CHAPTER – 1

PROJECT SPECIFIC REQUIREMENTS (PSR)

1.0 PROJECT DESCRIPTION AND SCOPE

1.1 GENERAL

Nepal Electricity Authority (NEA) is establishing three 400 kV GIS Substations with extension of existing/under construction 220 kV GIS substations at Khimti,Ramechap district, Barhabise, Sindhupalchowk district and Lapsiphedi, Kathmandu district of Nepal under Khimti-Barhabise-Lapsiphedi 400 kV Substation Project. The above project is being implemented by Nepal Electricity Authority funded from Asian Development Bank & Government of Nepal.

1.2 NEA is taking up the following works under Khimti-Barhabise-Lapsiphedi 400 kV Substation Project **:**

At New Khimti substation:–

i. Expansion of 400kV **New Khimti** Substation

At Barhabise substation:–

i. Expansion of 400kV **Barhabise** Substation

At Lapsiphedi substation:–

i. Expansion of 400kV **Lapsiphedi** Substation

1.3 Associated Transmission system:

The following transmission lines associated with substation under Tamakoshi(Khimti)-Kathmandu 220/400 KV Transmission Line Project are as below:-

i. New Khimti – Barhabise 400 kV Double Circuit Transmission Line: 45 km (along with OPGW)
ii. Barhabise - Lapsiphedi 400 kV Double Circuit Transmission Line: 44 km (along with OPGW)

1.4 SCOPE

The scope of this specification covers the following:

<u>New Khimti Substation</u>

A. Construction of a new 400 (GIS)/220(GIS) substation at new Khimti with the provision of following bays as per Single Line Diagram (The SF6 Gas Insulated Switchgear (GIS) of one-and-a half Breaker Bus scheme shall be 420 kV, 5000 A, 50 kA short circuit rating for 1 sec. and involves installation of following number of Bays):

i. 2 nos. of 400 kV Bays to terminate 400 kV D/C Quad Moose ACSR lines from Barhabise.

ii. 2 nos. of 400kV Auto Transformer bays for connecting each bank of 315 MVA, 400/220 kV Auto Transformers formed with 4 numbers (400/√3)/(220/√3/33) kV,105 MVA, single phase auto transformers with one number unit as spare along with supply and installation of autotransformers. Supply & Installation of 7 x 105 MVA Autotransformers is under present scope.

iii. GIS Extension of under construction 220kV New Khimti Substation with the following new bays:

- 2 nos. of 220kV Auto Transformer bays for above two bank of 315 MVA, 400/220 kV Auto Transformers.

Barhabise Substation

A. Construction of a new 400 (GIS)/220(GIS) substation at Barhabise with the provision of following bays as per Single Line Diagram (The SF6 Gas Insulated Switchgear (GIS) of one-and-a half Breaker Bus scheme shall be 420 kV, 5000 A, 50 kA short circuit rating for 1 sec. and involves installation of following number of Bays):

i. 2 nos. Bays to terminate 400 kV D/C Quad Moose ACSR lines from New Khimti.

ii. 2 nos. Bays to terminate 400 kV D/C Quad Moose ACSR lines from Lapsiphedi.

iii. 2 nos. of 400kV Auto Transformer bays for connecting each bank of 160 MVA, 400/220 kV Auto Transformers formed with 4 numbers(400/√3)/(220/√3/33) kV,53.33 MVA, single phase auto transformers with one number unit as spare along with supply and installation of autotransformers. Supply & Installation of 7 x 53.33 MVA Autotransformers is under present scope.

iv. 1 nos. bays for connecting 1 nos., 420 kV, 50 MVAR Three Phase Shunt Reactor along with supply and installation of reactor.

v. GIS Extension of Under construction 220kV Barhabise Substation with the following new bays

- 2 nos. of 220kV Auto Transformer bays for above two bank of 160 MVA, 400/220 kV Auto Transformers.

Lapsiphedi Substation

A. Construction of a new 400 (GIS)/220(GIS) substation at Lapsiphedi with the provision of following bays as per Single Line Diagram (The SF6 Gas Insulated Switchgear (GIS) of one-and-a half Breaker Bus scheme shall be 420 kV, 5000 A, 50 kA short circuit rating for 1 sec. and involves installation of following number of Bays):

i. 2 nos. Bays to terminate 400 kV D/C Quad Moose ACSR lines from Barhabise.

ii. 2 nos. Spare Bays to terminate 400 kV D/C Quad Moose ACSR lines.

iii. 1 nos. of 400kV Auto Transformer bays for connecting bank of 315 MVA, 400/220 kV Auto Transformers formed with 4 numbers (400/√3)/(220/√3/33)kV, 105 MVA, single phase auto transformers with one number unit as spare along with supply and installation of autotransformers. Supply & Installation of 4 x 105 MVA Autotransformers is under present scope and 3 x 105 MVA shall be connected in future.

iv. GIS Extension of Under construction 220kV Lapsiphedi Substation with the following new bays

- 1 nos. of 220kV Auto Transformer bays for above one bank of 315 MVA, 400/220 kV Auto Transformers.

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

1.5.1 400kV New Khimti GIS Substation

A. Design, engineering, manufacture, testing, supply including transportation & insurance, storage, erection, testing and commissioning of following equipments and items at 400(GIS)/220(GIS) kV New Khimti GIS substation complete in all respect:

A1) <u>400 KV GIS</u>

The 420 kV SF6 gas insulated switch gear shall have one and a half breaker bus bar arrangement. The Switchgear (50 Hz) shall be complete with all necessary terminal boxes, SF6 gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment and piping, support structures complete in all respects and consisting of following major items.

A1.1) 420kV, 50KA for 1 sec., Two (2) sets of 3 single-phase (isolated), SF6 gas insulated, metal-enclosed 5000A bus bars, each enclosed in three individual bus-enclosures running along the length of the switchgear to interconnect each of the circuit breaker bay module. Each bus bar set shall comprise of:

a) Three Nos. 5000A, individual bus bars enclosures running across the length of the switch gear to inter-connect each of the circuit breaker bay modules in one and half breaker bus system.

b) Three Nos. 1-phase, inductive potential transformers, complete with isolator switch.

c) One No. 3-phase, group operated safety grounding switch, complete with manual and motor driven operating mechanisms.

d) One Bay Module Control Cabinet/ Local Control Cubicle for Bus Bar system.

e) Interface module (under present scope) with the Isolating link for future extension of Bus bar module (on one side). As GIS is likely to be extended in future, the contractor shall make available all details such as cross section, gas pressure etc. required to design adopted in future for extension of GIS, during detailed engineering stage.

f) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

A1.2) 420kV, 50KA for 1 sec., SF6 gas insulated metal enclosed **Line feeder bay module**, each set comprising of:-

a) One set of three single-phase (isolated), 4000A, SF6 insulated circuit breaker complete with separate operating mechanism for each pole.

b) Three Nos. 1-phase, 4000A, 6-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.

c) Three Sets of three-phase, 4000A, group-operated disconnectors with safety grounding switch, each complete with manual and motor driven operating mechanism.

d) One Set of three-phase group operated high speed grounding switch complete with manual and motor driven operating mechanism.

e) Three Nos. 1-phase, inductive potential transformers, complete with isolator switch.

f) Three Nos. 1-phase, 4000A, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).

g) One Bay Module Control Cabinet including Bay Controller (Local Control Cubicle).

h) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

A1.3) 400kV, 50kA for 1 sec, SF6 gas insulated metal enclosed **Auto Transformer bay module**, each set comprising of :-

a) One set of three single-phase (isolated), 2000A, SF6 gas insulated circuit breaker with control switching device, complete with operating mechanism.

b) Three Nos. 1-phase, 4000A, 6-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.

c) Three Sets of three-phase, 2000A group operated disconnector with safety grounding switch complete with manual and motor driven operating mechanism.

d) One Set of three-phase group operated high speed grounding switch complete with manual and motor driven operating mechanism.

e) Three Nos. 1-phase, 2000A, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).

f) One Bay Module Control Cabinet including Bay Controller (Local Control Cubicle).

g) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

h) Three nos.1-phase, 2000A, 50 kA, individual pole operated, isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare ICT through 420kV Auxiliary bus . The isolator must meet the operational requirement in terms of insulation withstand requirement for connecting the same to auxiliary bus.

A1.4) 420kV, 50kA for 1 second, SF6 gas insulated metal enclosed **Tie bay module (For Lines Bays)** comprising of:-

a) One set of three single-phase (isolated), 4000A, SF6 insulated circuit breaker complete with separate operating mechanism for each pole.

b) Three Nos. 1-phase, 4000A, 6-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.

c) Two sets 3-phase, 4000A, group operated isolator switches, complete with manual and motor driven operating mechanisms.

d) Two sets 3-phase, group operated safety-grounding switches, complete with manual and motor driven operating mechanisms.

e) One Bay Module Control Cabinet including Bay Controller (Local Control Cubicle).

f) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

A1.5) 420kV, 50kA for 1 second, SF6 gas insulated metal enclosed **Tie bay module (For Auto Transformers Bays)** comprising of:-

a) One set of three single-phase (isolated), 2000A, SF6 insulated circuit breaker complete with operating mechanism.

b) Three Nos. 1-phase, 4000A, 6-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.

c) Two sets 3-phase, 2000A, group operated isolator switches, complete with manual and motor driven operating mechanisms.

d) Two sets 3-phase, group operated safety-grounding switches, complete with manual and motor driven operating mechanisms.

e) One Bay Module Control Cabinet including Bay Controller (Local Control

Cubicle).

f) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

A1.6) 420kV Auxiliary Bus to connect spare unit of Transformer with Two ICT bays module :-

a) One number 1-phase (isolated) SF6 ducts inside GIS hall (up to outer edge of wall) for connection of spare unit with one ICT bay.
b) One nos. 1-phases, 2000A, 50kA individual operated safety grounding switches complete with manual and motor driven operating mechanisms.
c) End Piece module with the test link for Future extension of Auxiliary Bus module at end. The end piece module may be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.
d) Local Bay control Cubicle, if required separately
e) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures,, platform etc. as required.

2) Pre-insert resistor (PIR) is required for all Main & Tie circuit breakers for line bays and Control switching device (CSD) is required for Main & Tie circuit breakers of Auto Transformers, Bus reactor bays as per specification. However, pre-insert resistor (PIR) which are required for all Main & Tie circuit breakers for line bays may be replaced with alternate suitable device (like control switching device (CSD), capacitance Current Switching device) provided that contractor shall ensure the proposed device shall also limit the switching surges as per technical specification with justification in line with relevant international standards (IEC/IEEE) and provide the details of the same along with bid. The price for the same is deem to be included in the GIS Module.

3) 400 kV, 4000A/2000A, 50 kA for 1Sec, Three 1-Phase (isolated**) SF6 gas ducts** (including support structures, gas monitoring devices, gas barrier, pressure switch, UHF PD sensor) from outside (i.e. wall surface) of the GIS building to center line of SF6/Air Bushing shall be as per BPS. SF6 gas Ducts inside GIS hall are part of GIS Module.
Multi-Tier GIS Bus ducts shall be used, as per requirements to be determined during detailed engineering, considering site constraints and layout arrangement. All present and future line bays shall be properly accommodated within available switchyard area with provision for personnel and equipments movements and maintenance.

4) 400 kV SF6/air bushings of GIS bay along with terminal connectors & support structure for outdoor connections to connect GIS with overhead lines/equipments.

5) 220 kV XLPE Cables along with accessories and Cable sealing for interconnection of 220 kV side of 400/220 kV Transformer with respective 220 kV autotransformer bays. *SF6 to Cable Bushing and cable termination is under the present scope of work.*

6) During Detail Engineering contractor is required to furnish the detailed document enlisting, each and every GIS Module (indoor and outdoor) complete along with its enclosure, gasket and all active parts such as conductor, conductor joints, corona shield etc. identifiable. The Purpose of above said document is to identify (as a part no.) each and every GIS Module individually in supplied GIS installation.

7) For 220 kV bays of 400/220kV Autotransformer, 245 kV GIS extension work at under construction 220kV New Khimti Substation is envisaged under present scope of works. The Scope includes Design & engineering, manufacture, testing, supply to site, including transportation & insurance, unloading, storage, erection, testing and commissioning of the following equipments and items complete in all respect:

245 KV GIS SYSTEM

The 245 KV SF6 gas insulated switchgear shall have double bus bar arrangement. The SF6 gas insulated switch gear (50 HZ) shall be complete with all necessary terminal boxes, SF_6 gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment & piping and support structures along with base plate & foundation bolts for fixing the switchgear with raft foundations.

The SF6 gas insulated switchgear shall be of the indoor metal enclosed type. Quantity of GIS modules shall be as per BPS. Description of each type of GIS module is as follows:

(A) Extension of two sets of three phase, 3150A, 40kA, SF_6 gas-insulated metal enclosed bus bars each comprising of :

(a) Bidder shall design the interface arrangement to suit existing bus bars enclosures running across the length of the switch gear to inter connect each of the circuit breaker bay modules in double main bus system. The interconnection space between upcoming GIS and existing GIS shall be as minimum, approximately one meter or less.

(b) Gas monitoring devices, barriers, pressure switches, etc. as required.

(c) Interface module (Under present scope) with the test link for Future extension of Bus bar module.

d) End Piece with the test link for future extension of Bus bar module**.** As 245kV GIS is likely to be extended in future, the contractor shall make available all details such as cross section, gas pressure etc. required to design adopted in future for extension of GIS, during detailed engineering stage.

However, make of existing GIS and layout drawings & drawing for bus bar Extension shall be furnished during detailed engineering.

(B) 245kV, 40 kA for 1 sec, SF6 gas insulated **Auto Transformer bay module** each comprising of:-

a) One no. **2000 A, 40kA**, 3-phase, SF_6 gas insulated circuit breaker, complete with operating mechanism.

b) Three Nos. 1-phase, 2000A, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker

c) Two nos. 3-phase, 2000A, 40kA group operated isolator switches complete with manual and motor driven operating mechanisms.

d) Two nos. 3-phases, 2000A, 40kA group operated safety grounding switches complete with manual and motor driven operating mechanisms.

e) Three nos. 1-phase, 2000A, 40kA individual pole operated isolator switches complete with manual and motor driven operating mechanisms.

f) Three nos. 1-phases, 2000A, 40kA individual operated safety grounding switches complete with manual and motor driven operating mechanisms.

g) Three nos.1-phase, 2000A,40 kA, individual pole operated , isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare Auto transformer through 220kV Auxiliary bus . The isolator must meet the operational requirement in terms of insulation withstand requirement for connecting the same to auxiliary bus.

h) Three nos. 1-phase (isolated) SF6 ducts inside GIS hall (up to outer edge of wall).

i) Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required

j) Local Bay control cubicle

(C) 245kV **Auxiliary Bus** to connect spare unit of Transformer.

a) One no. 1-Phase (Isolated) SF6 ducts inside GIS Hall (up to outer edge of wall) for connection of Spare unit with Auto Transformer bay.

b) One no. 1-phase, 2000A, 40kA individual operated safety grounding switches complete with manual and motor driven operating mechanisms.

c) End piece module with the test link for future extension of Auxiliary Bus Module at end. The end piece module may be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

d) Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required

e) Local Bay control cubicle, if required separately.

8) 245 kV, 2000A, 40 kA for 1Sec, Three 1-Phase (isolated) **SF6 Gas insulated Bus Duct (GIB)** with support structure (along with Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required) for connecting 220 kV side of 400/220kV Transformer.

9) 220 kV SF6/air bushings and SF6/cable bushings of GIS bay along with terminal connectors & support structure for outdoor connections to connect GIS with equipments.

10) Supply, Erection, testing & commissioning of **7X105 MVA, 400/√3/220/√3/33kV ,** 1-Phase Auto Transformer (Two bank + One Spare) including all materials/fittings/accessories/Digital RTCC panel/Common MB/Individual MB, *Control cabinet/cooling control cabinets*, Cables including special cable (if any), & loading arrangement, both Neutral (HV & IV) formations etc. The scope also includes supply of transformer bushing end terminal connectors suitable for GIS ICT Bay both for 400 kV and 220 kV sides of Transformer complete in all respect for the above mentioned auto transformers.

Connection arrangement of spare unit of transformer with other units shall be made by isolator switching as described in Chapter-5.

All associated equipments like 420 kV and 220 kV GIS Auxiliary Bus to connect spare unit of Transformer as described above with all associated materials like isolators, Bus post insulators, Aluminium tube, conductors, clamps & connectors, insulator strings, hardware, cables, support structures, required for the above-mentioned arrangement are deem to be included in the present scope of the work.

11) One nos. 630 kVA, 33/0.4 kV LT Transformer along with 72.5kV circuit breakers, isolators, earth switches, current transformers, voltage transformers and surge arresters for tertiary loading as per BPS. These LT transformers should not be used for construction purposes.

12) 400 kV, 220kV, 72.5 and 33 kV Bus Post Insulators, Insulator strings and hardware, clamps & connectors, Equipment terminal connectors (including terminal connectors for Transformer and Reactors), Conductors, Aluminum tubes, Bus bar and earthing materials, Bay marshalling box, spacers, cable supporting angles/channels, Cable trays & covers, Junction box, buried cable trenches etc. as required.

13) Augmentation and Extension of sub-station automation system by providing BCUs along with associated equipments including hardware and software for following bays (bay as defined in Technical Specification, Section - Substation

Automation). The make of existing SAS shall be provided during detailed Engineering.

- *400kV : 2 Line Bays, 2 ICT Bays & 2 Tie Bays*
- *220 kV : 2 ICT Bays*
- *Auxiliary System: 1 Set*

In the present scope, bidder shall include BCUs required for 400 kV bays including all necessary hardware and software to integrate with the existing Substation Automation System including updation of system database, displays, and development of additional displays and reports as per requirement. The extension of the existing SAS system is under the present scope of the contract. Bidders are requested to visit the substation site and make own acquaint with the scope of works as described herein. The contractor shall also supply necessary BCU for monitoring and control of auxiliary supply including operation of Isolator associated with auxiliary transformer.

14) Digital protection Coupler (suitable for interfacing with E1 port of SDH equipment) and associated power & control Cables, Fibre cables and Accessories for both ends of the following lines:-

Khimti – Barhabise - 400 kV D/C T/l (Currently Charged at 220 kV D/C T/L)

Barhabise – Lapsiphedi -400 kV D/C T/l (Currently Charged at 220 kV D/C T/L)

The Bidder shall also design the Digital Protection Coupler that will communicate next end using separate fiber and only 2 cores of fiber shall be provided for multiple of transmission line. The specification of Digital Protection coupler is attached as **Annexure-II**.

In the present scope of contract, the necessary interfacing of the existing communication system for the integration of 400 kV Lines shall be included. The Bidder shall install Giga-Ethernet cards compatible with existing SDH Equipment installed at **New Khimti** Substation.

15) SAS and SCADA Integration

All the online monitoring equipment i.e. Optical Temperature Sensors & Measuring Unit, Online Dissolved Gas (Multi-gas) and Moisture Analyzer, On-line insulating oil drying system (Cartridge type) provided for individual transformer unit including spare (if any), are IEC 61850 compliant (either directly or through a Gateway).Those monitoring equipment's are required to be integrated with SAS through managed Ethernet switch conforming to IEC 61850. This Ethernet switch shall be provided in MB by the contractor. The switch shall be powered by redundant DC supply (220V/48V DC). Ethernet switch shall be suitable for operation at ambient temperature of 50 Deg C. All required power & control cables including optical cable, patch chord (if any) up to MB shall be in the scope of contractor. All cable from RTCC to MB shall also be in the scope of contractor. Further, any special cable between MB to switchyard panel room/control room shall be in the scope of contractor.

However, fiber optic cable, power cable, control cables, as applicable, between MB to switchyard panel room/control room and power supply (AC & DC) to MB and integration of above said IEC-61850 compliant equipment with Substation Automation System shall be under the scope of sub-station contractor.

Augmentation and integration work related to SCADA System

The 400/220kV bays under present scope at **New Khimti** substation shall be integrated by the contractor into existing SCADA system of Siemens 'SINAUT Spectrum"(version 4.3.2) installed at Master Station i.e. Nepal Electricity Authority Load Dispatch Centre (located in Siuchatar, Kathmandu). The integration shall include all hardware and software required at the Control Centre as well as necessary data base, display generation and upgrades for proposed control and monitoring of station and Network Analysis. The above activities shall be carried out as appropriate, in all of the 3 stations. The manufacturer of the existing SCADA system is Siemens Germany. The existing communication protocol used for SCADA at LDC Kathmandu is IEC 101. In the present scope of work, the data for SCADA purpose shall be obtained from the Substation Automation System (based on IEC 61850) using Gateway port with communication protocol IEC 104 as per requirement being provided at **New khimti.** The following List of IO Points to be transmitted to LDC Kathmandu:

a) MW and MVAR for all lines , transformers, reactors and Capacitors
b) Voltage of all buses
c) Frequency of 400kV Bus
d) All Breakers
e) All isolators
f) Tap Position for all transformers
g) Master protection signal for all feeders, transformers Units and Bus Bar
h) Loss of Voltage signal for Bus bar
i) All the points identified above as GPS Time stamped.
j) Temperature value per substation.
k) Any other point decided during detailed engineering.

16) Complete relay and protection system for 400kV bays (Line bays and ICT Bays) and 220 kV ICT bays under present scope as per section – Control and Relay panels. Wiring and other necessary arrangements for integration of existing Bus Bar Protection scheme with 220 kV ICT bays is also under present scope.

17) 400kV Surge Arrestors (AIS type).

18) 220kV, 72.5kV, 33kV Surge Arrestors (AIS type).

19) Fire protection system (HVW spray & hydrant system) for all buildings, **7X105 MVA, 400/√3/220/√3/33kV ,** 1-Phase Auto Transformer (Two bank + One Spare) including extension of main water header (available near existing Fire Fighting Pump House) The HVWS system shall be tapped from the Existing fire

water system. The tapping point location & Existing firefighting system piping layout shall be provide to the successful bidders during detail engineering. FFPH & water Tank are not envisaged in the present scope of Contract.

20) Air Conditioning System for control room cum administrative building, panel room and Ventilation system for GIS hall.

21) 1.1kV grade Power & Control Cable along with complete accessories to complete the scope of works.

22) The earth mat for GIS earthing and the yard earthing required as per specification is in the bidder scope. The earth mat already exists in the 220 kV switchyard area. All the AIS/GIS equipments, Transformer, Reactors shall be earthed and this earth mat shall be connected to the Existing 220 kV earth mat by the contractor. Any additional earthing materials required shall be in the present scope of work. Measurement of earth resistivity is in the scope of Contractor.

23) Lattice and pipe structures (galvanized): 400 kV Double Dead end Transmission Tower Structure, Standard gantry structures (Beams & Columns) and Equipment support structures shall be prepared by the contractor and put up for approval of NEA during detailed engineering.

24) Complete lighting and illumination of switchyard under present scope of work.

25) EOT Crane as per Technical Specification is proposed in the GIS Building for handling and subsequent maintenance of GIS equipment. The bidder is required to keep the weight & size of the packages accordingly. Slings of required capacity for handling of GIS equipment /components shall be provided by the supplier. Embedment/Block outs, if any to be provided shall be considered and provided by the bidder. The bidder shall furnish his views regarding the proposed capacity of the crane.

26) LT switchgear (AC/DC Distribution boards).

LT switchgear (AC/DC Distribution boards) considering present bays and future bays. Integration of new AC/DC Distribution boards with existing AC/DC Distribution boards (if necessary) is also in present scope of work. The existing AC/DC drawings shall be provided during detail engineering.

27) Batteries & Battery Chargers

28) 1.1 kV grade Power & Control cables along with complete accessories. Auxiliary Power supply and control cables from control room and RTCC panel to common marshalling box of transformer are also in present scope of work.

29) Visual monitoring system required for watch and ward of Substation premises as per **Annexure-IV.**

30) Any other equipment/material required for completing the specified scope.

