	Laid in ducts	
	Installed in Air	
21	Short Time Overload capacity (2 hours)	
	Laid in ground (at a depth of 1.05 m)	
	Laid in dusts	
	Installed in Air	
22	Maximum AC Resistance at 90°C	
23	Equivalent Star Reactance of a Circuit comprising of 3 Nos. of Single Core cable laid in Trefoil Formation	
24	Maximum Charging Current per Conductor	
	at Nominal Voltage 1.64 Al km	
25	Loss in Metallic Screen of a Circuit comprising of 3 nos. of Single Core Cable installed in Trefoil Formation	
26	Maximum Current in Metallic Screen when the cable is installed (Circulating Current)	
27	Derating factor of Cable installed under following conditions Ambient Temperature	
	35°C	
	45°C	
28	Group derating factor of Cable Circuits installed under following conditions	
	Laid 100 mm. apart	
	Laid 250 mm. apart	
29	Induced voltage in metallic screen when Conductor is carrying 100 Amps(V/Km)	
30	Circulating current in metallic screen when conductor is carrying 100 Amps	
31	Test Voltages	
	Impulse Withstand Voltage at 90°C	
	Rated Power Frequency Withstand Voltage (kV)	
	Water penetration test as per IEC 60840	
	Abrasion Test on HDPE Outer sheath as per IEC 60229	
	Recommended Test Voltage after installation	
32	Details of Drum	
	Material and Weight of Drum	

	Weight of Drum with Cable	
	Flange Diameter of Drum	
	Barrel Width of Drum	
	Spindle hole Diameter	
33	Safe Pulling force	
34	Moisture barrierz	
	Material	
	Min. Thickness (in mm)	
35	Metallic sheath	
	Material	
	Type of corrugation	
	Gap (in mm)	
	Min & nom thickness	
	Diameter above metallic sheath	
	Anti Corrosive layer	
	Material	
	Tape	
36	The following details shall be embossed/ Printed on outer sheath at regular interval not exceeding one metre.	
	(a) Manufacturer"s Name or Trade name (b) Year of Manufacture (c) Voltage grade of Cable i.e. 132 kV (d) Cable Code (e) Number of cores & cable size e.g. 800 Sq mm (Cu) 1 core 1000 Sqmm (Cu) 1 core	
	Sequential length marking shall also be provided on outer sheath by inkjet printing.	
	Cable shall be supplied in steel drums	

ANNEXURE I

DRAWINGS



Single Line Diagram of New Patan 132 kV GIS Substation to be constructed

NEPAL ELECTRICITY AUTHORITY

(GoN Undertaking)