B. Mandatory Spares

Design, engineering, manufacture, testing, and supply including transportation, insurance & storage at site as per **Annexure-I**

C. Civil works - The scope of work shall include but shall not be limited to the following–

C.1 Design, Engineering and civil work (as per Contractor supplied drawings) for:

a) Foundation for GIS Hall Building and duct supporting structures inside the GIS hall.

b) Foundation for GIS bus duct supporting structures (outside the GIS hall), *SF6/Air bushings and SF6/Cable bushings*.

c) Foundation for *400/220 kV Transformers* along with jacking pads, rail track, Oil soak pit, sump pit, pylon support and fire resistant wall (s) as required.

d) GIS Buildings including control room cum administrative building. The size of 400kV GIS Building shall be suitable to accommodate five numbers bays in addition to the maintenance bay. The GIS hall shall be suitable for mounting of EOT crane. The GIS and control room building shall be of Pre-Engineered steel structure as per Section “Civil”.

e) Fire resistant wall between Transformer/Reactors.

f) Foundation for GIS equipment, GIS (SF6) to Air bushing/Cable bushing & supporting structure.

g) Cable trenches inside GIS hall.

h) Foundations of gantry, equipment support structures and LT Transformers as per BOQ and tender drawings.

i) Cable trenches along with covers, road/rail crossings, sump pits and cable trench crossings with roads or drains etc.

j) All roads including culverts. The roads shall be of RCC type.

k) Antiweed treatment, PCC and Stone spreading in switchyard area under present scope.

l) Drains along with drain crossings with cable trenches. Drain layout shall be developed by the contractor. Fencing for switchyard and switch yard gates. Dismantling/re-erection of existing fence as per requirement is also included.

m) Layout and details of Water supply and Sewage system.

n) Soil investigation, contouring, leveling and filling. Contouring and site leveling works; The substation area shall be developed in terraces at single or multi

levels by cutting and filling. The finished ground level shall be decided during detail engineering based on spot levels and highest flood level if applicable.

o) Foundation for lighting poles, Bay marshalling box, panels and control cubicles of equipments wherever required shall be as per design and drawings of contractor vendor drawings.

p) Any other item/design/drawing for completion of scope of works.

1.5.2 400kV Barhabise GIS Substation

A. Design, engineering, manufacture, testing, supply including transportation & insurance, storage, erection, testing and commissioning of following equipments and items at 400(GIS)/220(GIS) kV **Barhabise** GIS substation complete in all respect:

A1) 400 KV GIS

The 420 kV SF6 gas insulated switch gear shall have one and a half breaker bus bar arrangement. The Switchgear (50 Hz) shall be complete with all necessary terminal boxes, SF6 gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment and piping, support structures complete in all respects and consisting of following major items.

A1.1) 420kV, 50KA for 1 sec., Two (2) sets of 3 single-phase (isolated), SF6 gas insulated, metal-enclosed 5000A bus bars, each enclosed in three individual bus-enclosures running along the length of the switchgear to interconnect each of the circuit breaker bay module. Each bus bar set shall comprise of:

a) Three Nos. 5000A, individual bus bars enclosures running across the length of the switch gear to inter-connect each of the circuit breaker bay modules in one and half breaker bus system.
b) Three Nos. 1-phase, inductive potential transformers, complete with isolator switch.
c) One No. 3-phase, group operated safety grounding switch, complete with manual and motor driven operating mechanisms.
d) One Bay Module Control Cabinet/ Local Control Cubicle for Bus Bar system.
e) Interface module (under present scope) with the Isolating link for future extension of Bus bar module (on one side). As GIS is likely to be extended in future, the contractor shall make available all details such as cross section, gas pressure etc. required to design adopted in future for extension of GIS, during detailed engineering stage.
f) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

A1.2) 420kV, 50KA for 1 sec., SF6 gas insulated metal enclosed **Line feeder bay module**, each set comprising of:-

a) One set of three single-phase (isolated), 4000A, SF6 insulated circuit breaker complete with separate operating mechanism for each pole.
b) Three Nos. 1-phase, 4000A, 6-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.
c) Three Sets of three-phase, 4000A, group-operated disconnectors with safety grounding switch, each complete with manual and motor driven operating mechanism.
d) One Set of three-phase group operated high speed grounding switch complete with manual and motor driven operating mechanism.
e) Three Nos. 1-phase, inductive potential transformers, complete with isolator switch.
f) Three Nos. 1-phase, 4000A, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).
g) One Bay Module Control Cabinet including Bay Controller (Local Control Cubicle).
h) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

A1.3) 400kV, 50kA for 1 sec, SF6 gas insulated metal enclosed **Auto transformer bay module**, each set comprising of :-

a) One set of three single-phase (isolated), 2000A, SF6 gas insulated circuit breaker with control switching device, complete with operating mechanism.
b) Three Nos. 1-phase, 4000A, 6-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.
c) Three Sets of three-phase, 2000A group operated disconnector with safety grounding switch complete with manual and motor driven operating mechanism.
d) One Set of three-phase group operated high speed grounding switch complete with manual and motor driven operating mechanism.
e) Three Nos. 1-phase, 2000A, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).
f) One Bay Module Control Cabinet including Bay Controller (Local Control Cubicle).
g) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

h) Three nos.1-phase, 2000A, 50 kA, individual pole operated, isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare ICT through 420kV Auxiliary bus . The isolator must meet the operational requirement in terms of

insulation withstand requirement for connecting the same to auxiliary bus.

A1.4) 420kV, 50KA for 1 sec., SF6 gas insulated metal enclosed **Bus shunt reactor module** , each set comprising of:-

a) One set of three single-phase (isolated), 4000A, SF6 insulated circuit breaker complete with control switching device, complete with operating mechanism.
b) Three Nos. 1-phase, 4000A, 6-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.
c) Three Sets of three-phase, 4000A, group-operated disconnectors with safety grounding switch, each complete with manual and motor driven operating mechanism.
d) One Set of three-phase group operated high speed grounding switch complete with manual and motor driven operating mechanism.
e) Three Nos. 1-phase, 4000A, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).
f) One Bay Module Control Cabinet including Bay Controller (Local Control Cubicle).
g) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

A1.5) 420kV, 50kA for 1 second, SF6 gas insulated metal enclosed **Tie bay module** (For Lines Bays and Shunt Reactors Bays) comprising of:-

a) One set of three single-phase (isolated), 4000A, SF6 insulated circuit breaker complete with separate operating mechanism for each pole.
b) Three Nos. 1-phase, 4000A, 6-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.
c) Two sets 3-phase, 4000A, group operated isolator switches, complete with manual and motor driven operating mechanisms.
d) Two sets 3-phase, group operated safety-grounding switches, complete with manual and motor driven operating mechanisms.
e) One Bay Module Control Cabinet including Bay Controller (Local Control Cubicle).
f) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

A1.6) 420kV, 50kA for 1 second, SF6 gas insulated metal enclosed **Tie bay module** (For Auto Transformers Bays) comprising of:-

a) One set of three single-phase (isolated), 2000A, SF6 insulated circuit breaker complete with operating mechanism.
b) Three Nos. 1-phase, 4000A, 6-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.
c) Two sets 3-phase, 2000A, group operated isolator switches, complete with manual and motor driven operating mechanisms.
d) Two sets 3-phase, group operated safety-grounding switches, complete with manual and motor driven operating mechanisms.
e) One Bay Module Control Cabinet including Bay Controller (Local Control Cubicle).
f) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

A1.7) 420kV Auxiliary Bus to connect spare unit of Transformer with Two ICT bays module :-

a) One number 1-phase (isolated) SF6 ducts inside GIS hall (up to outer edge of wall) for connection of spare unit with one ICT bay.
b) One nos. 1-phases, 2000A, 50kA individual operated safety grounding switches complete with manual and motor driven operating mechanisms.
c) End Piece module with the test link for Future extension of Auxiliary Bus module at end. The end piece module may be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.
d) Local Bay control Cubicle, if required separately
e) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures,, platform etc. as required.

2) Pre-insert resistor (PIR) is required for all Main & Tie circuit breakers for line bays and Control switching device (CSD) is required for Main & Tie circuit breakers of Auto Transformers, Bus reactor bays as per specification. However, pre-insert resistor (PIR) which are required for all Main & Tie circuit breakers for line bays may be replaced with alternate suitable device (like control switching device (CSD), capacitance Current Switching device) provided that contractor shall ensure the proposed device shall also limit the switching surges as per technical specification with justification in line with relevant international standards (IEC/IEEE) and provide the details of the same along with bid. The price for the same is deem to be included in the GIS Module.

3) 400 kV, 4000A/2000A, 50 kA for 1Sec, Three 1-Phase (isolated**) SF6 gas ducts** (including support structures, gas monitoring devices, gas barrier, pressure switch, UHF PD sensor) from outside (i.e. wall surface) of the GIS

building to center line of SF6/Air Bushing shall be as per BPS. SF6 gas Ducts inside GIS hall are part of GIS Module.
Multi-Tier GIS Bus ducts shall be used, as per requirements to be determined during detailed engineering, considering site constraints and layout arrangement. All present and future line bays shall be properly accommodated within available switchyard area with provision for personnel and equipments movements and maintenance.

4) 400 kV SF6/air bushings of GIS bay along with terminal connectors & support structure for outdoor connections to connect GIS with overhead lines/equipments.

5) *220 kV (XLPE Cables along with accessories and Cable sealing for interconnection of 220 kV side of 400/220 kV Transformer* with respective 220 kV autotransformer bays. *SF6 to Cable Bushing and cable termination is under the present scope of work.*

220 kV XLPE Cables along with accessories and Cable sealing shall also be used for temporary bypassing of existing 220 kV Incoming/outgoing lines from 220 kV DDE tower/takeoff gantry to 220 kV GIS duct outside 220kV GIS hall as 400 kV GIS switchyard/ building area lies directly under the 220kV TL which connect 220kV GIS switchyard to 220kV DDE. SF6 to Cable Bushing and cable termination is under the present scope of work.

6) During Engineering contractor is required to furnish the detailed document enlisting, each and every GIS Module (indoor and outdoor) complete along with its enclosure, gasket and all active parts such as conductor, conductor joints, corona shield etc. identifiable. The Purpose of above said document is to identify (as a part no.) each and every GIS Module individually in supplied GIS installation.

7) For 220 kV bays of 400/220kV Autotransformer, 245 kV GIS extension work at under construction 220kV Barhabise Substation is envisaged under present scope of works. The Scope includes Design & engineering, manufacture, testing, supply to site, including transportation & insurance, unloading, storage, erection, testing and commissioning of the following equipments and items complete in all respect:

245 KV GIS SYSTEM

The 245 KV SF6 gas insulated switchgear shall have double bus bar arrangement. The SF6 gas insulated switch gear (50 HZ) shall be complete with all necessary terminal boxes, SF_6 gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment & piping and support structures along with base plate & foundation bolts for fixing the switchgear with raft foundations.

The SF6 gas insulated switchgear shall be of the indoor metal enclosed type. Quantity of GIS modules shall be as per BPS. Description of each type of GIS module is as follows:

(A) Extension of two sets of three phase, 3000A, 40kA, SF_6 gas-insulated metal enclosed bus bars each comprising of :

(a) Bidder shall design the interface arrangement to suit existing bus bars enclosures running across the length of the switch gear to inter connect each of the circuit breaker bay modules in double main bus system. The interconnection space between upcoming GIS and existing GIS shall be as minimum, approximately one meter or less.

(b) Gas monitoring devices, barriers, pressure switches, etc. as required.

(c) Interface module (Under present scope) with the test link for Future extension of Bus bar module.

d) End Piece with the test link for future extension of Bus bar module**.** As 245kV GIS is likely to be extended in future, the contractor shall make available all details such as cross section, gas pressure etc. required to design adopted in future for extension of GIS, during detailed engineering stage.

However, make of existing GIS and layout drawings & drawing for bus bar Extension shall be furnished during detailed engineering.

(B) 245kV, 40 kA for 1 sec, SF6 gas insulated **Auto Transformer bay module** each comprising of:-

a) One no. **2000 A, 40kA**, 3-phase, SF_6 gas insulated circuit breaker, complete with operating mechanism.

b) Three Nos. 1-phase, 2000A, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker

c) Two nos. 3-phase, 2000A, 40kA group operated isolator switches complete with manual and motor driven operating mechanisms.

d) Two nos. 3-phases, 2000A, 40kA group operated safety grounding switches complete with manual and motor driven operating mechanisms.

e) Three nos. 1-phase, 2000A, 40kA individual pole operated isolator switches complete with manual and motor driven operating mechanisms.

f) Three nos. 1-phases, 2000A, 40kA individual operated safety grounding switches complete with manual and motor driven operating mechanisms.

g) Three nos.1-phase, 2000A,40 kA, individual pole operated , isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare Auto transformer through 220kV Auxiliary bus . The isolator must meet the operational requirement in terms of insulation withstand requirement for connecting the same to auxiliary bus.

h) Three nos. 1-phase (isolated) SF6 ducts inside GIS hall (up to outer edge of wall).

i) Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required

j) Local Bay control cubicle

(C) 245kV **Auxiliary Bus** to connect spare unit of Transformer.

a) One no. 1-Phase (Isolated) SF6 ducts inside GIS Hall (up to outer edge of wall) for connection of Spare unit with Auto Transformer bay.

b) One no. 1-phase, 2000A, 40kA individual operated safety grounding switches complete with manual and motor driven operating mechanisms.

c) End piece module with the test link for future extension of Auxiliary Bus Module at end. The end piece module may be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

d) Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required

e) Local Bay control cubicle, if required separately.

8) 245 kV, 2000A, 40 kA for 1Sec, Three 1-Phase (isolated) **SF6 Gas insulated Bus Duct (GIB)** with support structure (along with Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required) for connecting 220 kV side of 400/220kV Transformer.

9) 220 kV SF6/air bushings and SF6/Cable bushings of GIS bay along with terminal connectors & support structure for outdoor connections to connect GIS with equipments.

10) Supply, Erection, testing & commissioning of **7X53.33 MVA, 400/√3/220/√3/33kV ,** 1-Phase Auto Transformer (Two bank + One Spare) including all materials/fittings/accessories/Digital RTCC panel/Common MB/Individual MB, Control cabinet/cooling control cabinets, Cables including special cable (if any), & loading arrangement, both Neutral (HV & IV) formations etc. The scope also includes supply of transformer bushing end terminal connectors suitable for GIS ICT Bay both for 400 kV and 220 kV sides of Transformer complete in all respect for the above mentioned auto transformers.

Connection arrangement of spare unit of transformer with other units shall be made by isolator switching as described in Chapter-5.

All associated equipments like 420 kV and 220 kV GIS Auxiliary Bus to connect spare unit of Transformer as described above with all associated materials like isolators, Bus post insulators, Aluminium tube, conductors, clamps &

connectors, insulator strings, hardware, cables, support structures, required for the above-mentioned arrangement are deem to be included in the present scope of the work.

11) Supply, Erection, testing & commissioning of 1 nos. **420kV, 3 Ph., 50 MVAR** Reactors, complete in all respect for the above mentioned Bus Reactor.

12) One nos. 630 kVA, 33/0.4 kV LT Transformer along with 72.5kV circuit breakers, isolators, earth switches, current transformers, voltage transformers and surge arresters for tertiary loading as per BPS. These LT transformers should not be used for construction purposes.

13) 400 kV, 220kV, 72.5 and 33 kV Bus Post Insulators, Insulator strings and hardware, clamps & connectors, Equipment terminal connectors (including terminal connectors for Transformer and Reactors), Conductors, Aluminum tubes, Bus bar and earthing materials, Bay marshalling box, spacers, cable supporting angles/channels, Cable trays & covers, Junction box, buried cable trenches etc. as required. Due to space constraint delta formation of autotransformer is not possible by overhead Al-tube arrangement, same shall be done by using 52 kV XLPE cable and deem to be included in the present scope of contract.

14) Augmentation and Extension of sub-station automation system by providing BCUs along with associated equipments including hardware and software for following bays (bay as defined in Technical Specification, Section - Substation Automation). The make of existing SAS shall be provided during detailed Engineering.

- *400kV : 4 Line Bays, 2 ICT Bays, 1 Reactor Bays & 4 Tie Bays*
- *220 kV : 2 ICT Bays Bays*
- *Auxiliary System: 1 Set*

In the present scope, bidder shall include BCUs required for 400 kV bays including all necessary hardware and software to integrate with the existing Substation Automation System including updation of system database, displays, and development of additional displays and reports as per requirement. The extension of the existing SAS system is under the present scope of the contract. Bidders are requested to visit the substation site and make own acquaint with the scope of works as described herein. The contractor shall also supply necessary BCU for monitoring and control of auxiliary supply including operation of Isolator associated with auxiliary transformer.

15) Digital protection Coupler (suitable for interfacing with E1 port of SDH equipment) and associated power & control Cables, Fibre cables and Accessories for both ends of the following lines:-

Khimti – Barhabise - 400 kV D/C T/l (Currently Charged at 220 kV D/C T/L)

Barhabise – Lapsiphedi -400 kV D/C T/l (Currently Charged at 220 kV D/C T/L)

The Bidder shall also design the Digital Protection Coupler that will communicate next end using separate fiber and only 2 cores of fiber shall be provided for multiple of transmission line. The specification of Digital Protection coupler is attached as **Annexure-II**.

In the present scope of contract, the necessary interfacing of the existing communication system for the integration of 400 kV Lines shall be included. The Bidder shall install Giga-Ethernet cards compatible with existing SDH Equipment installed at **Barhabise** Substation.

16) **SAS and SCADA Integration**

All the online monitoring equipment i.e. Optical Temperature Sensors & Measuring Unit, Online Dissolved Gas (Multi-gas) and Moisture Analyzer, On-line insulating oil drying system (Cartridge type) provided for individual transformer unit including spare (if any), are IEC 61850 compliant (either directly or through a Gateway). Those monitoring equipment's are required to be integrated with SAS through managed Ethernet switch conforming to IEC 61850. This Ethernet switch shall be provided in MB by the contractor. The switch shall be powered by redundant DC supply (220V/48V DC). Ethernet switch shall be suitable for operation at ambient temperature of 50 Deg C. All required power & control cables including optical cable, patch chord (if any) up to MB shall be in the scope of contractor. All cable from RTCC to MB shall also be in the scope of contractor. Further, any special cable between MB to switchyard panel room/control room shall be in the scope of contractor. However, fiber optic cable, power cable, control cables, as applicable, between MB to switchyard panel room/control room and power supply (AC & DC) to MB and integration of above said IEC-61850 compliant equipment with Substation Automation System shall be under the scope of sub-station contractor.

Augmentation and integration work related to SCADA System

The 400/220kV bays under present scope at **Barhabise** substation shall be integrated by the contractor into existing SCADA system of Siemens 'SINAUT Spectrum"(version 4.3.2) installed at Master Station i.e. Nepal Electricity Authority Load Dispatch Centre (located in Siuchatar, Kathmandu). The integration shall include all hardware and software required at the Control Centre as well as necessary data base, display generation and upgrades for proposed control and monitoring of station and Network Analysis. The above activities shall be carried out as appropriate, in all of the 3 stations. The manufacturer of the existing SCADA system is Siemens Germany. The existing communication protocol used for SCADA at LDC Kathmandu is IEC 101. In the present scope of work, the data for SCADA purpose shall be obtained from the Substation Automation System (based on IEC 61850) using

Gateway port with communication protocol IEC 104 as per requirement being provided at **Barhabise.** The following List of IO Points to be transmitted to LDC Kathmandu:

a) MW and MVAR for all lines , transformers, reactors and Capacitors
b) Voltage of all buses
c) Frequency of 400kV Bus
d) All Breakers
e) All isolators
f) Tap Position for all transformers
g) Master protection signal for all feeders, transformers Units and Bus Bar
h) Loss of Voltage signal for Bus bar
i) All the points identified above as GPS Time stamped.
j) Temperature value per substation.
k) Any other point decided during detailed engineering.

17) Complete relay and protection system for 400kV bays (Line bays and ICT Bays) and 220 kV ICT bays under present scope as per section –Control and Relay panels. Wiring and other necessary arrangements for integration of existing Bus Bar Protection scheme with 2 no's of 220 kV ICT bays is also under present scope.

18) 400kV Surge Arrestors.(AIS type).

19) 220kV,72.5kV,33kV Surge Arrestors (AIS type).

20) Fire protection system (HVW spray & hydrant system) for all buildings, **7X53.33 MVA, 400/√3/220/√3/33kV, 1-Phase Auto Transformer (Two bank + One Spare) and 1nos. 420kV, 50MVAR** Reactors including extension of main water header (available near existing Fire Fighting Pump House) The HVWS system shall be tapped from the Existing fire water system. The tapping point location & Existing firefighting system piping layout shall be provide to the successful bidders during detail engineering. FFPH & water Tank are not envisaged in the present scope of Contract.

21) Air Conditioning System for control room cum administrative building, panel room and Ventilation system for GIS hall.

22) 1.1kV grade Power & Control Cable along with complete accessories to complete the scope of works.

23) The earth mat for GIS earthing and the yard earthing required as per specification is in the bidder scope. The earth mat already exist in the 220 kV switchyard area. All the AIS/GIS equipments, Transformer, Reactors shall be earthed and this earth mat shall be connected to the Existing 220 kV earth mat by the contractor. Any additional earthing materials required shall be in the present scope of work. Measurement of earth resistivity is in the scope of Contractor.

24) Lattice and pipe structures (galvanized): 400 kV Double Dead end Transmission Tower Structure, Standard gantry structures (Beams & Columns) and Equipment

support structures shall be prepared by the contractor and put up for approval of NEA during detailed engineering.

25) Complete lighting and illumination of switchyard under present scope of work.

26) EOT Crane as per Technical Specification is proposed in the GIS Building for handling and subsequent maintenance of GIS equipment. The bidder is required to keep the weight & size of the packages accordingly. Slings of required capacity for handling of GIS equipment /components shall be provided by the supplier. Embedment/Block outs, if any to be provided shall be considered and provided by the bidder. The bidder shall furnish his views regarding the proposed capacity of the crane.

27) LT switchgear (AC/DC Distribution boards) considering present bays and future bays. Integration of new AC/DC Distribution boards with existing AC/DC Distribution boards (if necessary) is also in present scope of work. The existing AC/DC drawings shall be provided during detail engineering.

28) Batteries & Battery Chargers

29) 1.1 kV grade Power & Control cables along with complete accessories. Auxiliary Power supply and control cables from control room and RTCC panel to common marshalling box of transformer are also in present scope of work.

30) Visual monitoring system required for watch and ward of Substation premises as per **Annexure-IV.**

31) Any other equipment/material required for completing the specified scope.

B. Mandatory Spares

Design, engineering, manufacture, testing, and supply including transportation, insurance & storage at site as per **Annexure-I**

C. Civil works - The scope of work shall include but shall not be limited to the following–

C.1 Design, Engineering and civil work (as per Contractor supplied drawings) for:

a) Foundation for GIS Hall Building and duct supporting structures inside the GIS hall.

b) Foundation for GIS bus duct supporting structures (outside the GIS hall), *SF6/Air bushings and SF6/Cable bushings*.

c) foundation for *400/220 kV Transformers* and *420kV, 80MVAR Reactors* along with jacking pads, rail track, Oil soak pit, sump pit, pylon support and fire resistant wall (s) as required.

d) GIS Buildings including control room cum administrative building. The size of 400kV GIS Building shall be suitable to accommodate seven numbers bays in addition to the maintenance bay. The GIS hall shall be suitable for mounting of EOT crane. The GIS and control room building shall be of Pre-Engineered steel structure as per Section "Civil".

e) Fire resistant wall between Transformer/Reactors.

f) Foundation for GIS equipment, GIS (SF6) to Air bushing/Cable bushing & supporting structure.

g) Cable trenches inside GIS hall.

h) Foundations of gantry, equipment support structures and LT Transformers as per BOQ and tender drawings.

i) Cable trenches along with covers, road/rail crossings, sump pits and cable trench crossings with roads or drains etc.

j) All roads including culverts. The roads shall be of RCC type.

k) Antiweed treatment, PCC and Stone spreading in switchyard area under present scope.

l) Drains along with drain crossings with cable trenches. Drain layout shall be developed by the contractor. Fencing for switchyard and switch yard gates. Dismantling/re-erection of existing fence as per requirement is also included.

m) Layout and details of Water supply and Sewage system.

n) Soil investigation, contouring, leveling and filling. *Contouring and site leveling works; The substation area shall be developed in terraces at single or multi levels by cutting and filling . The finished ground level shall be decided during detail engineering based on spot levels and highest flood level if applicable*.

o) Foundation for lighting poles, Bay marshalling box, panels and control cubicles of equipments wherever required shall be as per design and drawings of contractor vendor drawings.

p) Any other item/design/drawing for completion of scope of works.

1.5.3 400kV Lapsiphedi GIS Substation

A. Design, engineering, manufacture, testing, supply including transportation & insurance, storage, erection, testing and commissioning of following equipments and items at 400(GIS)/220(GIS) kV Lapsiphedi GIS substation complete in all respect:

A1) 400 KV GIS

The 420 kV SF6 gas insulated switch gear shall have one and a half breaker bus bar arrangement. The Switchgear (50 Hz) shall be complete with all necessary terminal boxes, SF6 gas filling, interconnecting power and control wiring, grounding

connections, gas monitoring equipment and piping, support structures complete in all respects and consisting of following major items.

A1.1) 420kV, 50KA for 1 sec., Two (2) sets of 3 single-phase (isolated), SF6 gas insulated, metal-enclosed 5000A bus bars, each enclosed in three individual bus-enclosures running along the length of the switchgear to interconnect each of the circuit breaker bay module. Each bus bar set shall comprise of:

a) Three Nos. 5000A, individual bus bars enclosures running across the length of the switch gear to inter-connect each of the circuit breaker bay modules in one and half breaker bus system.
b) Three Nos. 1-phase, inductive potential transformers, complete with isolator switch
b) One No. 3-phase, group operated safety grounding switch, complete with manual and motor driven operating mechanisms.
c) One Bay Module Control Cabinet/ Local Control Cubicle for Bus Bar system.
d) Interface module (under present scope) with the Isolating link for future extension of Bus bar module (on one side). As GIS is likely to be extended in future, the contractor shall make available all details such as cross section, gas pressure etc. required to design adopted in future for extension of GIS, during detailed engineering stage.
f) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

A1.2) 420kV, 50KA for 1 sec., SF6 gas insulated metal enclosed **Line feeder bay module**, each set comprising of:-

a) One set of three single-phase (isolated), 4000A, SF6 insulated circuit breaker complete with separate operating mechanism for each pole.
b) Three Nos. 1-phase, 4000A, 6-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.
c) Three Sets of three-phase, 4000A, group-operated disconnectors with safety grounding switch, each complete with manual and motor driven operating mechanism.
d) One Set of three-phase group operated high speed grounding switch complete with manual and motor driven operating mechanism.
e) Three Nos. 1-phase, inductive potential transformers, complete with isolator switch.
f) Three Nos. 1-phase, 4000A, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).
g) One Bay Module Control Cabinet including Bay Controller (Local Control Cubicle).
h) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support

structures, platform etc. as required.

A1.3) 420kV, 50kA for 1 sec, SF6 gas insulated metal enclosed **Auto Transformer bay module**, each set comprising of :-

a) One set of three single-phase (isolated), 2000A, SF6 gas insulated circuit breaker with control switching device, complete with operating mechanism.

b) Three Nos. 1-phase, 4000A, 6-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.

c) Three Sets of three-phase, 2000A group operated disconnector with safety grounding switch complete with manual and motor driven operating mechanism.

d) One Set of three-phase group operated high speed grounding switch complete with manual and motor driven operating mechanism.

e) Three Nos. 1-phase, 2000A, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall).

f) One Bay Module Control Cabinet including Bay Controller (Local Control Cubicle).

g) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

h) Three nos. 1-phase, 2000A, 50 kA, individual pole operated, isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare ICT through 420kV Auxiliary bus . The isolator must meet the operational requirement in terms of insulation withstand requirement for connecting the same to auxiliary bus.

A1.4) 420kV, 50kA for 1 second, SF6 gas insulated metal enclosed **Tie bay module** (For Lines Bays) comprising of:-

a) One set of three single-phase (isolated), 4000A, SF6 insulated circuit breaker complete with separate operating mechanism for each pole.

b) Three Nos. 1-phase, 4000A, 6-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.

c) Two sets 3-phase, 4000A, group operated isolator switches, complete with manual and motor driven operating mechanisms.

d) Two sets 3-phase, group operated safety-grounding switches, complete with manual and motor driven operating mechanisms.

e) One Bay Module Control Cabinet including Bay Controller (Local Control Cubicle).

f) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

A1.5) 420kV, 50kA for 1 second, SF6 gas insulated metal enclosed **Tie bay module** (For Auto Transformers Bays) comprising of:-

a) One set of three single-phase (isolated), 2000A, SF6 insulated circuit breaker complete with operating mechanism.
b) Three Nos. 1-phase, 4000A, 6-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.
c) Two sets 3-phase, 2000A, group operated isolator switches, complete with manual and motor driven operating mechanisms.
d) Two sets 3-phase, group operated safety-grounding switches, complete with manual and motor driven operating mechanisms.
e) One Bay Module Control Cabinet including Bay Controller (Local Control Cubicle).
f) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures, platform etc. as required.

A1.6) **420kV Auxiliary Bus** to connect spare unit of Transformer with one ICT bays module :-

a) One number 1-phase (isolated) SF6 ducts inside GIS hall (up to outer edge of wall) for connection of spare unit with one ICT bay.
b) One nos. 1-phases, 2000A, 50kA individual operated safety grounding switches complete with manual and motor driven operating mechanisms.
c) End Piece module with the test link for Future extension of Auxiliary Bus module at end. The end piece module may be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.
d) Local Bay control Cubicle, if required separately
e) One lot of SF6 gas monitoring system, barriers, pressure switches etc. for the complete bay module, terminal boxes, interconnecting wires, grounding, support structures,, platform etc. as required.

2) Pre-insert resistor (PIR) is required for all Main & Tie circuit breakers for line bays and Control switching device (CSD) is required for Main & Tie circuit breakers of Auto Transformers, Bus reactor bays as per specification. However, pre-insert resistor (PIR) which are required for all Main & Tie circuit breakers for line bays may be replaced with alternate suitable device (like control switching device (CSD), capacitance Current Switching device) provided that contractor shall ensure the proposed device shall also limit the switching surges as per technical specification with justification in line with relevant international standards (IEC/IEEE) and provide the details of the same along with bid. The price for the same is deem to be included in the GIS Module.

3) 400 kV, 4000A/2000A, 50 kA for 1Sec, Three 1-Phase (isolated**) SF6 gas**

ducts (including support structures, gas monitoring devices, gas barrier, pressure switch, UHF PD sensor) from outside (i.e. wall surface) of the GIS building to center line of SF6/Air Bushing shall be as per BPS. SF6 gas Ducts inside GIS hall are part of GIS Module.
Multi-Tier GIS Bus ducts shall be used, as per requirements to be determined during detailed engineering, considering site constraints and layout arrangement. All present and future line bays shall be properly accommodated within available switchyard area with provision for personnel and equipments movements and maintenance.

4) 400 kV SF6/air bushings and SF6/Cable bushings of GIS bay along with terminal connectors & support structure for outdoor connections to connect GIS with overhead lines/equipments.

5) *220 kV XLPE Cables along with accessories and Cable sealing for interconnection of 220 kV side of 400/220 kV Transformer* with respective 220 kV autotransformer bays*. SF6 to Cable Bushing and cable termination is under the present scope of work.*

6) During Engineering contractor is required to furnish the detailed document enlisting, each and every GIS Module (indoor and outdoor) complete along with its enclosure, gasket and all active parts such as conductor, conductor joints, corona shield etc. identifiable. The Purpose of above said document is to identify (as a part no.) each and every GIS Module individually in supplied GIS installation.

7) For 220 kV bays of 400/220kV Autotransformer, 245 kV GIS extension work at under construction 220kV Lapsiphedi Substation is envisaged under present scope of works. The Scope includes Design & engineering, manufacture, testing, supply to site, including transportation & insurance, unloading, storage, erection, testing and commissioning of the following equipments and items complete in all respect:

245 KV GIS SYSTEM

The 245 KV SF6 gas insulated switchgear shall have double bus bar arrangement. The SF6 gas insulated switch gear (50 HZ) shall be complete with all necessary terminal boxes, SF_6 gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment & piping and support structures along with base plate & foundation bolts for fixing the switchgear with raft foundations.

The SF6 gas insulated switchgear shall be of the indoor metal enclosed type. Quantity of GIS modules shall be as per BPS. Description of each type of GIS module is as follows:

(A) Extension of two sets of three phase, 4000A, 40kA, SF_6 gas-insulated metal enclosed bus bars each comprising of :

(a) Bidder shall design the interface arrangement to suit existing bus bars enclosures running across the length of the switch gear to inter connect each of the circuit breaker bay modules in double main bus system. The

interconnection space between upcoming GIS and existing GIS shall be as minimum, approximately one meter or less.

(b) Gas monitoring devices, barriers, pressure switches, etc. as required.

(c) Interface module (Under present scope) with the test link for Future extension of Bus bar module.

d) End Piece with the test link for future extension of Bus bar module**.** As 245kV GIS is likely to be extended in future, the contractor shall make available all details such as cross section, gas pressure etc. required to design adopted in future for extension of GIS, during detailed engineering stage.

However, make of existing GIS and layout drawings & drawing for bus bar Extension shall be furnished during detailed engineering.

(B) 245kV, 40 kA for 1 sec, SF6 gas insulated **Auto Transformer bay module** each comprising of:-

a) One no. **2000 A, 40kA**, 3-phase, SF_6 gas insulated circuit breaker, complete with operating mechanism.

b) Three Nos. 1-phase, 2000A, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker

c) Two nos. 3-phase, 2000A, 40kA group operated isolator switches complete with manual and motor driven operating mechanisms.

d) Two nos. 3-phases, 2000A, 40kA group operated safety grounding switches complete with manual and motor driven operating mechanisms.

e) Three nos. 1-phase, 2000A, 40kA individual pole operated isolator switches complete with manual and motor driven operating mechanisms.

f) Three nos. 1-phases, 2000A, 40kA individual operated safety grounding switches complete with manual and motor driven operating mechanisms.

g) Three nos.1-phase, 2000A,40 kA, individual pole operated , isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare Auto transformer through 220kV Auxiliary bus . The isolator must meet the operational requirement in terms of insulation withstand requirement for connecting the same to auxiliary bus.

h) Three nos. 1-phase (isolated) SF6 ducts inside GIS hall (up to outer edge of wall).

i) Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required

j) Local Bay control cubicle

(C) 245kV **Auxiliary Bus** to connect spare unit of Transformer.

a) One no. 1-Phase (Isolated) SF6 ducts inside GIS Hall (up to outer edge of wall) for connection of Spare unit with Auto Transformer bay.

b) One no. 1-phase, 2000A, 40kA individual operated safety grounding switches complete with manual and motor driven operating mechanisms.

c) End piece module with the test link for future extension of Auxiliary Bus Module at end. The end piece module may be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

d) Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required

e) Local Bay control cubicle, if required separately.

8) 245 kV, 2000A, 40 kA for 1Sec, Three 1-Phase (isolated) **SF6 Gas insulated Bus Duct** (GIB) with support structure (along with Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required) for connecting 220 kV side of 400/220kV Transformer.

9) 220 kV SF6/air bushings and SF6/Cable bushings of GIS bay along with terminal connectors & support structure for outdoor connections to connect GIS with equipments.

10) Supply, Erection, testing & commissioning of **4X105 MVA, 400/√3/220/√3/33kV ,** 1-Phase Auto Transformer (One bank + One Spare) including all materials/fittings/accessories/Digital RTCC panel/Common MB/Individual MB, Control cabinet/cooling control cabinets, Cables including special cable (if any), & loading arrangement, both Neutral (HV & IV) formations etc. The scope also includes supply of transformer bushing end terminal connectors suitable for GIS ICT Bay both for 400 kV and 220 kV sides of Transformer complete in all respect for the above mentioned auto transformers.

Connection arrangement of spare unit of transformer with other units shall be made by isolator switching as described in Chapter-5.

All associated equipments like 420 kV and 220 kV GIS Auxiliary Bus to connect spare unit of Transformer as described above with all associated materials like isolators, Bus post insulators, Aluminium tube, conductors, clamps & connectors, insulator strings, hardware, cables, support structures, required for the above-mentioned arrangement are deem to be included in the present scope of the work.

11) One nos. 630 kVA, 33/0.4 kV LT Transformer along with 72.5kV circuit breakers, isolators, earth switches, current transformers,voltage transformers and surge arresters for tertiary loading as per BPS. These LT transformers should not be used for construction purposes.

12) 400 kV, 220kV, 72.5 and 33 kV Bus Post Insulators, Insulator strings and hardware, clamps & connectors, Equipment terminal connectors (including terminal connectors for Transformer and Reactors), Conductors, Aluminum tubes, Bus bar and earthing materials, Bay marshalling box, spacers, cable supporting angles/channels, Cable trays & covers, Junction box, buried cable trenches etc. as required.

13) Augmentation and Extension of sub-station automation system by providing BCUs along with associated equipments including hardware and software for following bays (bay as defined in Technical Specification, Section - Substation Automation). The make of existing SAS shall be provided during detailed Engineering.

- *400kV : 4 Line Bays, 2 ICT Bays, & 3 Tie Bays*
- *220 kV : 2 ICT Bays*
- *Auxiliary System: 1 Set*

In the present scope, bidder shall include BCUs required for 400 kV bays including all necessary hardware and software to integrate with the existing Substation Automation System including updation of system database, displays, and development of additional displays and reports as per requirement. The extension of the existing SAS system is under the present scope of the contract. Bidders are requested to visit the substation site and make own acquaint with the scope of works as described herein. The contractor shall also supply necessary BCU for monitoring and control of auxiliary supply including operation of Isolator associated with auxiliary transformer.

14) Digital protection Coupler (suitable for interfacing with E1 port of SDH equipment) and associated power & control Cables, Fibre cables and Accessories for both ends of the following lines:-

Khimti – Barhabise - 400 kV D/C T/l (Currently Charged at 220 kV D/C T/L)

Barhabise – Lapsiphedi -400 kV D/C T/l (Currently Charged at 220 kV D/C T/L)

The Bidder shall also design the Digital Protection Coupler that will communicate next end using separate fiber and only 2 cores of fiber shall be provided for multiple of transmission line. The specification of Digital Protection coupler is attached as **Annexure-II**.

In the present scope of contract, the necessary interfacing of the existing communication system for the integration of 400 kV Lines shall be included. The Bidder shall install Giga-Ethernet cards compatible with existing SDH Equipment installed at **Lapsiphedi** Substation.

15) SAS and SCADA Integration

All the online monitoring equipment i.e. Optical Temperature Sensors & Measuring Unit, Online Dissolved Gas (Multi-gas) and Moisture Analyzer, On-line insulating oil drying system (Cartridge type) provided for individual transformer unit including spare (if any), are IEC 61850 compliant (either directly or through a Gateway). Those monitoring equipment's are required to be integrated with SAS through managed Ethernet switch conforming to IEC 61850. This Ethernet switch shall be provided in MB by the contractor. The switch shall be powered by redundant DC supply (220V/48V DC). Ethernet switch shall be suitable for operation at ambient temperature of 50 Deg C. All required power & control cables including optical cable, patch chord (if any) up to MB shall be in the scope of contractor. All cable from RTCC to MB shall also be in the scope of contractor. Further, any special cable between MB to switchyard panel room/control room shall be in the scope of contractor. However, fiber optic cable, power cable, control cables, as applicable, between MB to switchyard panel room/control room and power supply (AC & DC) to MB and integration of above said IEC-61850 compliant equipment with Substation Automation System shall be under the scope of sub-station contractor.

Augmentation and integration work related to SCADA System

The 400/220kV bays under present scope at **Lapsiphedi** substation shall be integrated by the contractor into existing SCADA system of Siemens 'SINAUT Spectrum"(version 4.3.2) installed at Master Station i.e. Nepal Electricity Authority Load Dispatch Centre (located in Siuchatar, Kathmandu). The integration shall include all hardware and software required at the Control Centre as well as necessary data base, display generation and upgrades for proposed control and monitoring of station and Network Analysis. The above activities shall be carried out as appropriate, in all of the 3 stations. The manufacturer of the existing SCADA system is Siemens Germany. The existing communication protocol used for SCADA at LDC Kathmandu is IEC 101. In the present scope of work, the data for SCADA purpose shall be obtained from the Substation Automation System (based on IEC 61850) using Gateway port with communication protocol IEC 104 as per requirement being provided at **Lapsiphedi.** The following List of IO Points to be transmitted to LDC Kathmandu:

l) MW and MVAR for all lines , transformers, reactors and Capacitors
m) Voltage of all buses
n) Frequency of 400kV Bus
o) All Breakers
p) All isolators
q) Tap Position for all transformers
r) Master protection signal for all feeders, transformers Units and Bus Bar
s) Loss of Voltage signal for Bus bar
t) All the points identified above as GPS Time stamped.
u) Temperature value per substation.

v) Any other point decided during detailed engineering.

16) Complete relay and protection system for 400kV bays (Line bays and ICT Bays) and 220 kV ICT bays under present scope as per section – Control and Relay panels. Wiring and other necessary arrangements for integration of existing Bus Bar Protection scheme with 220 kV ICT bays is also under present scope.

17) 400kV Surge Arrestors (AIS type).

18) 220kV,72.5kV,33kV Surge Arrestors (AIS type).

19) Fire protection system (HVW spray & hydrant system) for all buildings, **4X105 MVA, 400/√3/220/√3/33kV ,** 1-Phase Auto Transformer (One bank + One Spare) including extension of main water header (available near existing Fire Fighting Pump House) The HVWS system shall be tapped from the Existing fire water system. The tapping point location & Existing firefighting system piping layout shall be provide to the successful bidders during detail engineering. FFPH & water Tank are not envisaged in the present scope of Contract.

20) Air Conditioning System for control room cum administrative building, panel room and Ventilation system for GIS hall.

21) Insulator strings and hardware, clamps & connectors, terminal connectors (including terminal connectors for Transformer and Reactors), conductor, earth wire and earthing materials, spacers, cable supporting angles/channels, cable trays & covers, Junction box, buried cable trenches etc. as required.

22) 1.1kV grade Power & Control Cable along with complete accessories to complete the scope of works.

23) The earth mat for GIS earthing and the yard earthing required as per specification is in the bidder scope. The earth mat already exist in the 220 kV switchyard area. All the AIS/GIS equipments, Transformer, Reactors shall be earthed and this earth mat shall be connected to the Existing 220 kV earth mat by the contractor. Any additional earthing materials required shall be in the present scope of work. Measurement of earth resistivity is in the scope of Contractor.

24) Lattice and pipe structures (galvanized): 400 kV Double Dead end Transmission Tower Structure, Standard gantry structures (Beams & Columns) and Equipment support structures shall be prepared by the contractor and put up for approval of NEA during detailed engineering.

25) Complete lighting and illumination of switchyard under present scope of work.

26) EOT Crane as per Technical Specification is proposed in the GIS Building for handling and subsequent maintenance of GIS equipment. The bidder is required to keep the weight & size of the packages accordingly. Slings of required capacity for handling of GIS equipment /components shall be provided by the supplier. Embedment/Block outs, if any to be provided shall be considered and provided by the bidder. The bidder shall furnish his views regarding the proposed capacity of the crane.

27) LT switchgear (AC/DC Distribution boards) considering present bays and future bays. Integration of new AC/DC Distribution boards with existing AC/DC Distribution boards (if necessary) is also in present scope of work. The existing AC/DC drawings shall be provided during detail engineering.

28) Batteries & Battery Chargers

29) 1.1 kV grade Power & Control cables along with complete accessories. Auxiliary Power supply and control cables from control room and RTCC panel to common marshalling box of transformer are also in present scope of work.

30) Visual monitoring system required for watch and ward of Substation premises as per **Annexure-IV.**

31) Any other equipment/material required for completing the specified scope.

B) Mandatory Spares –

Design, engineering, manufacture, testing, and supply including transportation, insurance & storage at site as per **Annexure-I**

C. Civil works - The scope of work shall include but shall not be limited to the following–

C.1 Design, Engineering and civil work (as per Contractor supplied drawings) for:

a) Foundation for GIS Hall Building and duct supporting structures inside the GIS hall.

b) Foundation for GIS bus duct supporting structures (outside the GIS hall), *SF6/Air bushings and SF6/Cable bushings*.

c) foundation for *400/220 kV Transformers* along with jacking pads, rail track, Oil soak pit, sump pit, pylon support and fire resistant wall (s) as required.

d) GIS Buildings including control room cum administrative building. The size of 400kV GIS Building shall be suitable to accommodate five numbers bays in

addition to the maintenance bay. The GIS hall shall be suitable for mounting of EOT crane. The GIS and control room building shall be of Pre-Engineered steel structure as per Section "Civil".

e) Fire resistant wall between Transformer/Reactors.

f) Foundation for GIS equipment, GIS (SF6) to Air bushing/Cable bushing & supporting structure.

g) Cable trenches inside GIS hall.

h) Foundations of gantry, equipment support structures and LT Transformers as per BOQ and tender drawings.

i) Cable trenches along with covers, road/rail crossings, sump pits and cable trench crossings with roads or drains etc.

j) All roads including culverts. The roads shall be of RCC type.

k) Antiweed treatment, PCC and Stone spreading in switchyard area under present scope.

l) Drains along with drain crossings with cable trenches. Drain layout shall be developed by the contractor. Fencing for switchyard and switch yard gates. Dismantling/re-erection of existing fence as per requirement is also included.

m) Layout and details of Water supply and Sewage system.

n) Soil investigation, contouring, leveling and filling. *Contouring and site leveling works; The substation area shall be developed in terraces at single or multi levels by cutting and filling. The finished ground level shall be decided during detail engineering based on spot levels and highest flood level if applicable*.

o) Foundation for lighting poles, Bay marshalling box, panels and control cubicles of equipments wherever required shall be as per design and drawings of contractor vendor drawings.

p) Any other item/design/drawing for completion of scope of works.

2.0 The Bidders are advised to visit the substation sites *at New Khimti, Barhabise & Lapsiphedi* and acquaint themselves with the topography, infrastructure and also the design philosophy. Before proceeding with the construction work in the existing substation, 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 substation in all respects. All materials required for the Civil and construction/installation work including cement and steel shall 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.

2.1 The Contractor shall also be responsible for the overall co-ordination with internal/external agencies; Supplier of Employer's supplied equipments, project management, training of Employer's manpower, loading, unloading, handling, moving to final destination for successful erection, testing and commissioning of the substation/switchyard.

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

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

2.2 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, wastages and damages shall be to the account of the contractor.

2.3 Design of substation and its associated electrical & mechanical auxiliaries systems includes preparation of single line diagrams, electrical layouts, Erection key diagrams, direct stroke lightning protection, electrical and physical clearance diagrams, control and protection schematics, wiring and termination schedules, foundation & cable trench layout drawing including associated invert levels, civil designs **(as applicable)** and drawings, firef ighting protection and air conditioning system, lighting/illumination and other relevant drawings & documents required for engineering of all facilities within the fencing to be provided under this contract, are covered under the scope of the Contractor.

2.4 Any other items not specifically mentioned in the specification but which are required for Erection, Testing and Commissioning and satisfactory operations of the substation are deemed to be included in the scope of the specification and the same shall be supplied and erected by the contractor unless specifically excluded elsewhere.

3.0 SPECIFIC EXCLUSIONS

The following items of work are specifically excluded from the scope of the specification:

(a) Employer's site office and stores.

(b) Approach Road up to Substation boundary

(c) Boundary wall along substation

4.0 PHYSICAL AND OTHER PARAMETERS

4.1 Location of the Substation

The substations (New Khimti, Barhabise & Lapsiphedi) of Nepal Electricity Authority are located in the North-Eastern part of Nepal.