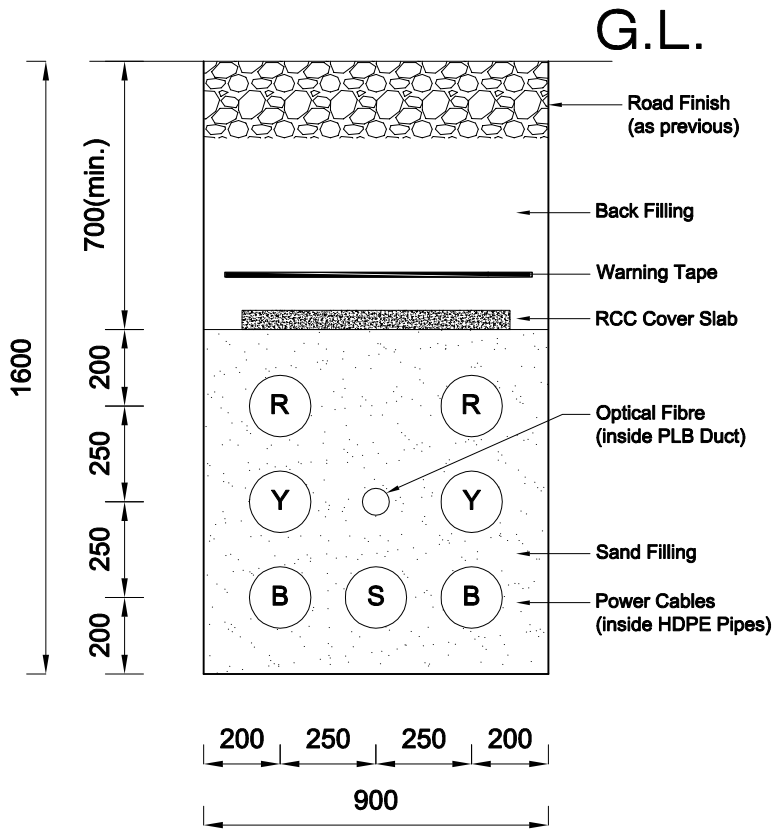
PROJECT MANAGEMENT DIRECTORATE

Chobhar Patan 132 kV Underground Transmission Line

For Bidding Purpose Only

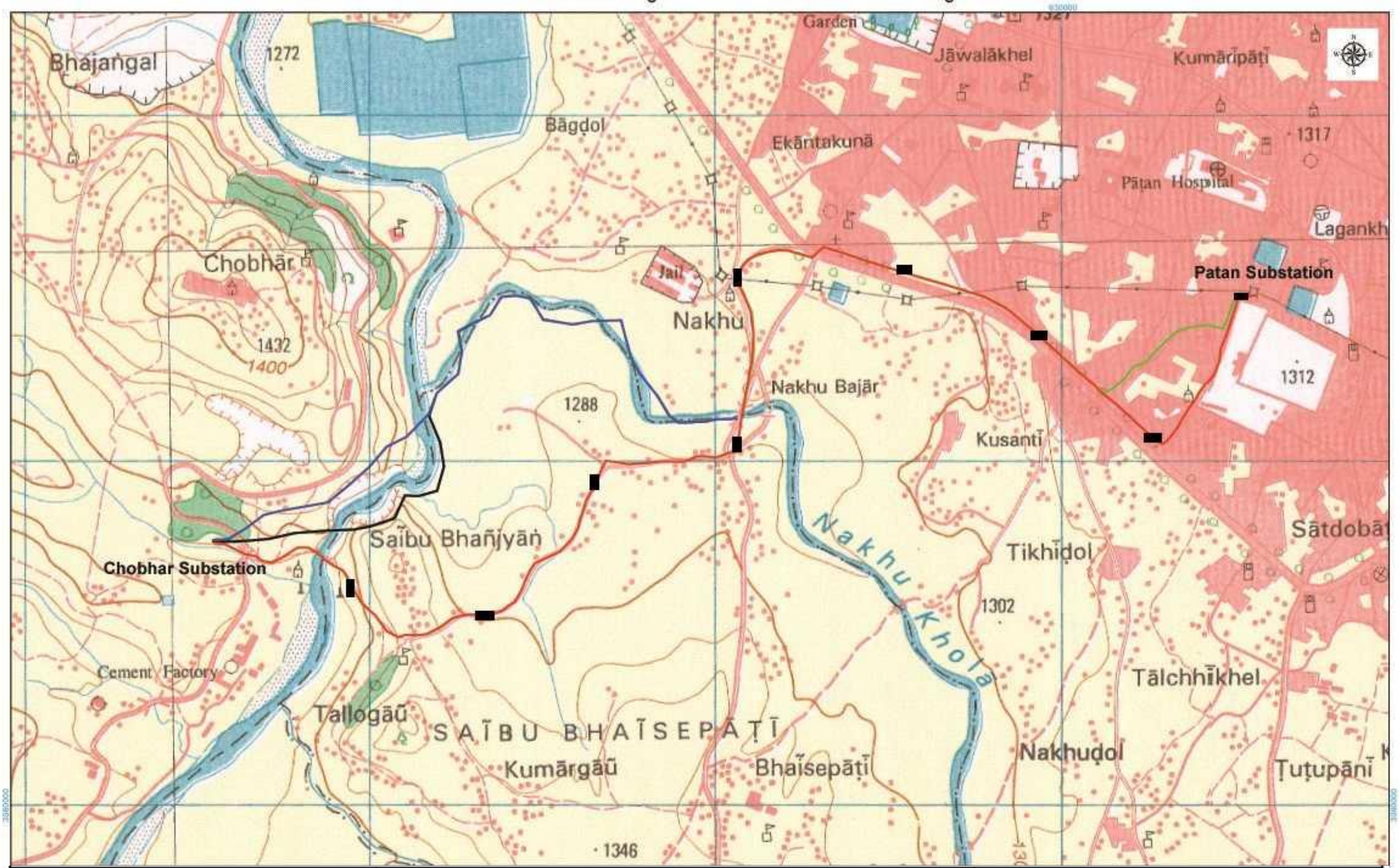
Notes:

1. Backfill shall be clean and free of stone and sharp objects.
2. Other utilities such as Gas, water, sewer etc if parallel to direct buried electric cables, should maintain a suitable separation.