4.1 Meteorological data :-

S.No.	Description	New Khimti	Barhabise	Lapsiphedi
i)	Max. ambient air temperature (°C)	45	45	45
ii)	Minimum ambient air temperature (°C)	0	-5.5	0
iii)	Altitude (above M.S.L.) (mtrs)	662	1190	1420
iv)	Relative humidity - Maximum	100	100	100
v)	Relative humidity - Minimum	20	20	20
vi)	Amount of snow fall (mm) 0	0	0	0
vii)	Wind speed	47m/s	47m/s	47m/s
viii)	Siesmic requirement	0.5g (Horizontal peak acceleration value).	0.5g (Horizontal peak acceleration value).	0.5g (Horizontal peak acceleration value).

However, for design purposes, ambient temperature should be considered as 50 degree centigrade and Relative humidity 100% for all three substations. Further altitude (from MSL) to be considered as 1190 Meter for Barhabise substation and less than 1000 Meter for Khimti Substation and 1420meter for Lapsiphedi.

5.0 SCHEDULE OF QUANTITIES

The requirement of various items/equipments and civil works are indicated in Schedules of Rates and Prices.

All equipments/items and civil works for which bill of quantity has been indicated in Schedules of Rates and Prices) 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 not indicated and quantified (i.e. Lump sump or lot items) the bidder is required to estimate the quantity required for entire execution and completion of works and incorporate their price in respective Schedules of Rates and Prices. 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 Schedules of Rates and Prices under contractor assessed quantities. 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 Schedules of rates and prices, as may be required shall be deemed to be included in the module itself.

The detailed bill of quantities of the mandatory spares for which break up is not given in the bid price Schedules are indicated at **Annexure-I** of this part.

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 considered included in the bid price and shall be provided at no extra cost to Owner.

6.0 BASIC REFERENCE DRAWINGS

6.1 The substations under present scope have the following Switching Schemes

Sl. No.	Name of Substation	400kV Switching Scheme	220kV Switching Scheme
1	400/220kV New Khimti S/S	One & half Breaker (GIS)	Double (DM) (GIS)
2	400/220kV Barhabise S/S	One & half Breaker (GIS)	Double (DM) (GIS)

3	400/220kV Lapsiphedi S/S	One & half Breaker (GIS)	Double (DM) (GIS)

6.2 Single line diagram and general arrangements are enclosed with the bid documents for reference, which shall be further engineered by the bidder. The enclosed drawings give the basic scheme, layout of substation, substation buildings, associated services 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 Owner.

7.0 DIFFERENT SECTIONS OF TECHNICAL SPECIFICATION

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

Chapter 1: Project Specific Requirements (PSR)
Chapter 2: General Technical Requirements (GTR)
Chapter 3: Gas Insulated Switchgears (GIS)
Chapter 4: Switchgear SA
Chapter 5: Auto Transformers
Chapter 6: Bus Reactor
Chapter 7: LT Switchgears
Chapter 8: EHV 220 kV XLPE Cable
Chapter 9: Lighting System
Chapter 10: Air Conditioning System
Chapter 11: Fire Protection System
Chapter 12: Power and Control Cable
Chapter 13: Battery & Battery Charger
Chapter 14: Switchyard Erection
Chapter 15: Structure
Chapter 16: Civil Works
Chapter 17: Control Relay and Protection Panels
Chapter 18: Substation Automation
Chapter 19: Fibre Optic Based Communication
Chapter 20: LT Transformers
Chapter 21: Drawings
Chapter 22: Technical Data Sheet (Guaranteed Technical Particulars)

7.2 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 Chapter.

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

8.0 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 purchaser to procure all of these mandatory spares.

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 contract.

9.0 SPECIAL TOOLS AND TACKLES

The bidder shall include in his proposal the deployment of all special tools and tackles required for erection, testing, commissioning and maintenance of equipment. 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

i. Owner shall make 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 Owner shall in no case be responsible for any delay in works because of non-availability of power.

ii. The contractor shall make his own arrangement at his own cost for arranging water required for construction purpose. NEA/Consultant shall in no case be responsible for any delay in works because of non-availability or inadequate availability of water.

11.0 SPECIFIC REQUIREMENT

1) The Bidders are advised to visit Substation site and acquaint themselves with the topography, infrastructure, etc.

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.

3) The lighting fixtures for switchyard lighting shall be mounted on LMs

wherever LMs are provided. Where LMs are not available, the fixture may be mounted on Gantry structures or on lighting poles to be provided by the contractor.

4) Erection, Testing and Commissioning of GIS, Transformers, EHV Cables, Relay & protection panels, sub-station automation system and Communication System shall be done by the contractor under the supervision of respective equipment manufacturers. Such supervision charges shall be included by the bidder in the erection charges for the respective equipment in the BPS.

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

S.N.	Voltage Level	Fault Level
1	400kV	50kA for 1 Sec
2	220kV	40kA for 1 Sec
3	132kV	31.5kA for 1 Sec
4	33kV	25kA , 3 sec
5	11 kV	25kA , 3 sec

6) The Contractor shall impart the necessary training to Owner's Personnel as per following details:-

6.1 Training at Manufacturer's works. The Contractor shall include in the training charges payment of per Diem allowance to NEA trainees @ **USD 150 per day per trainee** for the duration of training abroad towards accommodation, meals and other incidental expenses and 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 as per following:-

1. Control & Protection, Substation Automation System and Communication System: 5 Days (4Nos. Trainees)

2. GIS Equipments and System:5 Days (4Nos Trainees)

3. EHV GIS Substation Design: 5 Days (4Nos. Trainees)

6.2 On Job Training in Nepal: The traveling and living expenses of Owner's personnel for the training programme conducted in Nepal shall be borne by the Owner. The training shall be provided to Employer's personnel in the field of erection, testing, operation and maintenance at substation site as per following:-

1. Control & Protection: 5 Days.

2. Substation Automation System including integration aspect of existing SCADA (of Siemens supplied SINAUT spectrum) at Load Dispatch Centre: 5 days.

3. GIS Operation and Maintenance: 5 days.

4. Operation and Maintenance of Transformer & Reactors: 5 Days

7) All RCC shall be of M-25 grade (Minimum) with mixed design conforming to relevant BS/IS/ international standard. All Reinforcement steel shall be of FE-500(Minimum) grade conforming to BS/IS/ international standard.

8) The Frequency range for the earthquake spectra shall be as per IEC-62271-300.

9) *Under present scope of specification, one set of new 400kV Double Dead End(DDE) transmission tower each for New Khimti & Lapsiphedi substation is required for the termination of existing double circuit incoming line at the substation which shall be designed, supplied & erected(including foundation works) by the contractor. The tower shall be designed using reliability level 2.0. Payment for supply & Erection of 400kV DDE transmission tower shall be made on weight in metric ton basis under respective item of BPS. Regarding payment of tower foundation work, the quantity of excavation, concrete, reinforcement steel etc. shall be measured separately under respective items of BPS and paid accordingly.*

Similarly, Supply & Installation of Insulator String (including Hardware fittings) at new Dead End tower & Takeoff gantry as well as supply & stringing of Conductor required for 400kV Incoming line termination is under the present scope of specification and the price for the same is deemed to be included on "Erection Hardware" item of BPS of respective substation. This price also includes all cost incurred for removing conductors, insulators, hardware (if any) during erection of new DDE tower. The position of the new tower will be finalized during detail engineering.

10) The short description has been used in the bid price schedule. The details of all such short description are given in the respective chapter of this specification. The bidder shall refer these detailed descriptions for clarity.

11) One number each Energy meter for the record and revenue purpose is to be provided for each 400/220 bays (transfer & Bus coupler bays to be excluded) under present scope of contract, meeting the requirement as specified at **Annexure – III.**

12) Non CFC refrigerant shall be utilized for Air conditioning system, offered for GIS Hall is under the scope of contract.

13) The contractor may have option to use post installed anchor bolts of reputed manufacturer for fixing GIS Bus ducts and modules in place of normal pre-installed Anchor bolts without any cost implication to NEA. The type & thickness

of galvanization such post installed anchor bolts shall be as per manufacturer's practice.

14) Suitable oil tank for transformer oil shall be provided by the Contractor at his own cost. Oil tanks can be taken back by the Contractor after commissioning of transformers at new locations.

15) Dimension and color of C&R panels at all the existing switchyards shall match with existing panels.

16) One set 3½C x 300 Sq. mm XLPE power cable for oil filtration units shall be provided for 400/220kV Transformer/400kV Reactor. The cable shall be terminated at 250A receptacle near 400/220kV Transformer/400kV Reactor in the switchyard. XLPE Power cables shall be looped in & out for 250A Power receptacles.

17) The distance protection relays to be supplied for 400kV lines should have feature of load encroachment blinder to safeguard the protection trip during heavy load condition.

18) Separate protection relay (IED) shall be provided for 400kV Class Transformer directional over current and earth fault relay (for both HV & MV side). Inbuilt function in any other protection IED / BCU is not acceptable.

19) In the Sub-station automation system, each gas tight compartments of 400kV GIS shall be monitored individually per phase basis. In case it is not possible to monitor the gas tight compartment individually in one BCU, the contractor shall supply additional BCU for the monitoring without any additional cost implication to NEA.

20) For supply of SF6 Gas, the contractor shall obtain necessary license from the concerned statuary authorities in Nepal. The contractor shall comply with all the legal & statuary requirements as per the local laws for importing, handling & storage of SF6 gas in Nepal. For this purpose NEA shall extend necessary assistance (documentation etc) for obtaining such clearance & licenses, however the complete responsibility for submitting the application and co-ordination with authorities shall be in the scope of contractor.

21) The Empty gas Cylinders may be taken back by the contractors after filling the gas in GIS compartments. However, in view of the future maintenance requirement, the contractor shall provide the Gas storage capacity equivalent to the Gas used in largest Gas tight GIS Module. Further, the spare Gas shall be supplied in Gas storage cylinders.

22) The switchyard panel room as detailed in section Sub-station Automation System is not required for GIS station. The contractor shall place their panels i.e. Bay level units, relay and protection panels, Digital RTCC panels, DPC panels etc for 400kV GIS hall or in a separate room in the 400 kV GIS buildings which shall be decided during detail engineering. The room shall be air-conditioned and the supplier shall submit detailed heat load calculation during detailed engineering.

Further, the temperature of enclosure /room shall be monitored through substation automation system by providing necessary temperature transducers.

23) The Employer intends to carry out Dynamic Short Circuit Test (as Type Test) on all ratings of Power/Auto Transformers i.e. on one unit 53.33 MVA, 1-phase, 400/220kV Autotransformers & one unit 105 MVA, 1-phase, 400/220kV Autotransformers which shall be payable as per provisions of contract.

The price of conducting the test shall be quoted in the relevant schedule of Bid proposal sheet (BPS). The type test charges would be considered for evaluation. In case bidder does not quote any charges, it shall be carried out at no extra cost to Employer. Further, in case bidder indicates that he shall not carry out the test, his offer shall be considered incomplete and shall be liable to be rejected.
The Employer reserves the right to witness the type test. The contractor shall submit schedule at least 30 days in advance for conducting type test on the above items under the contract.

24) The duct connections should be such that it is possible to remove transformer for repair and maintenance conveniently

25) The price of Bus-duct inside the GIS hall shall be integral part of the respective bay module and it will not be paid separately. However, the payment of bus-duct for outside the GIS hall along with support structure shall be paid as per running meters in line with provision of Bid Price schedule. Therefore, bidder is required to quote for 400kV and 220kV GIB (SF6 Gas insulated Bus Duct) of Line/Transformer/Reactor feeder module required outside GIS hall with support structure and SF6/Air bushing for interconnecting with its respective gantry / equipment (Overhead connection) separately as per provision of Bid price schedule.

26) The connection of 220 kV side of 400/220 kV Transformer with respective 220 kV autotransformer bays in all three substations will be made using 220 kV Gas Insulated Bus duct or 220 kV Cable or combination of both which shall be decided as per site condition during detail engineering.

27) Technical parameter for 72.5 kV Equipment's & 33 kV NCT is attached at **Annexure-V**

28) 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.

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 Sections

(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 Section-'Substation Automation System.'

ANNEXURE-I

Mandatory Spares

S.N.	Item Description	Unit	Quantity		
			New Khimti	Barhabise	Lapsiphedi
A	**Spare for 400kV GIS**				
1.0	**General**				
1.1	SF6 gas Pressure Relief Devices, 3 Nos. of each type	Set	2	2	2
1.2	SF6 Pressure gauge with coupling device cum switch or density monitors and pressure switch as applicable (1 no of each type)	Set	1	1	1
1.3	Coupling device for pressure gauge cum switch for connecting Gas handling plant	Set	2	2	2
1.4	Rubber Gaskets, "O" Rings and Seals for SF6 gas of each type	Set	1	1	1
1.5	Molecular filter for SF6 gas with filter bags	Set	20% of total weight	20% of total weight	20% of total weight
1.6	All types of Control Valves for SF6 gas of each type	Set	2	2	2
1.7	SF6 gas	LS	20 % of total gas	20 % of total gas	20 % of total gas
1.8	All types of coupling for SF6 gas (1 no. of each type)	Set	1	1	1
1.9	Pipe length (Copper or Steel as applicable) for SF6 Circuit of each type	Set	1	1	1
1.10	Density Monitors for SF6 Gas	No	1	1	1
1.11	**Covers with all accessories necessary to close a compartment in case of dismantling of any part of the Enclosure to ensure the sealing of this compartment**				
1.11.1	For 3 phase enclosure if applicable	No	2	2	2
1.11.2	For 1 phase enclosure if applicable	No	3	3	3
1.12	Locking device to keep the Dis-connectors (Isolators) and Earthing switches in close or open position in case of removal of the driving Mechanism	Set	1	1	1
1.13	Bus support Insulator of each type for single phase/3 phase enclosure	No	5% of population	5% of population	5% of population

S.N.	Item Description	Unit	Quantity		
			New Khimti	Barhabise	Lapsiphedi
1.14	SF6 to air bushing (400KV) of each type & rating	Set	1	1	1
1.15	Spares for Local control cabinet including MCB, fuses, timers, Aux Relay of each type & rating terminal of each type	Set	1	1	1
2.0	**Circuit Breaker**				
2.0.A	**For 400 kV Circuit Breaker**				
2.1	Complete Circuit Breaker pole of each type & rating complete with interrupter, main circuit, enclosure and Marshalling Box with operating mechanism	Set	3	3	3
2.2	Fixed, moving and arcing contacts including insulating nozzles 3 Nos. of each type	Set	1	1	1
2.3	Rubber gaskets, `O' rings and seals for SF6 gas of each type	Set	1	1	1
2.4	Trip coil assembly with resistor as applicable, 3 Nos. of each type	Set	2	2	2
2.5	Closing coil assembly with resistor as applicable, 3 Nos. of each type	Set	2	2	2
2.6	Molecular filter for SF6 gas with filter bags	LS	10% of quantity	10% of quantity	10% of quantity
2.7	SF6 Pressure gauge cum switch or Density monitors and pressure switch as applicable, 3 nos each type	Set	1	1	1
2.8	Coupling device for pressure gauge cum switch for connecting Gas handling plant, 3 Nos. of each type	Set	1	1	1
2.9	Relays, Power contactors, push buttons, timers & MCBs etc of each type & rating	Set	1	1	1
2.10	Closing assembly/ valve, 3 Nos. of each type 1 No.	Set	2	2	2
2.11	Trip assembly/ valve, 3 Nos. of each type 1 No.	Set	2	2	2
2.12	Aux. switch assembly, 3 Nos. of each type	Set	1	1	1
2.13	Operation Counter, 3 Nos. of each type	Set	1	1	1
2.14	Rupture disc, 3 Nos. of each type	Set	1	1	1
2.15	Windoscope/Observing window, 3 Nos. of each type	Set	1	1	1

S.N.	Item Description	Unit	Quantity		
			New Khimti	Barhabise	Lapsiphedi
2.16	Spring operated closing mechanism, 1 No of each type, if applicable	Set	1	1	1
2.17	**Hydraulic Operating Mechanism, if applicable**				
2.17.1	Hydraulic operating mechanism with drive motor , 3 Nos of each type	Set	1	1	1
2.17.2	Ferrules, joints and couplings, 3 Nos. of each type	Set	1	1	1
2.17.3	Hydraulic filter, 3 Nos. of each type	Set	1	1	1
2.17.4	Hose pipe, 3 Nos. of each type	Set	1	1	1
2.17.5	N2 Accumulator, 3 Nos. of each type	Set	1	1	1
2.17.6	Pressure transducer, 3 Nos. of each type	Set	1	1	1
2.17.7	Valves 3 Nos. of each type	Set	1	1	1
2.17.8	Pipe length (copper & steel) 3 Nos. of each size & type	Set	1	1	1
2.17.9	Pressure switches 3 Nos. of each type	Set	1	1	1
2.17.10	Pressure gauge with coupling device, 3 Nos. of each type	Set	1	1	1
2.17.11	Hydraulic oil -20% of total requirement	Set	1	1	1
2.17.12	Pressure Relief Device, 3 Nos. of each type	Set	2	2	2
3.0	**ISOLATORS**				
3.0.A	**400 kV ISOLATORS**				
3.1	Complete set of 3 nos. of single phase / one no. of 3-phase dis-connector including main circuit, enclosure, driving mechanism	Set	1	1	1
3.2	High speed/Fast acting fault making grounding switch 3 nos of single phase /1 no of 3-phase of each voltage rating including main circuit , enclosure and driving mechanism	Set	1	1	1
3.3	3 no. of single phase / one no of 3-phase Earthing switch including main circuit, enclosure, driving mechanism	Set	1	1	1
3.4	Copper contact fingers for dis-connector male & female contact –for one complete (3 phase) dis-connector of each type and rating	Set	1	1	1
3.5	Copper contact fingers for earthing		1	1	1

S.N.	Item Description	Unit	Quantity		
			New Khimti	Barhabise	Lapsiphedi
	switch male & female contacts- for one complete (3 phase) earthing switch of each type and rating	Set			
3.6	Open / Close contactor assembly, timers, key interlock for one complete (3 phase) dis-connector and (3 phase) earthing switch of each type and rating	Set	1	1	1
3.7	Push button switch.-each type, as applicable	Set	1	1	1
3.8	**Limit switches and Aux. Switches for complete 3 phase equipment**				
3.8.1	For isolator	Set	3	3	3
3.8.2	For earth switch	Set	1	1	1
3.9	**Rotor housing bearing assembly for complete 3 phase equipment**				
3.9.1	For isolator	Set	2	2	2
3.9.2	For earth switch	Set	1	1	1
3.10	**Motor with gear assembly for complete 3 phase equipment**				
3.10.1	For isolator	Set	3	3	3
3.10.2	For earth switch	Set	1	1	1
3.11	Corona shield rings as applicable	Set	1	1	1
3.12	**Hinge pins for complete 3 phase equipment**				
3.12.1	For isolator	Set	3	3	3
3.12.2	For earth switch	Set	1	1	1
3.13	**Bearings for complete 3 phase equipment**				
3.13.1	For isolator	Set	5	5	5
3.13.2	For earth switch	Set	1	1	1
3.14	Interlocking coil with resistors, timers, key interlock for complete 3 phase equipment (each type and rating)	Set	1	1	1
3.15	**Relays, Power contactors, resistors, fuses, push buttons, timers & MCBs (complete for one 3 phase equipment)**				
3.15.1	For isolator	Set	3	3	3
3.15.2	For earth switch	Set	1	1	1
3.16	Aux. switch assembly (complete) with 10 NO & 10 NC or more contacts for both	Set	1	1	1

S.N.	Item Description	Unit	Quantity		
			New Khimti	Barhabise	Lapsiphedi
	isolator & earth switch				
4.0A	**400 KV CURRENT TRANSFORMER**				
4.1	Gas Insulated Complete CT of each type and rating with enclosure.	No	2	2	2
4.2	Secondary bushing of each type	Set	2	2	2
5.0A	**400kV VOLTAGE TRANSFORMER**				
5.1	Gas Insulated Complete PT of each type and rating with enclosure	No	2	2	2
6.0A	**Spares for Other Equipments :**				
1.0	**336 kV Surge Arrester (AIS) with insulating base, terminal connector , Surge counter & accessories**	No	1	1	1
2.0	**216 kV Surge Arrester (AIS) with insulating base, terminal connector , Surge counter & accessories**	No	1	1	1
7.0	**Relay and Protection Panel :**				
7.A	**Breaker Relay Panel**				
1	Breaker failure Relay	No	1	1	1
2	Trip/Close Circuit Supervision Relay	No	2	2	2
3	Self reset trip relay of each type (if applicable)	No	1	1	1
4	Auto Reclose relay with check synchronizing relay and dead line charging relay	No	1	1	1
5	Timer relay of each type (if applicable)	No	1	1	1
6	DC Supervision relays (if applicable)	No	1	1	1
7	Hand reset Trip Relay of each type (if applicable)	No	1	1	1
8	Flag relays of each type (if applicable)	No	1	1	1
9	Auxiliary relays of each type	No	1	1	1
7.B	**Line Protection Panel Equipment spare**				
1	Main-1 Numerical distance relay (excluding external trip relays) with software and cable for front panel communication to PC	Set	1	1	1
2	Main-2 Numerical distance relay (excluding external trip relays) with software and cable for front panel	Set	1	1	1

S.N.	Item Description	Unit	Quantity		
			New Khimti	Barhabise	Lapsiphedi
	communication to PC				
3	Disturbance recorder comprising of evaluation & acquisition units with software (if stand alone)	Set	1	1	1
4	Distance to fault locator including mutual compensation units (if stand alone)	Set	1	1	1
5	Over voltage protection relays with timers (Stage-I & Stage-II) (If stand alone)	Set	1	1	1
7.C	**Transformer Protection Panel**				
1	Transformer overall differential protection relay including all aux. CTs (if applicable) , associated software and cable for front panel communication to PC (in case of numerical relay)	No	1	1	1
2	Restricted Earth Fault protection relay with non linear resistor (if applicable) and associated software in case of numerical relay	No	1	1	1
3	Back up protection relay with 3 O/C and E/F element and associated software in case of numerical relay	Set	1	1	1
4	Over fluxing relay (if stand alone)	Set	1	1	1
5	VT fuse failure relay (if applicable)	Set	1	1	1
6	Over load relay with timer (if applicable)	Set	1	1	1
7.D	**Reactor Protection Panel**				
1	Reactor overall differential protection relay including all aux. CTs (if applicable) , associated software and cable for front panel communication to PC (in case of numerical relay)	No	-	1	-
2	Restricted Earth Fault protection relay with non linear resistor (if applicable) and associated software in case of numerical relay	No	-	1	-
3	Back up protection relay with 3 O/C and E/F element and associated software in case of numerical relay	Set	-	1	-
4	Over fluxing relay (if stand alone)	Set	-	1	-
5	VT fuse failure relay (if applicable)	Set	-	1	-
6	Over load relay with timer (if applicable)	Set	-	1	-
7.E	**Common Spares**				

S.N.	Item Description	Unit	Quantity		
			New Khimti	Barhabise	Lapsiphedi
1	Power supply module for Bus Bar Protection	Set	1	1	1
2	Metrosil (Non Linear resistor) each type if applicable	Set	1	1	1
3	Inter-posing CTs & PTs each type	Set	1	1	1
4	Power Supply module of Event logger	No	1	1	1
5	Processor Card of Event logger	Set	1	1	1
8.0	**Substation Automation system**				
1	Bay control unit with associated software	No	1	1	1
2	Ethernet switch of each type	No	1	1	1
3	Longest optical cable with end terminations	Set	1	1	1
9.0	**Fire Fighting System**				
9.1	**General**				
9.1.1	Quartzoid bulb detector	No	10% of total population	10% of total population	10% of total population
9.1.2	Projectors(Nozzles)	No	10% of total population	10% of total population	10% of total population
9.1.3	Smoke detectors				
9.1.3.1	Photo electric type	No	10% of total population	10% of total population	10% of total population
9.1.3.2	Ionisation type	No	10% of total population	10% of total population	10% of total population
9.1.4	Heat Detectors (for battery room)	No	10% of total population	10% of total population	10% of total population
9.1.5	Electrical Control Panel:Annunciation printed circuits (solid state annunciations) in Control Panel	Set	1	1	1
9.1.6	Strainer	Set	1	1	1
9.1.7	Deluge valve	No	1	1	1
9.1.8	Fire detection bulbs	No	10	10	10
9.1.9	Branch pipe fitted with nozzle & guide coupling	No	2	2	2
9.1.10	Hydrant Valve	No	1	1	1
9.1.11	Pressure switch	No	1	1	1

S.N.	Item Description	Unit	Quantity		
			New Khimti	Barhabise	Lapsiphedi
10.0	**420 kV ,50MVAR Bus Reactor**				
10.1	420 kV, 800 Amps, specified type bushing with metal parts and gaskets	No.	-	1	-
10.2	36 kV, 630 Amps bushing with metal parts and gaskets	No.	-	1	-
10.3	Local and remote WTI complete unit with sensing devices and contacts	Set	-	1	-
10.4	Local and Remote OTI complete unit with contacts and sensing bulbs	Set	-	1	-
10.5	Magnetic Oil Level gauge	No.	-	1	-
10.6	Pressure Relief Device	Nos.	-	2	-
10.7	Buchholz relay complete with float and contacts	No.	-	1	-
10.8	Flexible air cell		-	1	-
10.9	Neutral Current Transformer	Sets	-	2	-
10.10	Breather assembly	Sets	-	2	-
10.11	MCBs/MCCBs of each type used	No.	-	1	-
10.12	Sets of fuses of each type used	Sets	-	3	-
10.13	Oil pumps with motor & starter	Set	-	1	-
10.14	Fan Contactors used in the cooler control circuit of each type used	Nos.	-	2	-
10.15	Relays used in the cooler control circuit of each type used	Nos.	-	2	-
10.16	Indication lamps (one of each type)	Nos.	-	5	-
11.0	**Batteries and Battery Charger**				
11.1	**220V Battery Chargers**				
11.1.1	Set of Control Cards	Set	1	1	1
11.1.2	Set of relays	Set	1	1	1
11.1.3	Rectifier transformer	No.	1	1	1
11.1.4	Thyristor/ Diode	Set	1	1	1
11.1.5	Fuses of Thyristor with indicators	Set	6	6	6
11.2	**48V Battery Chargers**				
11.2.1	Set of Control Cards	Set	1	1	1

S.N.	Item Description	Unit	Quantity		
			New Khimti	Barhabise	Lapsiphedi
11.2.2	Set of relays	Set	1	1	1
11.2.3	Rectifier transformer	No.	1	1	1
11.2.4	Thyristor/ Diode	Set	1	1	1
11.2.5	Fuses of Thyristor with indicators	Set	6	6	6
12.0	**LT Switch Gear**				
12.1	Relays	Set	1	1	1
12.2	CTs and PTs	Set	1	1	1
12.3	Switches/ Push buttons and Meters	Set	1	1	1
12.4.A	TPN Switches / MCB	Set	1	1	1
12.4B	MCCB of each rating	Set	1	1	1
12.5	LT Breaker Spares :				
12.5.1	Spring Charging motor	No	1	1	1
12.5.2	Aux. Contact sets	Set	2	2	2
12.5.3	Bus Bar seal off insulators	No	5	5	5
12.5.4	Arc Chutes	Set	2	2	2
12.5.5	Moving contacts	Set	1	1	1
12.5.6	Arcing contacts (Fixed/Moving)	Set	1	1	1
12.5.7	Springs(Closing/Opening)	No	1	1	1
12.5.8	Closing Coil	No	1	1	1
12.5.9	Tripping Coil	No	1	1	1
12.5.10	Aux. finger contact	Set	1	1	1
12.5.11	Limit Switches	Set	1	1	1
12.5.12	Jaw Contacts	Set	1	1	1
12.5.13	Bus Bar Insulators	No	5	5	5
12.5.14	Interphase Barrier	No	2	2	2
12.5.15	Bus Bar Stip1 mm (Aluminium)	MTR	5	5	5
13.0	**Illuminations**	LS	5% of each type of lighting fixture supplied	5% of each type of lighting fixture supplied	5% of each type of lighting fixture supplied
14.0	**Erection Hardware :**				
14.1	5% spares of the actual quantities for Insulator strings & hardwares, clamps & connectors (including equipment	LS	1	1	1

S.N.	Item Description	Unit	Quantity		
			New Khimti	Barhabise	Lapsiphedi
	connectors), spacers, corona bell (No spares are to be considered for ACSR Moose conductor, 4" IPS Al tube, BMB, grounding conductors, cable tray, Pipes(GI/PVC/hume), angles, channels and Junction Boxes)				
15.0	**400/220 kV Auto Transformers :**				
15.1	HV (420 kV), specified type bushings with with gaskets etc.	No.	1	1	1
15.2	245kV, specified type bushings with gaskets etc.	No.	1	1	1
15.3	LV (52kV) bushings complete with gaskets etc.	No.	1	1	1
15.4	HVN(52kV) neutral bushing complete with gaskets etc.	No.	1	1	1
15.5	Gaskets for all openings on Transformer tank.	Set	1	1	1
15.6	Oil and Winding Temperature Indicators.	Nos.	6	6	6
15.7	Magnetic oil level gauge.	No.	1	1	1
15.8	Pressure Relief Device.	No.	1	1	1
15.9	Oil pumps with motor & starter.	No.	1	1	1
15.10	Oil flow indicator.	Nos.	2	2	2
15.11	Contactors used in the cooler control circuit.	Nos.	6	6	6
15.12	Relays used in the cooler control circuit.	Nos.	6	6	6
15.13	Indication lamps assembly complete used in the Marshalling box/marshalling box.	Nos.	10	10	10
15.14	MCCBs/ MCBs used in Marshalling Box/RTCC/Panels	Nos.	6	6	6
15.15	Buchhloz Relay	Nos.	2	2	2
15.16	Valves of each type used	Nos.	2	2	2
15.17	Air cell	Nos.	1	1	1
15.18	Neutral CTs	Nos.	1	1	1
15.19	Switches/ Push Buttons used in the	No	9	9	9

S.N.	Item Description	Unit	Quantity		
			New Khimti	Barhabise	Lapsiphedi
	panels	s.			
15.20	Heater used in the panels	Nos.	2	2	2
15.21	Thermostat used in the panels	Nos.	2	2	2
15.22	Terminal blocks used in the panels	Nos.	6	6	6
15.23	Relay for OLTC	Nos.	1	1	1
15.24	Drive Motor for OLTC with gear assembly	Nos.	1	1	1
15.25	Fuses used in panels	Nos.	9	9	9
15.26	Breather for Conservator tank	Nos.	3	3	3
15.27	Silicagel	kg	6	6	6
15.28	Oil Sampling bottle of stainless steel having capacity of 1 litre	No.	1	1	1
15.29	Oil Syringe as per TS	Set	1	1	1
15.30	Hand Tools as per TS	Set	1	1	1
15.31	BDV Kit	Set	1	1	1
15.32	Portable DGA Kit	Set	1		

SPECIFICATION FOR DIGITIAL PROTECTION COUPLER

1.0 Digital protection coupler for protection signalling through optical fibre cable system.

1.1 The Digital protection signalling equipment is required to transfer the trip commands from one end of the line to the other end in the shortest possible time with adequate security and dependability. It shall also monitor the healthiness of the link from one end to the other and give alarms in case of any abnormality. The protection signalling equipment shall have a proven operating record in similar application over EHV systems and shall operate on 48V DC (+10%, -10%). It shall provide minimum four commands. These commands shall be suitable for Direct tripping, Intertripping and Blocking protection schemes of EHV lines.

The protection signalling equipment shall be able to communicate to the remote end interfacing with SDH terminal equipment at its 2Mbps port as well as using separate fibres. It shall provide suitable interfaces for protective relays, which operate at 220/110V DC. Power supply points shall be immune to electromagnetic interface.

1.2 Principle of operation

During normal operation, protection signalling equipment shall transmit a guard signal/code. In case Protection signalling equipment is actuated by protective relays for transmission of commands, it shall interrupt the guard signal/code and shall transmit the command code to the remote end. The receiver shall recognize the command code and absence of the guard code and will generate the command to the protective relays.

All signal processing i.e. generation of tripping signal and the evaluation of the signals being received shall be performed completely digital using Digital Signal Processing techniques.

1.3 Loop testing

An automatic loop testing routine shall check the teleprotection channel.

It shall also be possible to initiate a loop test manually at any station by pressing a button on the front of the equipment.

Internal test routine shall continuously monitor the availability of the protection signaling equipment.

Proper tripping signal shall always take the priority over the test procedure.

The high speed digital protection signalling equipment shall be designed and provided with following features.

- Shall work in conjunction with SDH terminal equipment.
- It shall communicate on G 703 (E1,2 Mbps)
- Full Duplex operation
- Auto loop facility shall be provided
- Shall meet IEC 60834-1 standard
- Shall be able to transmit upto 4 commands with trip counter simultaneously or sequentially in one 2Mbps channel

Bidder shall quote for protection signalling equipment suitable for 4 commands with separate trip counters for transmit and receive. With regard to trip counters alternate arrangement .i.e. Laptop along with software & all accessories to download events including carrier receipt and transmit shall be acceptable. Laptop for the above shall be supplied at each substation under substation package.

High security and dependability shall be ensured by the manufacturer. Probability of false tripping and failure to trip shall be minimum. Statistical curves/figures indicating above mentioned measures shall be submitted along with the bid.

The DPC can be either housed in offered Control & Protection Panel / PLCC Panel or in separate panel.

Reports of the following tests as per clause 9.2 of Chapter 2-GTR shall be submitted for approval for protection signalling equipment and relays associated with the protection signalling equipment and interface unit with protective relay units, if any.

i) <u>General equipment interface tests</u> :

a) Insulated voltage withstand tests
b) Damped oscillatory waves disturbance test
c) Fast transient bursts disturbance test
d) Electrostatic discharge disturbance test
e) Radiated electromagnetic field test
f) RF disturbance emission test

ii) <u>Specific power supply tests</u>

a) Power supply variations
b) Interruptions
c) LF disturbance emission
d) Reverse polarity

iii) Tele-protection system performance tests

a) Security
b) Dependability
c) Jitter
d) Recovery time
e) Transmission time
f) Alarm functions
g) Temperature and Humidity tests (As per IEC 68-2)

- Dry heat test (50°C for 8 hours)
- Low temperature test (-5°C for 8 hours)
- Damp heat test (40°C/95%RH for 8 hours)

All the above tests at i, ii & iii (except temperature & humidity tests) shall be as per IEC 60834-1 and the standards mentioned therein.

iv) Relays

a) Impulse voltage withstand test as per IEC 60255.

b) High frequency disturbance test as per IEC 60255.

The protection signalling equipment shall be of modular construction and preferably mounted in the Relay panels. Cabling between the protection signalling equipment & Protection relays and between protection signalling equipment & Communication equipment shall be in the scope of bidder.

The input/output interface to the protection equipment shall be achieved by means of relays and the input/output rack wiring shall be carefully segregated from other shelf/cubicle wiring.

The isolation requirements of the protection interface shall be for 2kV rms.

1.4 Major technical Particulars

The major technical particulars of protection signalling equipment shall be as follows.

i) Power supply 48V DC +10%, -10%

ii) Number of commands 4 (four)

iii) Operating time <7 ms

iv) Back to back operate time without propagation delay ≤ 8 ms

v) Interface to Protection relays

	Input:	Contact Rating:	
	Rated voltage	:	250 volts DC
	Maximum current rating:	5 amps	
Output:	Contact Rating:		
	Rated voltage	:	250 volts DC
	Rated current	:	0.1 A DC
	Other parameters :	As per IEC-255-0-20	

vi) Alarm contact

Rated voltage	:	250 volts DC
Rated current	:	0.1 A DC
Other parameters :	As per IEC-255-0-20	

vii) Digital communication interface: G.703(E1)

Specification for Revenue Meter & Metering (Instrument) Transformer

General

The units shall be suitable for operating in Outdoor environment and shall be manufactured by International Reputed ISO 9001 Company

Energy Meter

The Energy Meter shall have the following minimum requirement

Type	Electronic, 3Phase, 4wire, Wye Connection, Bi-directional
Accuracy Class	0.2
Applicable Standard	IEC 687 (latest edition) or Equivalent
Measurement	a) Polyphase Quantities kWh, kVARh, kVAh
	b) Instantaneous Quantities Real Time, kW, kVA, PF, Volts, Amps, Frequency
Rated Current (In)	5A or 1A
Rated Maximum Current	1.2xIn
Starting Current	0.001xIn
Voltage (Phase)	110V/√3
Frequency	50Hz
Programmable Interval length	At least 1 to 30 min
Load Profile Memory Storage	At Least 60 days of storage using 4 channels at 15min Intervals
Channels of Load Profile Data	At Least 4 channels of storage (kWh import, kWh export, kVARh Import, kVARh export)
Other Features to be Included	a) Serial communication port and Accessories b) Optical Port Communication (With optical Probe) c) Remote Download Modem (in built) d) Hardware Key to Prevent any Calibration and configuration change e) PT or CT error gain correction f) Non Volatile memory g) Inbuilt Super capacitor h) Meter shall be able to record and store in Non-Volatile memory the instant of Power failure and the instant of supply restoration.

Technical Specifications for Visual Monitoring System

Visual monitoring system for watch and ward of Substation premises :

Visual monitoring system (VMS) for effective watch and ward of sub station premises covering the areas of entire switchyard, Control Room cum Administrative building, Fire fighting pump house, and main gate, shall be provided. The contractor shall design, supply, erect, test and commission the complete system including cameras, Digital video recorder system, mounting arrangement for cameras, cables, LAN Switches, UPS and any other items/accessories required to complete the system. To provide all the necessary licenses to run the system successfully shall be in the scope of contractor.

System with Color IP Cameras for VMS surveillance would be located at various locations including indoor areas and outdoor switchyard and as per the direction of Engineer-In-Charge. The VMS data partly/completely shall be recorded (minimum for 15 days) and stored on network video recorder.

The number of cameras and their locations shall be decided in such a way that any location covered in the area can be scanned. The cameras shall be located in such a way to monitor at least:

1. The operation of each and every isolator pole of the complete yard (including future scope).
2. All the Transformer and Reactors (including future scope)
3. All the Entrance doors of Control Room Building and Fire-fighting Pump House and Switchyard Panel room.
4. All the gates of switchyard.
5. Main entrance Gate
6. All other Major Equipments (such as CB, CT, CVT, SA etc. for present and future)

   The cameras can be mounted on structures, buildings or any other suitable mounting arrangement to be provided by the contractor.

1.1 Technical requirements of major equipment of Visual Monitoring System.

1.1.1 The Video Monitoring system shall be an integrated system with IP network centric functional and management architecture aimed at providing high-speed manual/automatic operation for best performance.

1.1.2 The system should facilitate viewing of live and recorded images and controlling of all cameras by the authorized users.

1.1.3 The system shall use video signals from various types of indoor/outdoor CCD colour cameras installed at different locations, process them for viewing on workstations/monitors in the control Room and simultaneously record all the cameras after compression using **H 264/**MPEG 4 or better standard. Mouse/Joystick-Keyboard controllers shall be used for Pan,

Tilt, Zoom, and other functions of desired cameras.

1.1.4 The System shall provide sufficient storage of all the camera recordings for a period of 15 days or more @ 25 FPS, at 4 CIF or better quality using necessary compression techniques for all cameras. It shall be ensured that data once recorded shall not be altered by any means. The recording resolution and frame rate for each camera shall be user programmable.

1.1.5 The surveillance VMS System shall operate on 230 V, 50 Hz single-phase power supply. System shall have back up UPS power supply meeting the power supply need of all the cameras in the stations including those which are installed at gate for a period of 2 hours. The bidder shall submit the sizing calculation for the UPS considering the total load requirement of Video Monitoring System.

1.2 System requirements:

a) System must provide built-in facility of watermarking or Digital certificate to ensure tamperproof recording.

b) All cameras may be connected through a suitable LAN which shall be able to perform in 765kV class sub-station environment without fail.

c) All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.

d) Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.

e) Facility of Camera recording in HD (1280X720p), D1 , 4CIF , CIF, VGA, as well as in any combination i.e. any camera can be recorded in any quality.

f) System to have facility of **100%** additional camera installation beyond the originally planned capacity.

g) In order to optimize the memory, while recording, video shall be compressed using H **264/**MPEG-4 or better standard and streamed over the IP network.

h) System shall be triplex i.e. it should provide facility of Viewing, Recording & Replay simultaneously.

i) The offered system shall have facility to export the desired portion of clipping (from a specific date/time to another specific date/time) on CD or DVD. Viewing of this recording shall be possible on standard PC using standard software like windows media player etc.

j) System shall have provision of WAN connectivity for remote monitoring.

k) The equipment should generally conform to Electro magnetic compatibility requirements for outdoor equipment in EHV switchyards. The major EMC required for Cameras and other equipment shall be as under:

1. Electrical Fast Transient (Level 4) – As per IEC 61000-4-4
2. Damped Oscillatory (1 MHz and 100 KHz) (level 3) – As per IEC 61000-4-12
3. AC Voltage Dips & Interruption/Variation (level 4) – As per IEC 61000-4-12
4. Electrostatic Discharge (Level 4) – As per IEC 61000-4-2
5. Power Frequency Magnetic Field (level 4) – As per IEC 61000-4-8
6. Ripple on DC Power Supply (level 4) – As per IEC 61000-4-17

Type test reports to establish compliance with the above requirement shall be submitted during detailed engineering.

1.2.1 VIDEO SURVEILLANCE APPLICATION SOFTWARE

a) Digital video surveillance control software should be capable to display and manage the entire surveillance system. It should be capable of supporting variety of devices such as cameras, video encoder, Servers, NAS boxes/Raid backup device etc.

b) The software should have inbuilt facility to store configuration of encoders and cameras.

c) The software should Support flexible 1/2/4/8/16/32 Windows Split screen display mode and scroll mode on the PC monitor.

d) The software should be able to control all cameras i.e. PTZ control, Iris control, auto / manual focus, and color balance of camera, Selection of presets, Video tour selection etc.

e) The software should have user access authority configurable on per device or per device group basis. The system shall provide user activity log with user ID, time stamp, action performed, etc.

f) The users should be on a hierarchical basis as assigned by the administrator. The higher priority person can take control of cameras, which are already being controlled by a lower priority user.

g) It should have recording modes viz. continuous, manual, or programmed modes on date, time and camera-wise. All modes should be disabled and enabled using scheduled configuration. It should also be possible to search and replay the recorded images on date, time and camera-wise. It should provide onscreen controls for remote operation of PTZ cameras. It should have the facility for scheduled recording. Different recording speeds (fps) and resolution for each recording mode for each camera should be possible.

h) The software for clients should also be working on a browser based system for remote users. This will allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls.

i) Retrieval: The VMS application should allow retrieval of data instantaneously or any date / time interval chosen through search functionality of the application software. In case data is older than 15 days and available, the retrieval should be possible. The system should also allow for backup of specific data on any drives like DVD's or any other device in a format which can be replayed through a standard PC based software. Log of any such activity should be maintained by the system.

j) VMS shall provide the full functionality reporting tool which can provide reports for user login/logoff, camera accessibility report, server health check reports etc.

1.2.2 Network video recorder

The Network Video recorder shall include at least Server (min 3.0 GHZ, 4GB RAM, 3000GB HDD(min)), RAID 5 ,with suitable configuration along with Colored TFT 22" High resolution monitor, and Internal DVD writer. Windows XP/Vista/7 Prof. or VMS compatible operating system latest version with hardware like graphic cards, licensed Anti-virus etc.

Further the digital video recorder shall conform to the following requirements:

1.	Server Spec	Intel Quad Core (or better) 3.0 Ghz (min.) , 8 MB Cache , 4 GB memory , with suitable NVIDIA graphics card,3 TB HDD , Raid 5
2.	Recording and Display Frame Rate	Real-time 25 frames per second per channel , manual select
3.	Recording Resolution	(PAL): 1280X720 , 704(H) x 586(V) It should be possible to select lower resolutions
4.	Compression Method	H.264/MPEG-4 or better and latest
5.	Video Motion Detection Capable	Standard and built-in (selectable in menu)
6.	Monitoring Options	Split screen 1, 2, 4 , 8, 16, 32 or more cameras
7.	Playback Options	Search, still image capture
8.	Alarm/Event Recording Capable	To be provided with built-in external alarm input/ output ports minimum(8 in, 2 out)
9.	Network Operation Capable	To be provided by using WAN or LAN router
10.	Remote Internet Viewing Capable	Using WAN or LAN router
11.	HDD Storage Consumption	1GB ~ per hour / channel variable based on frame speed and resolution settings, as well as compression
12.	Operation	Triplex operation (simultaneous recording, playback, network operation)
13.	Number of Video Channel	32
14.	Audio Recording Capable	32
15.	Input Voltage	230V AC or equivalent with UPS as a back up for 30 minutes.

1.2.3 VMS Camera

a) The color IP camera for substation shall have PAN, TILT and ZOOM facilities so that it can be focused to the required location from the remote station through a controller. Whereas wireless IP cameras with PTZ controls are required for installation at gates of the NEA premises as per the direction of Engineer-In-Charge

b) The IP Camera at the main gate can be fixed or PTZ based and shall be used for monitoring entry and exit

c) It should have sufficient range for viewing all the poles of isolators and other equipments with high degree of clarity.

d) The VMS camera shall be suitable for wall mounting, ceiling mounting and switchyard structure mounting.

e) It shall be possible to define at 128 selectable preset locations so that the camera gets automatically focused on selection of the location for viewing a predefined location.

f) The camera should be able to detect motion in day & night environments having light intensity of Color: 0.5 Lux; B&W:0.05 Lux

g) Housing of cameras meant for indoor use shall be of IP 42 or better rating whereas outdoor camera housing shall be of IP 66 or better rating. Housing shall be robust and not have the effect of electromagnetic induction in 765/400KV switchyard.

h) All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password

i) Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.