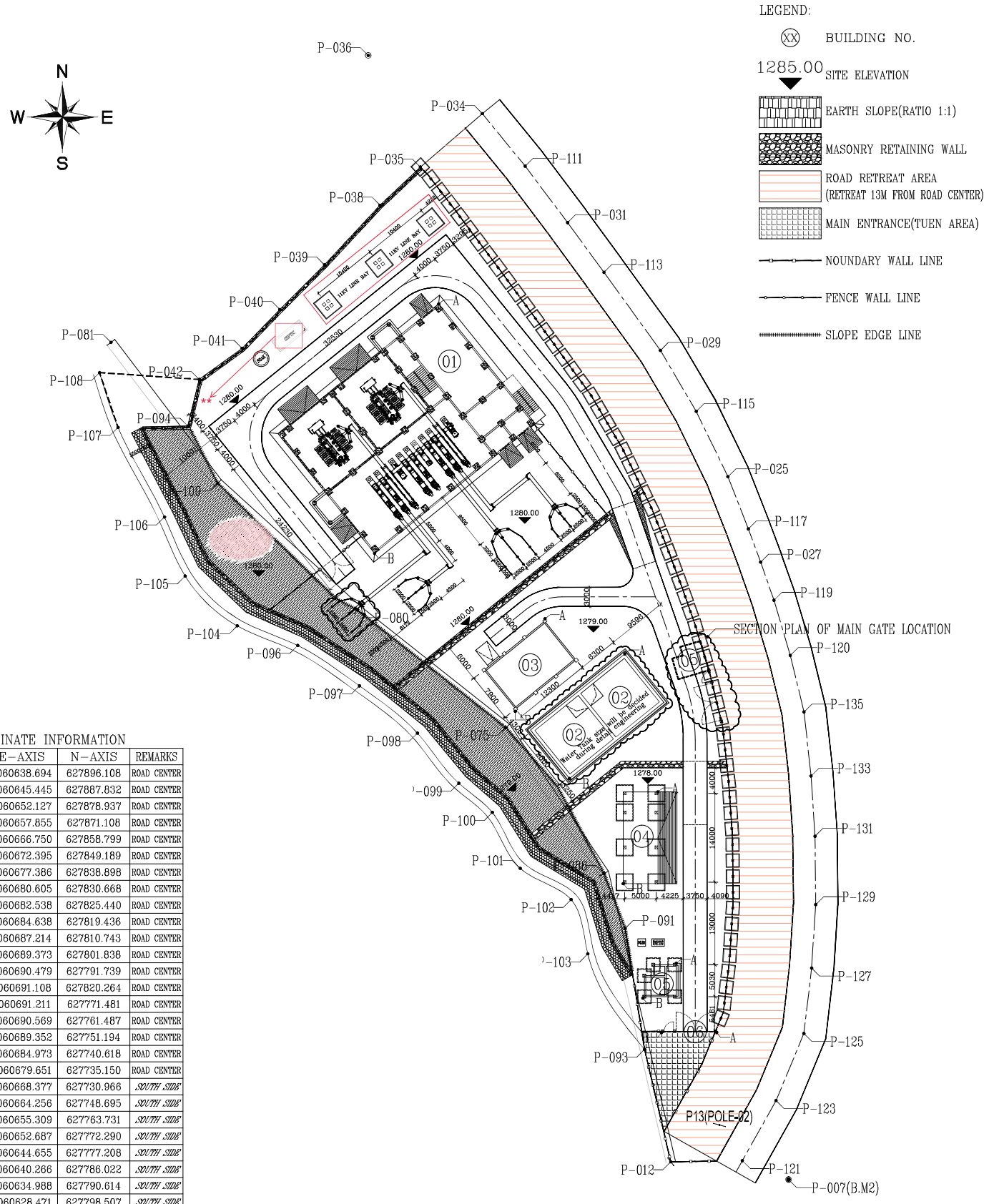


Cable Laying Layout

Chobhar-Patan 132 kV Transmission Line/ Underground Cable Alternative Route Alignments