A. Outdoor IP Fixed Megapixel Camera Specifications (For Main Gate)

1.	Image Sensor	2-megapixel Progressive ,1 / 3" CMOS/CCD sensor, Minimum illumination 0.1 Lux
2.	Min Luminous	0.5LUX(Color) 0.05Lux(Black)
3.	Camera Enclosure Type	IP66 Grade
4.	Iris/Focus	Auto/Manual
5.	Video Compression	Dual Stream H.264 and MPEG 4 user selectable
6.	Support Dual-stream	primary/secondary stream, H.264/MPEG 4 optional
7.	Video Definition	Primary stream:1600x1200,1280x960,1280x720, Secondary stream:800x600,400x288,192x144
8.	Video Parameters	Brightness, hue, contrast, saturation and image quality
9.	Video Frame Rate	PAL: 1-25frames/second NTSC:1-30frames/second
10.	Video Compression BR	32Kbit/S - 6Mbit/S
11.	Video Output	One channel composite Streaming
12.	Supported Protocols	TCP, UDP, IP, HTTP, FTP, SMTP, DHCP, DNS,ARP, ICMP, POP3, NTP, IPsec, UpnP, RTP, RTCP
13.	Operating Temperature	-5 ~ +50℃
14.	Operating Humidity	10 ~ 90%

B. Outdoor IP66 PTZ HD Camera Specifications (For Switch Yards)

1.	Image sensor	1/3 type Solid State Progressive Scan CCD,WDR(High Definition)
2.	Security	Multiple user access with password protection
3.	Effective Pixels	**(PAL): Main Stream：1280x720** Sub Stream：640x360、320x280 selectable
4.	Compression	Dual Stream H.264 and MPEG 4 user selectable
5.	Signal System	50 Hz
6.	S/N (signal to noise) Ratio	Better than 50 dB
7.	Electronic Shutter	1/60 ~ 1/10,000 sec. automatic or better
8.	Scanning System	Progressive/interlace
9.	Low Light Sensitivity (lux)	Color: 0.5 Lux; B&W:0.02 Lux

10.	Lens	Minimum 10x (minimum) optical in High Definition (**The system shall be able to zoom the images on the monitor without any distortion to the maximum level of optical zoom)**
11.	Lens Size	Minimum 4.1~73.8 mm
12.	Lens Aperture	F1.6(wide)~F2.8(tele), f=4.1~41.0mm, 10X Zoom, Video Auto Focus Angle of View Horizontal : 52°(wide) , 2.8°(tele)
13.	PTZ Data Transfer Baud/Bit Rates Supported	Selectable 2400 bps / 4800 bps / 9600 bps
14.	Panning Range	Complete 360 degrees (horizontal)
15.	Pan Speed	Adjustable, 0.1 degrees / second ~ 250 degrees / second
16.	Tilting Range	Minimum 180° Tilt Rotation
17.	Tilt Speed	Adjustable, 0.1 degrees / second ~ 150 degrees / second
18.	In Built Storage	Camera should have inbuilt storage TF or SD format for recording and storing Pictures
19.	IP Class	IP66 Standard
20.	Working temperature	-0℃ ~ +50℃
21.	Working Humidity	10 ~ 90%

1.2.4 PTZ-Keyboards

The features of PTZ shall include:

- Fully functional dynamic keyboard/joystick controllers
- Controls all pan, tilt, zoom, iris, preset functions
- Control up to 255 units from a single keyboard
- Many preset options and advanced tour programming
- Compatible with all connected cameras

1.	Key Application	wired keyboard control operation of PTZ functions for weatherproof dome cameras
2.	Pan / Tilt / Zoom Protocol Languages Supported	Selectable
3.	PTZ Data Transfer Baud Rates Supported	selectable 1200 bps / 2400 bps / 4800 bps / 9600 bps
4.	Additional Features	dynamic joystick for smooth camera movements, preset location option for quick access to frequently monitored areas

ANNEXURE– V

Technical parameter for 72.5 kV Equipment's & 33 kV NCT

A. Technical Parameters for 72.5 kV Current Transformers

1	Rated Primary current	50 A
2	Rated extended current	120%
3	Rated short time current	25 kA for 3 sec.
4	Rated dynamic current	63 kAp
5	Maximum temperature rise over design ambient temperature	As per IEC-60044-1
6	One minute power frequency withstand voltage sec. terminal & earth	5 kV (rms)
7	Number of terminals	All terminals of control circuits are to be wired upto marshalling box plus 20% spare terminals evenly distributed on all TBs.
8	Type of insulation	Class A

Current transformers shall also comply with requirements of technical specification & below table.

REQUIREMENTS FOR 72.5 kV CURRENT TRANSFORMER

No. of Cores	Core No.	Application	Current Ratio	Output burden (VA)	Accuracy class & AL as per IEC 44-1
2	1	O/C & E/F	50/1	10	5P10
	2	Metering	50/1	10	0.5

B. TECHNICAL PARAMETERS FOR 72.5 kV VOLTAGE TRANSFORMERS

1.	System Fault level	25kA for 3 second
2.	Standard reference range of frequencies for which the accuracies are valid	96% to 102% for protection and 99.5 to 101% for measurement
3.	One minute power frequency withstand voltage for secondary winding	3kV (rms)
4.	Maximum temperature rise over design ambient	As per IEC:60044-2 or IEC:60044-5

	temperature	
5	Number of terminals in control cabinet	All terminals of control circuits are wired upto marshalling box plus 20% spare terminals evenly distributed on all TBs.

Voltage Transformers shall also comply with requirements of technical specification & below table.

Requirements of 72.5 kV Voltage transformer

S.No.	PARTICULAR		
1.	Rated primary voltage (kV rms)	72.5	
2.	Type	Single phase Electro-magnetic or Capacitive VT	
3.	No. of secondaries	2	
4.	Rated Voltage Factor	1.2 continuous 1.5 – 30 seconds	
5.	Phase angle error	+ 20 minutes (For metering core)	
		Secondary I	Secondary II
6.	Voltage ratio	33/_/3 / 0.11/_/3	33/_/3 / 0.11/_/3
7.	Application	Protection	Metering
8.	Accuracy	**3P**	0.5
9.	Output Burden (VA) (minimum)	10	10

C. Technical Parameters for 72.5 kV Circuit Breaker

1.	Rated continuous current (A) at design ambient temperature of 50oC	1250
2.	Rated short circuit current breaking capacity at rated voltage	25kA with percentage DC component as per IEC 62271-100 corresponding to minimum opening time under operating conditions specified.
3.	Symmetrical interrupting capability kA (rms)	25
4.	Rated short circuit making current kA (peak)	63
5.	Short time current carrying capability for three second kA (rms)	25
6.	Rated line/cable charging interrupting current at 90o leading power factor angle (A rms)	As per IEC

	(The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of U/_/3 and 1.4 as per IEC 62271-100	
7.	Maximum allowable switching over voltage under any switching condition	As per IEC
8.	Total break time as per Clause 3.0 of Technical specification. (ms)	Less than 80
9.	Rated break time as per IEC (ms)	Less than 75
10.	Total closing time (ms)	Not more than 200
11.	Rated operating duty	O-0.3S-CO-3min-CO Cycle
12.	Operating mechanism	Spring
13.	Trip coil and closing coil voltage	220V DC with variation as specified in clause 8.2.5 of Tech. spec.
14.	Auxiliary contacts	Besides requirement of Technical specification, the contractor shall wire up 2 NO + 2 NC contacts for future use of Employer
15.	Noise level at base and upto 50 m distance from base of breaker	140 dB (Max.)
16.	Rated terminal load	As per IEC or as per the value calculated in section - GTR of Tech. Spec., whichever is higher.
17.	Temperature rise over the design ambient temperature	As per IEC 60694
18.	First pole to clear factor	1.5
19.	No. of terminals in common control cabinet	All contacts & control circuits to be wired out upto common control cabinet plus 10 Terminals exclusively for Employer's use.

72.5 kV CB shall also comply with requirements of technical specification.

D. Technical Parameters for 72.5 kV Isolator

1.	Rated voltage	72.5 kV
2.	Rated current	400 A
3.	Standards	IEC 62271-102
4.	Rated short time withstand (in KA)	25KA for 3 sec.
5.	Operating drive	AC Motor operated (isol) Manual operated (E/S)
6.	Type	Double break Isolator without E/S, 3 pole, outdoor, Gang operated
7.	Interlock	Electrical interlock with circuit breaker. Mechanical castle key interlock to be provided between electrical and manual operation.
8.	Construction details	All ferrous parts to be galvanized

		except nuts and bolts which shall be electroplated as per relevant IS
9.	Terminal connector	To suit site conditions and layout requirements.
10	Operating time	12 seconds or less

72.5 kV Isolator shall also comply with requirements of technical specification.

E. Technical Parameters of 33 kV Neutral Current Transformers(NCT)

33 kV Neutral Current Transformer (NCT) shall also comply with the requirements of technical specification & below Table

Description	Current Transformer Parameters (Transformer)
CORE 1	**Ratio** 1000/1
CORE 1	**Minimum knee point voltage or burden and accuracy class** : 600V, TPS
CORE 1	**Maximum CT Secondary Resistance** : 1.5 Ohm
CORE 1	**Application** : Restricted Earth Fault
CORE 1	**Maximum magnetization current (at knee point voltage):** 100 mA

Note: *The CT ratio shall be finalized during detail engineering*

ANNEXURE- VI

LIST OF PREFERED (SHORTLISTED) MAKE

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

(i) M**ain 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) **SF6 Circuit Breakers from:** ABB, AREVA /ALSTOM, Hitachi, Siemens, Toshiba/Mitsubishi, LG, Fuji, GE or equivalent.

(iv) **VCB Switchgear from:** ABB, AREVA/ALSTOM, Hitachi, Siemens, Toshiba/Mitsubishi, LG, Fuji, GE, Schnieder Electric or equivalent.

(v) **On-Load Tap Changer:** The on-load tap-changer (OLTC) to be equipped on the power transformers and associated control equipment shall be from MR Germany or ABB Sweden

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

(vi) **Gas Insulated Substation:** ABB, AREVA/ALSTOM, SIEMENS, Toshiba / Mitsubishi, GE, HYOSUNG, Hyundai, Hitachi or equivalent.

(vii) **Communication System:** NOKIA, NOKIA SIEMENS, SIEMENS, ABB, AREVA/ALSTOM 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.

TECHNICAL SPECIFICATIONS

TOWER, FOUNDATION, ERECTION, STRINGING

1.0 General

The scope of works comprises of design, manufacture, shop test, supply, erection, field testing and commissioning of self-standing, galvanized latticed double dead end type steel towers with suitable body/leg extension designed to carry the line conductors with necessary insulators, earth wires and all fittings under all loading conditions., two for each of the New Khimti and Lapsiphedi substation. The tower shall be designed using reliability level 2.0. The Contractor shall investigate the site and propose a suitable tower type and location.

In order to minimize the power interruption during the dismantling, re-erection and interconnecting works, the Contractor is required to develop the construction methodology, shut-down sequences and schedules etc., and obtain prior approval from NEA. The Contractor is also required to study the transmission system of Nepal and familiarize himself thoroughly the operation system of NEA before executing the mentioned work. The project office shall assist the Contractor obtaining the necessary information and permission

1.1 General Description of the Tower

1.1.1 The towers shall be self-supporting, hot dip galvanised, latticed steel type & designed to carry the line conductors with necessary insulators, earth wires and all fittings under all loading conditions.

1.2 Classification of Towers

1.2.1 The towers for 400 kV Lines are classified as given below:

Type of Tower	Deviation Limit	Typical Use
DA	0-2 deg	a) To be used as tangent/suspension tower with suspension insulator strings
DB	2 to 15 degrees	a) Angle towers with tension insulator string. b) Also to be used for uplift force resulting from an uplift span up to 600m under broken wire conditions c) Also to be used for Anti Cascading Condition.

DB	0 degree	To be used as Section Tower.
DC	15 to 30 degrees	a) Angle tower with tension insulator string. b) Also to be used for uplift forces resulting from an uplift span up to 720m under broken wire condition. c) Also to be used for anti-cascading condition.
DC	0 deg.	To be used as Section tower.
DD	30 - 60 deg.	a) Angle tower with tension insulator string. b) Also to be used for uplift forces resulting from an uplift span up to 900m under broken wire condition. c) Dead end with 0 deg to 15 deg deviation both on line side and sub-station side (slack span)
DDE	0 deg.	a) Complete dead end. b) For river crossing anchoring with longer wind span & 0 deg. deviation on crossing span side and 0 deg to 30 deg. deviation on other side.

1.2.2 Extensions

1.2.2.1 The Double Circuit towers shall be designed so as to be suitable for adding –3M, -1.5M, 1.5M, 3M, 4.5M, 6M, 7.5M and 9M body extensions / leg extensions *where necessary* for maintaining adequate ground clearances without reducing the factor of safety (actual stress /allowable stress)

1.3 Spans

1.3.1 Design Span or Normal Span

The Design Span or Normal Ruling Span of the line is **400m** for 400KV transmission line.

.1.3.2 Wind Span

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

1.3.3 Weight span

The weight span is the horizontal distance between the lowest point of the conductors on the two spans adjacent to the tower. For spotting of structures, the span limits are given in Table 1.3.1 below

TABLE 1.3.1 (400 kV)

TOWER TYPE	NORMAL CONDITION		BROKENWIRE CONDITION	
	MAX (m)	MIN (m)	MAX (m)	MIN (m)
DA	600	200	360	100
DB	1000	(-)1000	600	(-) 600
DC	1200	(-)1200	720	(-) 720
DD/DDS	1600	(-)1500	960	(-) 900

1.3.4 In case at certain locations where actual spotting spans exceed the design spans and cross-arms and certain members of towers are required to be modified/ reinforced, in that case design, structural & shop drawings for the modified/ reinforced towers will be prepared by the Contractor as per requirement on basis of approved line diagram without any additional financial implications to the Employer for the design and drawings.

1.4 Electrical Clearances

1.4.1 Ground Clearance (400kV)

The minimum ground clearance from the bottom conductor shall not be less than 9500 mm for 400kV lines at the maximum sag conditions i.e at 80°C and still air.

a) An allowance of 150mm shall be provided to account for errors in stringing.

b) Conductor creep shall be compensated by over tensioning the conductor at a temperature of 26°C, lower than the stringing temperature for ACSR “MOOSE” for 400kV transmission lines.

1.4.2 Power Line Crossing

Minimum clearance between power lines to power line crossing should be 5490 mm for 400kV.

1.4.4 Live Metal Clearance

The minimum live metal clearance to be provided between the live parts and steel work of superstructure shall be as given in Table 1.2

TABLE 1.2

(400kV)

DESCRIPTION	SWING ANGLE	LIVE METAL CLEARENCE
Suspension String (Single / Double)	NIL	3620 mm
	15 Degree	3620 mm
	25 Degree	3620 mm
	40 Degree	2210 mm
Tension String (Single / Double)	--	3620 mm
Jumper	NIL	3620 mm
	25 Degree	3620 mm
	40 Degree	2210 mm

NOTE: in case of pilot insulator strings, the angle of swing of the jumper alongwith the pilot string shall be considered as 15 deg.

1.4.5 Bidder shall adopt same cross arm design where jumper is projecting outside of cross-arm for DD type tower, used as dead end and angle tower.

1.4.6 The design of the tower shall be such that it should satisfy all the above conditions when clearances are measured from any live point of the strings. As the Contractor may use & supply insulator strings with disc insulators or long rod insulators or polymer insulators, the tower design shall be such that it satisfies the clearance requirements in that particular case.

1.4.7 Cross arm projections for Dead end towers shall be fixed in such a way that it can accommodate a condition of 0º to 90º deviation of conductors towards tower at both Left and Right side cross arms on slack span side(Substation Gantry side) and 0-15 degrees deviation on line side. I*f necessary, Auxiliary Crossarm shall also be provided to get required deviation angle.*

1.4.8 Angle of Shielding

The angle of shielding is defined as the angle formed by the line joining the centre lines of the earthwire and outer power conductor in still air at tower supports, to the vertical line through the centre line of the earthwire. Bidders shall design the tower in such a way that the angle of shielding does not exceed 20 deg for all towers for 400kV & 30 deg for all towers for 132 kV. The drop of

the earthwire clamp equal to 150 mm should be considered while calculating the minimum angle of protection.

1.4.9 Mid Span Clearance

The minimum vertical mid span clearance between the earthwire and the nearest power conductor shall not be less than 9.0 metres (for 400kV) & 6.33 meters(for 132kV)), which shall mean the vertical clearance between earthwire and the nearest conductor under all temperatures and still air condition in the normal ruling span. Further, the tensions of the earthwire and power conductor, shall be so co-ordinated that the sag of earthwire shall be at least 10% less than that of power conductors under all temperature loading conditions.

1.5 Normal Loading Conditions

1.5.1 Loads at Conductor and Earthwire Points

-The Contractor shall develop the tower designs based on relevant design standards.The contractor has to apply wind loads as per the relevant design standards in addition to the point loads on the towers.

1.5.2 Wind Loads on Tower Body

The wind load on tower body shall be calculated by the Contractor as per clause 9.1 of IS 802(Part 1/Sec 1):1995. The following data shall be considered for calculating wind load on tower body.

a) Dynamic reference wind pressure shall be considered as 89.6 kg/m^2 for all 400 kV towers and multi-circuit towers of 132 kV whereas it shall be taken as 71.5 kg/m^2 for 132 kV DA and DD towers.

b) Reliability Level and Terrain category shall be considered as 2 for 400 kV and multi-circuit towers of 132 kV & Reliability Level 1 and Terrain category 2 shall be considered for 132 kV

c) The angle of incidence of Wind θ (Theta) = 0 Degree.

1.5.3 Maximum Tension

1.5.3.1 Max. tension for non-snow zone (DA/DB/DC/DD towers) shall be based on either

a) at 0 deg C with 36 percent full wind pressure, or

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

1.5.3.2 The initial conductor and earthwire tension (maximum) at 32ºC and without wind shall be 22% of the ultimate tensile strength of the conductor and 20% of the ultimate tensile strength of the earthwire.

1.5.4 Limiting Tensions of Conductor & Earthwire

The ultimate tension of conductor and earthwire shall not exceed 70 per cent of the ultimate tensile strengths.

1.5.5 Broken Wire Condition

1.5.5.1 Tower Type DB and DC

For 400 KV

Breakage of any two phases (all four sub-conductors) on the same side and on the same span or breakage of any one phase (all four sub-conductors) and one earthwire on the same side and same span whichever combination is stringent for a particular member.

For 132 kV

Breakage of any two phases on the same side and on the same span or breakage of any one phase and one earthwire on the same side and same span whichever combination is stringent for a particular member.

1.5.5.2 Tower Type DD/DDS

Breakage of all the three phases (all four sub-conductors) on the same side and on the same span or breakage of two phases (all four sub-conductors) and one earthwire on the same side and on the same span, whichever combination is more stringent for a particular member.

1.5.5.3 Tower Type DA or QA

Breakage of any one phase (all four sub-conductors for 400 kV)) or one earthwire whichever is stringent for a particular member. 75% wind loading on tower shall be taken in broken wire condition for DA/QA type tower.

1.6 Design of Towers

1.6.1 Design Criteria

Towers shall be designed based on spans and clearances as per Clause 1.3 & 1.4 and loading conditions as per Clause 1.5 above.

1.6.2 Design Temperatures

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

i) Minimum Temperature : -5 deg.C

ii) Every day temperature of conductor : 32 deg.C

iii) Max. temperature of

a) Conductor : 80 deg.C

b) Earthwire exposed to sun : 53 deg.C

1.6.3 Conductor and Earthwire Configuration

For double circuit towers the three phases shall be in vertical formation. The phase to phase spacing for conductors shall be not less than 8.0 meters (400 KV) and 4.05 meters (132 KV) vertically. However, the minimum horizontal separation between phase conductors of two circuits shall be 9.0 meters (400 KV) and 6.33 meters for 132 KV.

1.6.4 Redundant Design

1.6.4.1 All redundant in the tower are to be triangulated.

1.6.4.2 All bracing and redundant members of the towers which are horizontal or inclined up to 15º from horizontal shall be designed to withstand an ultimate vertical load of 1500 N considered acting at centre independent of all other loads. The bending moment for designing of redundant members shall be considered as WL/4 irrespective of end connections and continuity. The contractor has to furnish the calculations for the same (where W is ultimate load of 1.5 kN and 'L' is the length of redundant from bolt to bolt).

1.6.4.3 All redundant shall be designed individually for 2.5% of maximum axial load of connecting members (i.e. leg members, bracing members etc.). The contractor has to furnish the calculations for the same.

1.6.4.4 Connection of single Redundant to leg member having a section of 110 x 110 x 10 and above shall be done with minimum of 2 bolts.

1.6.5 THICKNESS OF MEMBERS

The minimum thickness of angle sections used in the design of towers, unless otherwise specified elsewhere in this Specification**,** shall be kept not less than the following values:

a) Main corner leg members including the earthwire peak and main cross arm : 5 mm

b) For all other members : 4 mm

1.6.6 **BOLTS AND NUTS**

1.6.6.1 The minimum bolt spacing and rolled edge distance and sheared edge distance from the centers of bolt holes to be maintained are given in Table 1.3

TABLE 1.3

Diameter of Bolt (mm)	Hole Diameter (mm)	Min. Bolt Spacing (mm)	Min. Rolled Distance (mm)	Min. Sheared Edge Distance (mm)
16	17.5	40	20	23
24	25.5	60	33	38

Bolts sizes mentioned above shall only be used. The minimum width of the flanges without bolt holes shall be 30 mm

1.6.6.2 For the purpose of calculating shearing stress and bearing stress for bolts clause 5.4 of IS: 802 (Part-1/Sec 2):1992 shall be referred.

1.6.7 SLENDERNESS RATIO

1.6.7.1 Slenderness ratio for members shall be computed in accordance with clause 6.4 of IS: 802 (Part-1/Sec 2):1992. Slenderness ratio for compression and tension members shall not exceed the values specified therein**.**

1.6.7.2 The following maximum limit of the slenderness ratio i.e. the ratio of unsupported length of the section in any plane to the appropriate radius of gyration will be adopted:

		VALUE OF KL/R
a)	For main corner leg members including the corner members of earthwire peak and the lower corner members of the cross-arms	120
b)	For other members having calculated stresses	200
c)	For redundant members	250
d)	For members having tensile stress only	375

1.6.8 ERECTION STRESS

Where erection stress combined with other permissible co-existent stresses could produce a working stress in any members appreciably above the specified

working stress, such other provision are to be made as may be necessary to bring the working stress within the specified limit**.**

1.6.9 STRUCTURAL ARRANGEMENT OF MEMBERS IN A TOWER

1.6.9. Lifting Points shall be provided in the tension tower and shall be designed for a load of 1020 kg assumed as acting at a 600 mm distance from the tip of the cross arm.

1.6.9.2 Internal angle between two members shall not be less than 15 degrees.

1.6.10 Design Calculation and Drawings

1.6.10.1 The following design calculation and drawings are required to be furnished to the Employer:

A) After award of contract:

The Contractor shall submit detailed design of tower & extension alongwith stress diagram / computer output together with sample calculations for few critical members etc., stub templates and loading / rigging arrangement of tower testing to enable the Employer to make a preliminary check regarding structural stability of tower (before) tests.

1.6.10.2 After subsequent approval of design, drawings and bill of materials, the Contractor shall furnish the following in ten (10) copies to the Employer for necessary distribution with in fifteen(15) days after approval of drawings:

a) Detailed design calculation and drawing for towers and foundations.

b) Detailed structural drawings indicating section size, length of members, sizes of plates along with hole to hole distance & joint details etc.

c) Bill of materials, indicating cutting and bending details against each member.

d) Shop drawings showing all details relevant to fabrication.

e) All the drawings for the tower accessories.

1.6.10.3 The Contractor is required to submit four copies of the drawings as mentioned in clause 1.6.10.2 for Employer's approval. While submitting the designs, structural drawings bill of materials and any other drawing pertaining to the subject transmission line, the Contractor shall clearly indicate on each drawing NEA Specification No., Name of the transmission line and project , letter reference No. and date on which the submission are made. The same practice is also to be followed while submitting distribution copies.

1.6.10.4 The design and drawings as covered in clause 1.6.10.1 (~~B~~A) above shall be approved / commented by the Employer as the case may be within twenty

eight (28) days of receipt of design / drawings in NEA office. If the design / drawings are commented by the Employer, the Contractor shall submit revised designs / drawings with in fifteen (15) days of date of issue of comments.

1.6.10.5 The Contractor is required to furnish the progress of submissions and approvals of designs and drawings on twenty fifth day of every month till the completion of all the design activities.

The details shall include description of design / drawing, schedule date of submission, actual date of submission schedule date of approval ,actual date of approval, schedule date of submission of distribution copies, actual date of submission of distribution copies, schedule date of tower test, actual date of tower test and 'Remarks' column. Provision of six additional columns shall also be made in the above progress report to indicate date of comments issued by the Employer and details of submission of revised designs / drawings.

1.6.10.6 The tower accessories drawings like name plate, danger plate, phase plate, circuit plate, anticlimbing device, step bolt, D-shackle etc. shall also be prepared by the Contractor and shall be submitted to the Employer, in three copies, along with one reproducible, for record. These drawings shall be prepared in A4 size only.

1.6.10.7 All the drawings shall have a proper name plate clearly displaying the name of Employer on right hand bottom corner. The approval for exact format of the nameplate shall be obtained by the successful bidder from the Employer for adopting the same on all the drawings. Also all the drawings shall carry the following statement and shall be displayed conspicuously on the drawing:

WARNING: THIS IS PROPRIETORY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH NEPAL ELECTRICITY AUTHORITY (NEA). UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM NEA IN WRITING.

1.7 Materials

1.7.1 Tower Steel Sections

1.7.1.1 IS Steel Sections of tested quality of conformity with IS:2062:2011 grade E250 (Designated Yield Strength. 250 MPa) and/ or grade E350 (Designated Yield Strength 350 MPa) are to be used in towers, extensions, stubs and stub setting templates. For Snow Zone towers MS & HT Steel Sections shall conform to E250 Grade-C & E350 Grade-C respectively. The Contractor can use other equivalent grade of structural steel angle sections and plates conforming to latest International Standards viz BSEN 10025. However, use of steel grade having designated yield strength more than that of EN 10025 grade S355 JR/JO

(designated yield strength 355 MPa) is not permitted, unless otherwise indicated in this specification.