NEPAL ELECTRICITY AUTHORITY (GoN Undertaking)	**PROJECT MANAGEMENT DIRECTORATE** Chobhar Patan 132 kV Underground Transmission Line	For Bidding Purpose Only



GA LAYOUT OF CHOVAR SUBSTATION 1:300

COORDINATE INFORMATION

NO.	COOR.NO.	E-AXIS	N-AXIS	REMARKS
01	P-034	3060638.694	627896.108	ROAD CENTER
02	P-111	3060645.445	627887.832	ROAD CENTER
03	P-031	3060652.127	627878.937	ROAD CENTER
04	P-113	3060657.855	627871.108	ROAD CENTER
05	P-029	3060666.750	627858.799	ROAD CENTER
06	P-115	3060672.395	627849.189	ROAD CENTER
07	P-025	3060677.386	627838.898	ROAD CENTER
08	P-117	3060680.605	627830.668	ROAD CENTER
09	P-027	3060682.538	627825.440	ROAD CENTER
10	P-119	3060684.638	627819.436	ROAD CENTER
11	P-120	3060687.214	627810.743	ROAD CENTER
12	P-135	3060689.373	627801.838	ROAD CENTER
13	P-133	3060690.479	627791.739	ROAD CENTER
14	P-131	3060691.108	627820.264	ROAD CENTER
15	P-129	3060691.211	627771.481	ROAD CENTER
16	P-127	3060690.569	627761.487	ROAD CENTER
17	P-125	3060689.352	627751.194	ROAD CENTER
18	P-123	3060684.973	627740.618	ROAD CENTER
19	P-121	3060679.651	627735.150	ROAD CENTER
20	P-012	3060668.377	627730.966	*SOUTH SIDE*
21	P-093	3060664.256	627748.695	*SOUTH SIDE*
22	P-103	3060655.309	627763.731	*SOUTH SIDE*
23	P-102	3060652.687	627772.290	*SOUTH SIDE*
24	P-101	3060644.655	627777.208	*SOUTH SIDE*
25	P-100	3060640.266	627786.022	*SOUTH SIDE*
26	P-099	3060634.988	627790.614	*SOUTH SIDE*
27	P-098	3060628.471	627798.507	*SOUTH SIDE*
28	P-097	3060619.330	627805.952	*SOUTH SIDE*
29	P-096	3060609.619	627812.332	*SOUTH SIDE*
30	P-104	3060600.085	627815.404	*SOUTH SIDE*
31	P-105	3060591.885	627823.253	*SOUTH SIDE*
32	P-106	3060588.625	627832.556	*SOUTH SIDE*
33	P-107	3060581.305	627846.665	*SOUTH SIDE*
34	P-042	3060594.101	627854.230	WEST SIDE
35	P-041	3060600.858	627859.120	WEST SIDE
36	P-040	3060606.803	627865.245	WEST SIDE
37	P-039	3060613.817	627872.286	WEST SIDE
38	P-038	3060622.567	627881.681	WEST SIDE
39	P-035	3060628.939	627887.686	WEST SIDE
40	P-081	3060580.181	627860.082	11KV POLE
41	P-109	3060596.996	627837.910	11KV POLE