1.7.1.2 Steel plates below 6mm size exclusively used for packing plates/packing washers produced as per IS : 1079 (Grade-0) are also acceptable. However, if below 6mm size plate are used as load bearing plates viz gusset plates , joint splices etc. the same shall conform to IS : 2062 or equivalent standard meeting mechanical strength/metallurgical properties corresponding to grade E250 or above grade (designated yield strength not more than 355MPa), depending upon the type of grade incorporated into design. Flats of equivalent grade meeting mechanical strength/ metallurgical properties may also be used in place of plates for packing plates/ packing washers. The chequered plates shall conform to IS : 3502. SAILMA 350HI grade plate can also be accepted in place of HT plates (EN 10025 grade S355 JR/JO / IS 2062:2011 – grade E350, as applicable) provided SAILMA 350HI grade plate meet all the mechanical properties of plate as per EN 10025 grade S355 JR/JO (designated yield strength 355 MPa) / IS 2062: 2011 – grade E350.

1.7.1.3 For designing of towers, preferably rationalised steel sections shall be used. During execution of the project, if any particular section is not available, the same shall be substituted by higher section at no extra cost to Employer and the same shall be borne by the Contractor. However, design approval for such substitution shall be obtained from the Employer before any substitution.

1.7.2 Fasteners: Bolts, Nuts and Washers

1.7.2.1 All tower members shall be joined together with Bolts and nuts. All hexagonal bolts and nuts shall conform to IS-12427. They shall have hexagonal head and nuts, the heads being forged out of the solid, truly concentric, and square with the shank, which must be perfectly straight.

All bolts and nuts shall be galvanised as per IS:1367 (Part-13) / IS:2629 .

1.7.2.2 The bolt shall be of 16 / 24 mm diameter and of property class 5.6 as specified in IS:1367 (Part-III) and matching nut of property class 5.0 as specified in IS:1367 (Part-VI).

1.7.2.3 Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolts for 5.6 grade should be 310 MPa minimum as per IS:12427. Bolts should be provided with washer face in accordance with IS: 1363 (Part-I) to ensure proper bearing.

1.7.2.4 Nuts for hexagonal bolts should be double chamfered as per the requirement of IS: 1363 Part-III. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4mm oversize on effective diameter for size up to M16.

1.7.2.5 Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the place of contact of the members.

1.7.2.6 All bolts shall be threaded to take the full depth of the nuts and threaded for enough to permit firm gripping of the members, but not further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3mm and not more than 8mm when fully tightened. All nuts shall fit tight to the point where the shank of the bolt connects to the head.

1.7.2.7 Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be steel electro-galvanised, positive lock type and 3.5mm in thickness for 16mm diameter bolt and 4.5 mm for 24 mm bolt.

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

1.7.2.9 The bolt positions in assembled towers shall be as per IS: 5613 (Part-II / Section 2) -1976.

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

1.7.2.11 To ensure effective in-process Quality control it is desirable that the manufacturer should have in house testing facility for all tests like weight of zinc coating, shear strength and other tests etc. The manufacturer should also have proper Quality Assurance System which should be in line with the requirement of this specification and IS: 14000 series Quality System Standard.

1.8 Tower Accessories

Arrangement shall be provided for fixing of all tower accessories to the tower at a height between 2.5 meters and 3.5 meters above the ground level.

1.8.1 Step Bolts & Ladders

Each tower shall be provided with step bolts conforming to IS: 10238 of not less than 16mm diameter and 175 mm long spaced not more than 450mm apart and extending from 2.5 meters above the ground level to the top of the tower. However, the head diameter shall be 50mm as indicated in the enclosed drawing. For double circuit tower the step bolt shall be fixed on two diagonally opposite legs up to top of the towers. Each step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN. For special towers, where the height of the super structure exceeds 50 meters, ladders along with

protection rings as per the Employer's approved design shall be provided in continuation of the step bolts on one face of the tower from 30 meters above ground level to the top of the special structure. From 2.5m to 30m height of super structure step bolts shall be provided. Suitable platform using 6mm thick perforated chequered plates along with suitable railing for access from step bolts to the ladder and from the ladder to each cross-arm tip and the ground wire support shall also to be provided. The platform shall be fixed on tower by using counter-sunk bolts.

1.8.2 Insulator String Attachments

Strain plates of suitable dimensions under each cross-arm tip, shall be provided for taking the hooks or D-shackles of the tension insulator strings. Full details of the attachments shall be provided by the contractor. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate etc. before connecting the insulator string the same shall be supplied by the Contractor.

1.8.3 Earth wire Clamp Attachments

Earth wire peaks of tension towers shall be provided with suitable plates to accommodate the shackle of tension clamps. The contractor shall also supply the U-bolts wherever required and take Employer's approval for details of the attachments before the mass fabrication.

1.8.4 Anti Climbing Device

Barbed wire type anti climbing device, as per enclosed drawing shall be provided and installed by the Contractor for all towers. The barbed wire shall conform to IS-278 (size designation A1). The barbed wires shall be given chromating dip as per procedure laid down in IS: 1340.

1.8.5 Danger, Number, Circuit and Phase plate

Danger plates, Number plates, Circuit plates and Phase plates shall be provided and installed by the Contractor.

a) Each tower shall be fitted with a danger plate, number plate and one set of phase plates for double circuit tower. Circuit plates shall be provided on all The Double Circuit towers.

b) The letters, figures and the conventional skull and bones of danger plates shall conform to IS-2551 and shall be in a signal red on the front of the plate.

c) The corners of the danger, number and circuit plates shall be rounded off to remove sharp edges.

d) The letters of number and circuit plates shall be red enameled with white enameled background.

1.8.6 Aviation Requirements

1.8.6.1 Aviation requirements viz Span marker, night marker (obstruction light) and painting of towers conforming to IS: 5613 shall be in the scope of Contractor, wherever indicated in BPS.

1.8.6.2 Night Markers (Obstruction lights)

1.8.6.2.1 The scope of night markers covers the design, manufacture, testing at manufacturers works, if any, supply, delivery, erection, testing and commissioning of medium intensity, low intensity, lights along with storage battery & solar panel, control panel, cables, clamps other accessories etc. as per the provision of IS-5613 (Part-II/ section-I), 1989, amendment no. 1, July'94 regarding night & day visual aids for denoting transmission line structures as per the requirement of directorate of flight safety.

1.8.6.2.2 The detail of each component of medium intensity, low intensity lights & associated accessories to be provided on the towers shall be as per the technical specifications given in the preceding clauses and IS/ICAO, International Standards recommended practices.

1.8.6.2.3 One set of Aviation Lights shall consist of one medium intensity light & two/four (as applicable) low intensity lights along with all accessories such as solar panel, control panel, batteries, cables etc.

1.8.6.2.4 **Medium Intensity Light**

Medium Intensity light shall be provided on the top of each tower. The medium light should have night time intensity as per ICAO requirements in international Standards Recommended Practices. The light on top of the structure should flash at the rate of 20 sequences per minute. The effective intensity during night time for the medium flashing light shall be 1600 CD. The light shall conform to ICAO requirements/BS 3224a and shall have weather protection conforming to IP-55.

The above lights conforming to ICAO specifications flashing red lights shall be DC operated through a suitably sized battery bank at the operating voltage 12V/24V DC. The burning life of the lamps shall be maximum possible in view of the maintenance hazard of H.T. live but in no case it should be less than 15,000 burning hours. In case of failure of the lamp before 15,000 burning hours, the same shall have to be replaced by the Contractor free of cost even if the pendency of contract expires. The light shall be equipped with radio suppression facility conforming to BS800 in order to avoid any interference with signals of PLCC etc.

1.8.6.2.5 **Low Intensity Lights**

Two/four (as applicable) nos. of low intensity lights are required to be put on each of the towers. Placement drawing for the same shall be submitted by the bidder Contractor.

The light shall be stationary lamp with minimum effective intensity of 10 CD. of red light. The lamps shall conform to the ICAO requirement/relevant BS and shall have weather protection of minimum IP-55 class.

Two/four nos. of L.I. lamp required for each tower shall be operated through a suitable size common battery bank solar panel as per the requirement of operating voltage and load current of the type of lamps being offered.

The burning life of the lamps shall be maximum possible in view of the maintenance hazard of H.T live line, but in no case it should be less than 15,000 burning hours. In case of failure of the lamp before 15,000 hrs, the same shall have to be replaced by the Contractor free of cost even if the pendency of contract expires. Performance certificate of the lamps to be offered shall be furnished by the Contractor.

The low intensity lamp shall not generate any R.F. which can interfere with the PLCC signals.

1.8.6.2.6 **Storage Battery**

Storage Battery required for the above purpose shall be sealed maintenance free, valve regulate lead acid and suitable for mounting on the top of the transmission line towers. Contractors shall offer the most optimum capacity of the Battery Bank at 120 hour discharge rate (considering 80 % percentage usage) matching with the load requirement of the type of lamps being offered including any power loss in the associated cables. The battery sizing shall conform to JISC 8707/relevant Indian Standard or any other internationally recognized standard. The battery shall be hermetically sealed explosion proof and self-resealing type and free from orientation constraints. The working temperature ranges shall be minimum 0 degree centigrade and maximum 50 degree centigrade. Performance certificate of the offered batteries shall be submitted by the Contractor.

1.8.6.2.7 **Battery Box**

The battery box suitable for mounting on 400kV power transmission tower shall be robust construction suitable to accommodate desired number of SOLAR BATTERIES WITH proper clearance between the batteries. The sides and the top of the battery box shall be made from MS sheets not less than 14 SWG thickness duly mounted on MS angle frame. The bottom of the battery box shall have suitably designed MS structure to freely hold the total weight of the batteries. The batteries should be placed on insulated base with proper drainage holes. Lifting lugs shall be provided. Dust and vermin proof lockable doors shall

be provided for safety and easy access to the batteries for the maintenance. The battery box should incorporate the design for proper ventilation system in order to prevent a gas concentration inside the box. The ventilation opening shall be protected against rain/splash water and dust. The inside of the battery box shall be lined with insulating polyurethane plating and the exterior painted with weather proof polyurethane paint. The cable entry into the battery box shall be through suitable cable glands.

1.8.6.2.8 **Solar Modules**

Solar module required for the system shall be suitable for mounting on the transmission line towers and shall be designed for high performance, maximum reliability and minimum maintenance and shall be installed below bottom cross arms levels. The solar modules shall be IP 55 grade protection class. These should be highly resistant to water, abrasion, nail, impact and other environmental factors.

These should be placed on the tower at a most optimum angle so as to harness the maximum solar energy and facilitate self cleaning and shall conform to relevant Indian/International Standards.

Module mounting frames shall be weather proof suitable for mounting on tall towers. Details of mounting frames shall be furnished by the Contractor.

Junction box shall be provided with weather proof hinged lid with provision for cable glands entry and protections grade of class IP-55.

The Contractor shall submit the basis of selecting the numbers of solar modules.

The provision for design, supply & erection of mounting arrangements for photovoltaic modules on the transmission towers in a suitable manner to harness maximum solar energy shall be in the scope of the Contractor.

Provision for design, supply & erection of resting platform for the erection of battery bank in a closed enclosure with safety arrangement on the transmission towers shall also be in the scope of the Contractor the design and load consideration for safety of towers due to additional plate form shall be kept in view while designing, selecting the above.

1.8.6.2.9 **Control Panels**

Control panels shall consist of solar charge controller, flasher unit, sensor, isolator, MCB, Voltmeter, Ammeter and other control gears. Panel enclosure shall be fabricated out of 14 SWG CRCA sheet and thoroughly treated and painted. Suitable neoprene rubber gasket and pad locking device shall be provided and the protection class shall be of IP-55 class.

The Solar charge controller shall be most efficient and preferably fully solid state. It shall be provided with protection to load against increase in temperature, Surge, automatic low voltage and automatic disconnection and reconnection during high inrush current and normalcy respectively.

The flash regulator shall be provided for regulating light flashing. The same shall be completely solid state and provided with flash rate set points. The protection against overload current shall also be provided.

Necessary sensor/timer shall be provided in the system to "switch on" the light automatically in the evening and poor visibility period and switch off the same during day time and normal visibility period.

1.8.6.2.10 **Cables, Cable Glands, Conduits and Accessories**

The cable to be supplied and erected shall be of multi strands copper conductor, weather proof, PVC insulated PVC sheathed, armoured 1.1 KV grade. The same shall conform to IS:1554.

All the cable accessories such as thimble, glands etc. shall be in the scope of supply and erection of the Contractor.

Supply and erection of all the PVC conduits and accessories shall be in the scope of the contract. All the conduit and accessories shall be as per the relevant ISS or ISI brand.

The inter-connection cable/conduit will be clamped in a secured manner with the tower members and any interconnection should be made only inside the environmentally protected junction box.

1.8.6.2.11 **Earthing**

All the installations on the tower shall be securely and properly earthed with the tower body by using flexible copper braided wire. Cost of earthing material shall deemed to be included in the total cost.

1.9 Tower Fabrication

The fabrication of towers shall be in conformity with the following:

1.9.1 Except where hereinafter modified, details of fabrication shall conform to IS: 802 (Part-II) or the relevant international standards.

1.9.2 Butt splices shall be used and the inside angle and outside plate shall be designed to transmit the load. Inside cleat angle shall not be less than half the thickness of the heavier member connected plus 2mm. Lap splice may be used

for connecting members of unequal sizes and the inside angle of lap splice shall be rounded at the heel to fit the root radius of the outside angle. All the splices shall develop full strength in the member connected through bolts. Butt as well as lap splice shall be made as above and as close to the main panel point as possible.

1.9.3 Joints shall be so designed as to avoid eccentricity as far as possible. The use of gusset plates for joining tower members shall be avoided as far as possible. However, where the connections are such that the elimination of the gusset plates would result in eccentric joints, gussets plates and spacers plates may be used in conformity with modern practices. The thickness of the gusset plates, required to transit stress shall not be less than that of members connected.

1.9.4 The use of filler in connection shall be avoided as far as possible. The diagonal web members in tension may be connected entirely to the gusset plate wherever necessary to avoid the use of filler and it shall be connected at the point of intersection by one or more bolts.

1.9.2 The tower structures shall be accurately fabricated to connect together easily at site without any undue strain on the bolts.

1.9.3 No angle member shall have the two leg flanges brought together by closing the angle.

1.9.4 The diameter of the hole shall be equal to the diameter of bolt plus 1.5mm.

1.9.5 The structure shall be designed so that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depression are likely to hold water.

1.9.6 All identical parts shall be made strictly inter-changeable. All steel sections before any work is done on them, shall be carefully leveled, straightened and made true to detailed drawings by methods which will not injure the materials so that when assembled, the adjacent matching surfaces are in close contact throughout. No rough edges shall be permitted in the entire structure.

1.9.7 Drilling and Punching

1.9.7.1 Before any cutting work is started, all steel sections shall be carefully straightened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled.

1.9.7.2 Holes for bolts shall be drilled or punched with a jig but drilled holes shall be preferred. The punching may be adopted for thickness up to 16mm. Tolerances regarding punched holes are as follows:-

a) Holes must be perfectly circular and no tolerances in this respect are permissible.

b) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8mm. i.e. the allowable taper in a punched holes should not exceed 0.8mm on diameter.

c) Holes must be square with the plates or angles and have their walls parallel.

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

1.9.8 Erection mark

1.9.8.1 Each individual member shall have erection mark conforming to the component number given to it in the fabrication drawings. The mark shall be marked with marking dies of 16mm size before galvanizing and shall be legible after galvanizing.

1.9.8.2 Erection Mark shall be A-BB-CC-DDD

A = Employer's code assigned to the Contractors- Alphabet

BB = Contractor's Mark-Numerical

CC = Tower Type Alphabet.

DDD = Number mark to be assigned by Contractor - Numerical.

Erection mark for high tensile steel members shall be prefixed by the letter "H"

1.10 Quantities and weights

1.10.1 The provisional quantity of towers & extensions are mentioned in the respective Schedule of Prices. Final quantities shall be determined after completion and approval of the tower spotting & check survey. The final quantities of tower shall be confirmed by the Employer based on the required quantities of various towers & extensions furnished by the Contractor after completion of final tower spotting & check survey. Hence, it will be responsibility of the Contractor to intimate the exact requirements of all towers and various line materials required for line immediately after the tower spotting & check survey.

The Employer reserves the right to order the final quantities including reasonable quantities of spares for which the rates quoted in the Bid shall be valid. Regarding quantity variation, the provisions of relevant clauses of SCC shall apply.

1.10.2 The estimated unit weight of each type of galvanized towers, stubs and leg extensions shall be furnished by the bidder. The weight of tower shall mean the weight of tower calculated by using the black sectional (i.e. un galvanized) weight of steel members of the size indicated in the approved fabrication drawings and bill of materials, without taking into consideration the reduction in weights due to holes, notches and bevel cuts etc. but taking into consideration the weight of the anticlimbing devices, D shackles, hangers, strain plates, pack plates, gusset plates and pack washers etc. The weight of gusset plates shall mean the weight of its circumscribing rectangle, without taking into consideration the reduction in weights due to holes, notches etc.. For bolts and nuts along with spring washers and step bolts, the weight per tower shall be calculated from the bolt schedule applicable to each type of towers, stubs and leg extensions as approved by the Employer. The rate quoted by the bidder for supply of tower / tower parts is deemed to be inclusive of galvanising charges including the cost of zinc.

1.10.3 The contractor is permitted to get inspected and supply up to 2.5% extra fasteners to take care of losses during erection. No payment shall be admissible for these extra supplies.

1.11 Galvanising

1.11.1 Fabricated Tower Parts & Stubs

The tower parts, stubs and pack washers shall be hot dip galvanized .The galvanization shall be done as per requirements of IS: 4759 after all fabrication work is completed. The contractor shall also take guidelines from the recommended practices for hot dip galvanizing laid down in IS 2629 while deciding and implementing galvanizing procedure. The mandatory requirements however, are specified herein.

Unless otherwise specified the fabricated tower parts and stubs shall have a minimum overall Zinc coating of 610 gms per sq. m of surface except for plates below 5mm which shall have Zinc coating of 460 gms per sq. m of surface. The average zinc coating for sections 5mm & above shall be maintained as 87 microns and that for sections below 5mm shall be maintained as 65 microns.

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

The surface preparation for fabricated tower parts and stubs for hot dip galvanizing shall be carried out as indicated herein below:

(i) Degreasing & Cleaning of Surface: Degreasing and cleaning of surface, wherever required, shall be carried out in accordance with clause 4.1 of IS 2629-1985. After degreasing the article shall be thoroughly rinsed. However, if acidic degreasers are used rinsing is not required.

(ii) Pickling: Pickling shall be done using either hydrochloric or sulfuric acid as recommended at clause 4.3 of IS 2629 -1985. The actual concentration of the acids and the time duration of immersion shall be determined by the Contractor depending on the nature of material to be pickled. Suitable inhibitors also shall be used with the acids to avoid over pickling. The acid concentration, inhibitors used, and maximum allowable iron content shall form part of plant standard to be formulated and submitted to Purchaser along with Quality Assurance Program.

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

(iv) Fluxing: The rinsed article shall be dipped in a solution of Zinc ammonium chloride. The concentration and temperature of the flux solution shall be standardized by the contractor depending on the article to be galvanized and individual circumstances. These shall form part of plant standard to be formulated and submitted to Purchaser along with Quality Assurance Program. The specific gravity of the flux solution shall be periodically monitored and controlled by adding required quantity of flux crystals to compensate for drag-out losses. Free acid content of the flux solution also shall be periodically checked and when it is more than two (2) grams of free acid per litre of the solution, it shall be neutralized. Alternatively, Ph value should be monitored periodically and maintained between 5 to 5.5

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

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

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

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

(ix) Storing, Packing and Handling: In order to prevent white rust formation sufficient care should be exercised while storing handling and transporting galvanized products. The articles shall be stored in an adequately ventilated area. The articles shall be stored with spacers in between them and kept at an inclination to facilitate easy drainage of any water collected on the articles. Similar care is to be taken while transporting and storing the articles at site.

The Contractor shall prepare a detailed galvanizing procedure including Flow Chart with control parameters and all plant standards as required above and submit to Employer for approval as part of Quality Assurance Plan.

1.11.2. **Fasteners.**

For fasteners, the galvanizing shall conform to IS-1367(Part-13). The galvanizing shall be done with centrifuging arrangement after all mechanical operations are completed. The nuts, may however be tapped (threaded) or rerun after galvanizing and the threads oiled .The threads of bolts & nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of bolts. Spring washers shall be electro galvanized as per Grade-IV of IS-1573.

1.12 Earthing

The Contractor shall measure the tower footing resistance (TFR) of each tower after it has been erected and before the stringing of the earth wire during dry weather. Each tower shall be earthed. The tower footing resistance shall not exceed 10 ohms. Pipe type earthing and counter poise type earthing wherein required shall be done in accordance with the latest additions and revisions of:

IS: 3043 Code of practice for Earthing.

IS: 5613 Code of practice for Design, Installation and maintenance (Part-II/Section-2) of overhead power lines.

1.12.1 *The cost for tower earthings shall be deemed to be included on somewhere in price schedule. No separate payment will be made.*

1.13 Inspection and Tests

1.13.1 General

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

1.13.2 Inspection

1.13.2.1
a) The Contractor shall keep the Purchaser informed in advance about the time of starting and of the progress of manufacture and fabrication of various tower parts at various stages, so that arrangements could be made for inspection.
b) The acceptance of any part of items shall in no way relieve the Contractor of any part of his responsibility for meeting all the requirements of the Specification.

1.13.2.2 The Employer or his representative shall have free access at all reasonable times to those parts of the Contractor's works which are concerned with

the fabrication of the Employer's material for satisfying himself that the fabrication is being done in accordance with the provisions of the Specification.

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

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

1.13.2.5 Defect which may appear during fabrication shall be made good with the consent of, and according to the procedure proposed by the Contractor and approved by the Employer.

1.13.2.6 All gauges and templates necessary to satisfy the Purchaser shall be supplied by the Contractor.

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

1.14 Tower Load Tests

The load test and destruction test are not envisaged. The Contractor is required to design the tower such as to withstand all conditions. The contractor shall be responsible for design and safety of the tower, and shall guarantee. However if testing is deemed to be required, the method to be followed is indicated as follows: The cost of such testing shall be included in the price of the tower.

1.14.1 Testing of Tower

A Galvanized tower of each type complete with 9 M extension shall be subjected to design and destruction tests by first applying test loads applied in a manner approved by the Employer. Multi-circuit towers shall be tested with 0M extension, i.e. normal tower. The tower shall withstand these tests without showing any sign of failure or permanent distortion in any part. Thereafter the tower shall be subjected to destruction by increasing the loads further in an approved manner till it fails. The tower shall be tested for all the conditions considered for the design of tower. The Contractor shall submit to the Employer, for approval, the detailed programme and proposal for testing the towers showing the methods of carrying out the tests and manner of applying the loads. After the Employer has approved the test procedures and programmes the Contractors will intimate the Employer about carrying out the tests at least 30 days in advance of the scheduled date of tests during which the

Employer will arrange to depute his representative to be present at the time of carrying out the tests. Six copies of the test reports shall be submitted. The Contractor shall submit one set of shop drawings alongwith the bill of materials at the time of prototype tower testing for checking the tower material. Further at the time of submitting test report, the contractor has to submit the final drawings of shop drawings and Bill of materials for Employer's reference and record. The type testing charges shall be released only after approval of test report, structural drawings, bill of material and shop drawings of tower.

1.14.1.1 In case of premature failure the tower shall be retested and steel already used in the earlier test shall not be used again. However, in case of minor failures, the contractor can replace the members with higher section and carry out the testing. The Contractor shall provide facilities to the Employer or their representatives for inspection of materials during manufacturing stage and also during testing of the same.