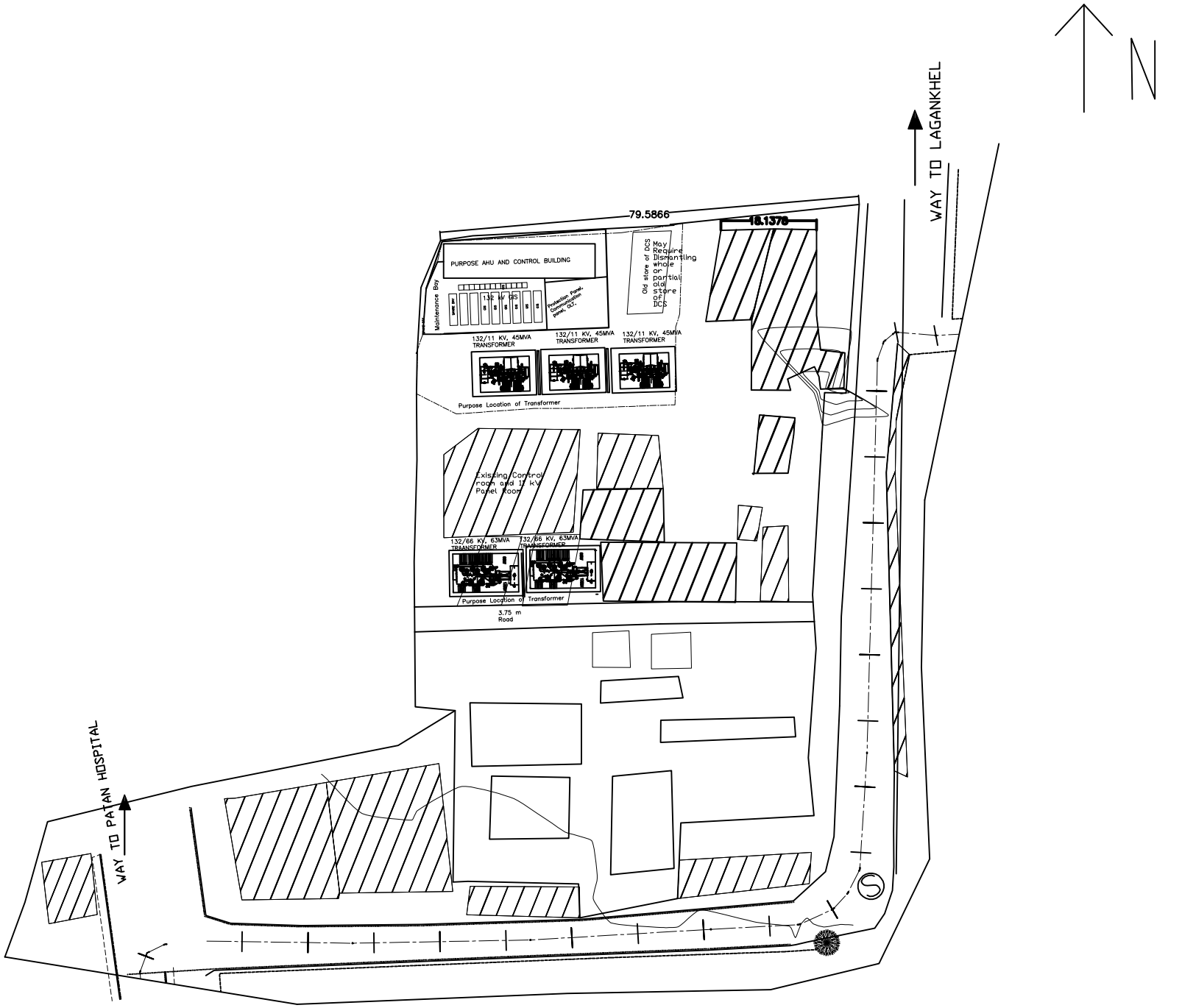
BUILDING INFORMATION

NO.	NAME	AREA COVERED		E-AXIS	N-AXIS	REMARKS
01	CRB	834.50 SQ.M	A	3060631.819	627866.122	OUTER CORNER
			B	3060621.717	627826.837	OUTER CORNER
02	WATER TANK	187.50 SQ.M	A	3060661.138	627810.991	OUTER CORNER
			B	3060652.426	627791.371	OUTER CORNER
03	FFPH	98.00 SQ.M	A	3060648.574	627816.531	OUTER CORNER
			B	3060643.886	627801.956	OUTER CORNER
04	CAR PARKING	78.75 SQ.M	A	3060666.349	627789.251	OUTER CORNER
			B	3060660.899	627774.801	OUTER CORNER

NEPAL ELECTRICITY AUTHORITY
(GoN Undertaking)

PROJECT MANAGEMENT DIRECTORATE
Chobhar Patan 132 kV Underground Transmission Line

For Bidding Purpose Only



REFERENCE DRAWING IS ONLY FOR TENDOR PURPOSE

REV	Date	Description			Approved

NEPAL ELECTRICITY AUTHORITY

(GoN Undertaken)

Project Management Directorate

CPC 132 KV Underground TL Project

New Patan Sub-Station Construction Project

Title:

Site plan