1.14.1.2 In case of any premature failure even during waiting period, the tower is to be retested with rectified members. However, if the failures are major in nature and considerable portion of tower is to be re-erected, in such cases all the tests which has been carried out earlier are required to be re-conducted again in compliance with Specification.

1.14.1.3 No part of any tower subject to test shall be allowed to be used on the line. The price for the tower tests will be quoted after allowing rebate for the scrap value of the tower material which will be retained by the Contractor.

1.14.1.4 The Contractor shall ensure that the specification of materials and workmanship of all towers actually supplied conform strictly to the towers which have successfully under gone the tests. In case any deviation is detected, the Contractor shall replace such defective towers free of cost to the Employer. All expenditure incurred in erection, to and fro transportation and any other expenditure or losses incurred by Employer on this account shall be full born by the Contractor. No extension in delivery time shall be allowed on this account.

1.14.1.5 Each type of tower to be tested shall be a full scale prototype galvanized tower and shall be erected vertically on rigid foundation of the stub protruding above ground level as provided in the design/drawing between ground level and concrete level. This portion of the stub shall be kept un-braced while testing. The tower erected on test bed shall not be out of plumb by more than 1 in 360.

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

1.14.1.7 The suspension tower is to be tested with an arrangement similar to 'I' string. The tension tower is to be tested with strain plate as per approved design / drawings.

1.14.1.8 The sequence of testing shall be decided by the Employer at the time of approving the rigging chart / test data sheet.

1.14.1.9 The Employer may decide to carry out the tensile test, bend test etc. as per the relevant IS on few members of the test tower after completion of the test or in case of any premature failure. The Contractor shall make suitable arrangement for the same without any extra cost to the Employer.

1.14.1.10 Prefix 'T' shall be marked on all members of test tower in addition to the Mark No. already provided.

1.14.2 **Method of Load Application**

1.14.2.1 Loads shall be applied according to the approved rigging arrangement through normal wire attachments angles on bent plates.

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

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

1.14.3 **Tower Testing Procedure**

The procedure for conducting the tower test shall be as follows:

1.14.3.1 **Bolt Slip Test**

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

For measurement of deflection the initial and final readings on the scales(in transverse & longitudinal directions) before application and after the release of Loads respectively shall be taken with the help of theodolite. The difference between readings gives the values of the bolt slip.

1.14.3.2 **Normal Broken Wire Load Tests**

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

25 percent,

50 percent,

75 per cent,

90 percent,

95 percent and

100 percent

1.14.3.3 **Observation Periods**

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

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

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

The structure shall be considered to be satisfactory, if it is able to support the specified full design loads for five (5) minutes, with no visible local deformation after unloading (such as bowing, buckling etc.) and no breakage of elements or constitute parts.

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

1.14.3.4 Recording

The deflections of the tower in transverse and longitudinal directions shall be recorded at each intermediate and final stage of normal load and broken wire load tests by means of a theodolite and graduated scale. The scale shall be of about one meter long with marking up to 5 mm accuracy.

1.14.3.5 Destruction Test

The destruction test shall be carried out under normal condition or broken wire condition. Under which load condition the destruction test is to be carried out shall be intimated to the contractor at the time of approving rigging chart / test data sheet.

The procedure for application of load for normal/broken wire test shall also be applicable for destruction test. However, the load shall be increased in steps of five (5) per cent after the full design loads have been reached.

1.15 Packing

1.15.1 Angle section shall be wire bundled.

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

1.15.3 Bolts, nuts washers and other attachments shall be packed in double gunny bags accurately tagged in accordance with the contents.

1.15.4 The contractor is required to suitably protect all steel members during shipment and storing to prevent damages to galvanized surfaces. The packing shall be properly done to avoid losses & damages during transit. Each bundle or package shall be appropriately marked.

1.16 Standards

1.16.1 The design, manufacturing, fabrication, galvanising, testing, erection procedure and materials used for manufacture and erection of towers, design and construction of foundations shall conform to the following Indian Standards (IS) / International Standards which shall mean latest revisions, with amendments / changes adopted and published, unless specifically stated otherwise in the Specification. In the event of supply of material conforming to Standards other than specified, the Bidder shall confirm in his bid that these Standards are equivalent to those specified. In case of award, salient features of comparison between the Standards proposed by the Bidder and those specified in this document will be provided by the Contractor to establish their equivalence.

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

Sl. No.	Indian Standard	Title	International Standard
1.	IS:209-1992	Specification for Zinc	ISO/R/752 ASTM B6

Sl. No.	Indian Standard	Title	International Standard
2.	IS 278-1991	Galvanised Steel Barbed wire	ASTM A131
3.	IS 800-1991	Code of Practice for General Building Construction in Steel	CSA 6.1
4(a).	IS:802(Part 1) Sec 1-1995 Sec 2-1992	Code of Practice for General Building Construction in Steel in Overhead Transmission Line Tower : Materials, loads and Permissible Stress Section- 1: Materials and loads Section-2 : Permissible stresses.	ASCE 52 IEC 826 BS 8100
4(b).	IS:802(Part 2)-1990	Code of Practice for use of structural steel in Overhead Transmission Line : Fabrication, Galvanising, inspection & Packing	ASCE 52
4(c).	IS:802(Part 3)-1990	Code of Practice for use of structural steel in Overload Transmission Line: Tower testing	ASCE 52 IEC 652
5.	IS:808-1991	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections.	
6.	IS:875-1992	Code of Practice for Design Loads (other than Earthquakes) for Buildings and Structures.	
7.	IS:1363-1990	Hexagon Nuts (size range M5 to M36)	
8.	IS:1367-1992	Technical Supply Conditions for Threaded Steel/ Fasteners	
9.	IS:1477-1990	Code of practice for Painting of Ferrous Metals in Buildings: Part-I: Pre-treatment Part-II: Painting.	
10.	IS:1573-1991	Electro-Plated Coatings of inc on iron and Steel	
11.	IS:1852-1993	Rolling and Cutting Tolerances of Hot	

Sl. No.	Indian Standard	Title	International Standard
		Rolled Steel Products	
12.	IS-1893-1991	Criteria for Earthquake Resistant Design of Structures	IEEE 693
13.	IS:2016-1992	Plain Washers	ISO/R887 ANSIB18-22.1
14.	IS:2062-1992	Steel for general structural purposes	
15.	IS:2074-1992	Ready Mixed Paint. Air Drying, Oxide. Zinc Chrome, Priming Specification.	
16.	IS:2551-1990	Danger Notice Plates	
17.	IS:2629-1990	Recommended Practice for Hot Dip Galvanising of iron and steel.	
18.	IS:2633-1992	Method of Testing Uniformity of Coating of Zinc Coated Articles	ASTM A123 CSA G164
19.	IS:3043-1991	Code of Practice for Earthing	
20.	IS:3063-1994	Single coil Rectangular section Spring Washers for Bolts, Nuts Screws	DIN-127
21.	IS:3757-1992	High Strength Structural Bolts	
22.	IS:4759-1990	Specification for Hot zinc coatings on structural steel and other Allied products	
23.	IS:5369-1991	General Requirements for Plain Washers	
24.	IS:5613-1993	Code of Practice for Design installation and Maintenance of Overhead Power Lines Section-1: Design Part 2, Section-2: Installation and Maintenance	
25.	IS:6610-1991	Specification for Heavy Washers for Steel structures	
26.	IS:6623-1992	High Strength Structural Nuts	

Sl. No.	Indian Standard	Title	International Standard
27.	IS:6639-1990	Hexagon Bolts for Steel Structure.	ASTM A394 ASTM A90
28.	IS:6745-1990	Method for Determination of weight of Zinc coated iron and Steel Articles.	ASTM A90
29.	IS:8500-1992	Specification for Weldable Structural Steel (Medium & High Strength Qualities)	
30.	IS:10238-1989	Step Bolts for Steel Structures	
31.	IS:12427-1988	Bolts for Transmission Line Towers	
32.		Indian Electricity Rules.	
33.	Publication No. 19(N)/700	Regulation for Electrical Crossing of Railway Tracks	

The standards mentioned above are available from

Reference Abbreviation	Name and Address
BIS/IS	Beureau Of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi - 110001. INDIA
ISO	International Organisation for Standardization. Danish Board of Standardization Danish Standardizing Sraat, Aurehoegvej-12 DK-2900, Heeleprup, DENMARK.

CSA	Canadian Standard Association 178, Rexadale Boulevard, Rexdale (Ontario) Canada, M9W 1R3
DIN	Deutsches Institute fiir Normung, Burggrafenstrassee 4-10 Post Farh 1107 D-1000, Berlin 30 GERMANY
ASTM	American Society for testing and Material 1916 Race Street Philadelphia. PA 1903-1187 USA
Indian electricity Rules Regulation for electricity crossing of railway Tracks	Kitab Mahal Baba Kharak singh Marg New Delhi-110001 INDIA
ASTM	American Society of civil Engineers 345 East 47th Street New York, NY 10017-2398 USA
IEEE	Institute of Electrical and Electronics Engineers 445 Hoes LanePiscataway, NJ 0085-1331, USA
IEC	International Electro technical Commission, Bureau Central de la Commission, electro Technique international, 1 Rue de verembe, Geneva SWITZERLAND

2.0 Foundations

2.1 The foundation shall generally be of open cast type. Reinforced Cement concrete footing shall be used for all types of towers in conformity with the present day practices and the specification laid herein. Footings for all the four legs (without unequal chimney extension) of the tower and their extension shall be similar, irrespective of down thrust and uplift.

2.2 Foundation includes supply of all labour, tools & machineries, materials such as cement, sand, coarse aggregates and reinforcement steel. Rates quoted for foundations in appropriate schedules shall include transportation of construction materials to site, excavation, stub setting, concreting, reinforcement, shoring, shuttering, dewatering, stock piling, dressing, curing, backfilling the foundation after concreting with excavated / borrowed earth (irrespective of leads), consolidation of earth and carriage of surplus earth to the suitable point of disposal as required by the Employer or any other activities related to completion of foundation works.

2.3 Classifications of Foundations

Classification of foundations and design of foundation depend upon the type of soil, sub- soil water level and the presence of surface water which have been classified as follows:

2.3.1 Normal dry

To be used for locations where normal dry cohesive or non-cohesive soils are met. Foundations in areas where surface water encountered from rain runoff shall also be classified as normal dry.

2.3.2 Sandy Dry Soil

To be used for locations where cohesion less pure sand or sand with clay content less than 10% met in dry condition. If the clay content is more than 10 % met in dry condition, the foundation shall be classified as Normal Dry.

2.3.3 Wet

To be used for locations where sub-soil water table is met between 1.5 meters from ground level and the depth of foundation below the ground level.

2.3.4 Wet Cultivated

To be used for locations where there is no sub-soil water within the foundation depth but which are in surface water for long period with water penetration not exceeding one meter below the ground level e.g paddy fields/cultivated field. However, if water penetration due to surface water is more than one meter

below ground level, the adoption of suitable foundation shall be decided by site In-charge in consultation with corporate engineering deptt.

2.3.5 **Partially Submerged**

To be used at locations where sub-soil water table is met between 0.75 meter and 1.5metre below the ground level.

2.3.6 **Fully Submerged**

To be used at locations where sub-soil water table is met at less than 0.75 meter below the ground level.

2.3.7 **Black Cotton Soil**

To be used at locations where soil is clayey type, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement. For designing foundations, for such locations, the soil is considered submerged in nature.

2.3.8 **Fissured - Rock**

To be used at locations where decomposed or fissured rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature is met. Under cut type foundation is to be used for fissured rock locations.

In case of fissured rock locations, where water table is met at 1.5M or more below ground level, wet fissured rock foundations shall be adopted. Where fissured rock is encountered with subsoil water table less than 1.5 meter below ground level, submerged fissured rock foundations shall be adopted. In case of dry locations dry fissured rock foundations shall be adopted.

2.3.9 **Hard Rock**

The locations where chiseling, drilling and blasting is required for excavation for monolithic rock for a particular leg/tower, Hard rock type foundations are to be used. For these locations rock anchoring is to be provided to resist uplift forces.

For quoting prices of Hard Rock foundations, Rock level shall be assumed at 1.5 meters below the ground level. Due to change in Rock level, no extra payment shall be payable on account of increase in concrete volume, excavation volume and weight of reinforcement, also no recovery shall be made if the actual volume of concrete, excavation and weight of reinforcement are less than that quoted in Schedule of prices. However, for design purpose, Rock level shall be considered at ground level and no over burden soil weight shall be considered for resisting the uplift.

2.3.10 The sub-soil water table is not constant and its level changes during different seasons due to various factors. In case during soil investigation/trial pit or during excavation, if wet soil / fissures rock is encountered within the foundation depth, it is to be considered that water table has been encountered (considering that water table had reached that level sometime in past) and accordingly type of foundation shall be classified.

2.3.11 Where soil is of composite in nature, classification of foundation shall be according to the type of soil predominant in the foundation pit**.**

2.3.12 The foundation classification at any particular location shall be based on the type of soil (clay / sandy / silt / fissured rock etc) and water table, presence of surface water, etc. at the location. However, in case of locations which are in vicinity of rivers, depending upon case to case, type of foundation is to be decided considering other aspects also e.g in case RL (reduced level) of a location in comparison to the HFL is lower and there is possibility of submergence at the time of floods due to absence of river bunds / protection etc., FS type foundation with suitable raised chimney is to be adopted. Further in case there is a possibility of change in river course, considering the nature and turbulence of probable water flow and subsequent scouring of soil, pile type or special foundation may be considered for these locations.

2.3.13 In addition to above, if required, depending on the site conditions special type foundations shall also be provided by the contractor suitable for intermediate conditions under the above classifications to effect more economy for following reasons:

(a) Shallow Depth or Raised Chimney foundations are necessarily required to suit the site condition or

(b) Soil properties as per the soil report at particular location are found inferior than that considered in design . However, in case ,soil properties as per soil report are found superior than that considered in design ,no change in foundation design / price shall be applicable.

2.4 Type of Foundations

The Bidder shall offer open type of foundation (i.e. slab and chimney) with maximum depth of foundation as 3.0 meters for above classification of foundations depending on economy and feasibility of construction at site.

Bidder has to furnish along with the bid one sample calculation for each type of foundation required as per BPS for verification of correctness of design procedure adopted by the Bidder.

2.5 Soil Investigation

The contractor shall undertake soil investigation at tower locations as approved by the Employer.

2.6 Design of Foundations

2.6.1 Loads on Foundations

2.6.1.1 The foundations shall be designed to withstand the specific loads of the superstructure and for the full footing reactions obtained from the structural stress analysis in conformity with the relevant factors of safety.

2.6.1.2 The reactions on the footings shall be composed of the following type of loads for which these shall be required to be checked:

a) Max. Tension or uplift along the leg slope.

b) Max. Compression or down-thrust along the leg slope.

c) Max. Horizontal shear or side thrust.

2.6.1.3 Overload Factor for Foundation Loads:

The overload factor for foundation loads shall be considered as 1.1 i.e. the reaction on the foundations shall be increased by 10 percent.

2.6.2 Stability Analysis

2.6.2.1 In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of failure by over-turning, uprooting, sliding and tilting of the foundation.

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

A) Resistance Against Uplift

The uplift loads will be assumed to be resisted by the weight of earth in an inverted frustum of a conical pyramid of earth as per formula detailed in Annexure –A of this Section on the footing pad whose sides make an angle equal to the angle of repose of the earth with the vertical, in average soil. The weight of concrete embedded in earth and that above the ground will also be considered for resisting the uplift. In case where the frustum of earth pyramids of two adjoining legs super-imposed each other, the earth frustum will be assumed truncated by a vertical plane passing through the centre line of the tower base.

B) Resistance Against Down Thrust

The down-thrust loads combined with the additional weight of concrete above earth will be resisted by bearing strength of the soil assumed to be acting on the total area of the bottom of the footings.

C) Resistance Against Side-Thrust

The lateral load capacity of a chimney foundation shall be based on chimney acting as a cantilever aided by passive earth resistance developed 500 mm below the ground level.

The chimney shaft shall be reinforced for the combined action of axial force, tension and compression and the associated maximum bending moment. In these calculations, the tensile strength of concrete shall be ignored. Similarly, since stub angle is embedded in the centre of the chimney, its effectiveness in the reinforcement calculation is to be ignored.

The increase in vertical toe pressure due to maximum bending moment at the bottom of the slab shall be taken into account and the base itself shall be designed for structural adequacy. In this case, the allowable vertical toe pressure may be increased by 25%. The unit weight of reinforced concrete is stipulated in Table 2-2.

2.7 Design Criteria

2.7.1 As per IS: 456-2002 Partial safety factor shall be considered 1.5 for concrete and 1.15 for steel.

2.7.2 The overload factors for open type foundations shall be as 1.1 i.e. all the reactions (compression, tension and side thrust) on foundations shall be increased by 10 percent for development of foundation design.

2.7.3 The physical properties of soil under various conditions are furnished in TABLE 2.3 to be considered for the design of foundations. These type of foundations correspond to list of foundations furnished in Schedule of prices VOL III.

2.7.4 The foundation shall be designed such as to satisfy the following conditions:

2.7.5 The thickness of concrete in the chimney portion of the tower footing would be such that it provides minimum cover of not less than100 mm from any part of the stub angle to the nearest outer surface of the concrete in respect of all dry locations limiting the minimum section of chimney to 300 mm square .In respect of all wet location, the chimney should have all around clearance of 150 mm from any part of stub angle limiting to 450 mm square minimum.

2.7.6 The chimney top or muffing must be at least 225 mm above ground level and also the coping shall be extended up to lower most joint level between the bottom lattices and the main corner legs of the tower. .

2.7.7 The centroidal axis of slab shall coincide with the axis of the chimney and pass through the center of foundation base. The design of the foundation(base slab and its reinforcement) shall take into account the additional stresses in the foundation resulting from the eccentricity introduced due to non-compliances of this requirement.

2.7.8 At least 100 mm thick pad of size equal to the base of slab with its sides vertical will be provided below the slab for R.C.C. type foundations.

2.7.9 In case of reinforced concrete slab, the slab thickness should not be less than 300 mm.

2.7.10 The minimum distance between the lowest edge of the stub angle and the bottom surface of concrete footing shall not be less than 100 mm or more than 150 mm in case of dry locations and not less than 150 mm or more than 200 mm in case of wet locations.

2.7.11 The total depth of open type foundations below the ground level shall not be less than 1.5 meters and more than 3.0 meters. To maintain the interchangeability of stubs for all types of foundations, for each type of tower, almost the same depths of foundations shall be used for different types of foundations.

2.7.12 The portion of the stub in the slab shall be designed to take full down-thrust or uplift loads by the cleats combined with the bond between stub angles and slab concrete. The Contractor shall furnish the calculation for uprooting of stub along with the foundation design. Bolted cleat angles evenly spaced in sets of 4 along all sides of embedded portion of the stub shall be provided to act as shear connector with sufficient number of bolts.

2.7.13 In case of R.C.C. foundations are having steel reinforcement in base slab, at least 50 mm. thick pad of lean concrete corresponding to 1:3:6 nominal mixes shall be provided to avoid the possibility of reinforcement rod being exposed due to unevenness of the bottom of the excavated pit.

2.7.14 The base slab of the foundation shall be designed for additional moments developing due to eccentricity of the loads.

2.7.15 The additional weight of concrete in the footing below ground level over the earth weight and the full weight of concrete above the ground level in the footing and embededded steel parts will also be taken into account adding to the down thrust.

TABLE 2.3

PROPERTIES OF SOIL	ULTIMATE BEARING CAPACITY KN/M2(Kg/M2)	ANGLE OF REPOSE DEGREE
1. For Normal Soil		
(a) Normal Dry Soil	**268 (27350)**	**25**
(b) Wet Soil Due to Presence of Subsoil/Surface Water	134 (13675)	15
1a. **SANDY SOIL**		
(a) Sandy Soil	**268 (27350)**	**20**

2. WEIGHT OF EARTH for Normal soil	**UNIT**	**VALUE**
(a) Dry	KN/M3 (Kg/M3)	14.12 (1440)
(b) In presence of Surface Water	KN/M3 (Kg/M3)	14.12 (1440)
(c) In presence of Subsoil Water	KN/M3 (Kg/M3)	9.22 (940)
3. FISSURED ROCK		
(a) Ultimate Bearing Capacity (both for Dry & Wet Fissured Rock)	KN/M2 (Kg/M2)	498 (50800)
(b) WEIGHT OF FISSURED ROCK		
i) Dry	KN/M3 (Kg/M3)	14.12 (1440)
ii) In presence of Subsoil Water	KN/M3 (Kg/M3)	9.22 (940)
(c) ANGLE OF REPOSE		
i) Fissured Rock in Dry Portion	Degrees	20
ii) Fissured Rock in Presence of Water	Degrees	10
4. HARD ROCK		
a) Ultimate Bearing Capacity	KN/M2 (Kg/M2)	1225.83 (125000)

b) Ultmate Bond between steel KN/M2 (Kg/M2) 0.147 (15)

The above soil properties of the earth will be measured by the Contractor at the various locations in conformity with the standard method of testing and the foundation design will be revised suiting the site conditions from such tests.

2.8 Properties Of Concrete

The cement concrete used for the foundations shall generally be of grade M-20 having 1:1.5:3 nominal volumetric mix ratio with 20mm coarse aggregate for chimney portion and 20mm/40mm aggregates for pyramid or slab portion. *Same shall be decided during Detailed engineening.* All the properties of concrete regarding its strength under compression, tension, shear, punching and bending etc. as well as workmanship will conform to IS:456.

2.8.1 The weight of concrete to be considered for design of foundations is given in TABLE 2-2.

TABLE 2.2

WEIGHT OF CONCRETE .

TYPE OF CONCRETE	WEIGHT OF DRY REGION KN / M3(Kg/m3)	WEIGHT IN PRESENCE OF SUB-SOIL WATER KN / M3(Kg/m3)
Plain Concrete	21.96 (2240)	12.16 (1240)
Reinforced Concrete	23.54 (2400)	13.73 (1400)

2.8.2 The Quantity of minimum cement to be used per unit quantity of consumption for different mix (nominal mix) of concrete should be as follows:

Sl.no.	Description	Unit	Quantity of Minimum cement to be used perUnit quantity of work (in kgs)
1.	1:1.5:3 nominal mix concrete	Cu.m.	400
2.	1:2:4 nominal mix concrete	Cu.m.	320
3.	1:3:6 nominal mix concrete	Cu.m.	220
4.	Random Rubble Masonry with 1:6 cement mortar	Cu.m.	83

In this regard utilisation record is to be maintained at site.

2.8.3 Alternatively, Ready Mix concrete from batching plant as per IS 4925 can also be used used with no extra payment and without any recovery. However Cement content shall be as per IS 456. The ready mix concrete shall conform to IS:4926. The selection and use of Materials for the ready mix concrete shall be in accordance with IS:456. The concrete shall be of M20 grade design mix as per IS:456. *Same shall be decided during Detailed engineering.* The transport of concrete and transportation time shall be as per IS:4926.

2.8.4 a) Cement used shall be ordinary Portland Cement, unless mentioned otherwise, conforming to the latest Indian Standard Code IS:269 or IS:8112 or IS:12269.

b) Alternatively, other varieties of cement other than ordinary Portland Cement such as Portland Pozzolana Cement conforming to IS;1489 (latest edition) or Portland Slag Cement conforming to IS:455 (Latest edition) can also be used. The Contractor shall submit the manufacturer's certificate, for each consignment of cement procured, to the Employer. However Employer reserves the right to direct the Contractor to conduct tests for each batch/lot of cement used by the Contractor and Contractor will conduct those tests free of cost at the laboratory so directed by the Employer. The Contractor shall also have no claim towards suspension of work due to time taken in conducting tests in the laboratory. Changing of brand or type of cement within the same structure shall not be permitted without the prior approval of the Employer. Sulphate Resistant Cement shall be used if sulphate content is more than the limits specified in IS: 456, as per Geotechnical investigation report.

The curing time of cement will be decided at the time of execution of the work under the contract based on the certificate from a reputed laboratory which will be obtained and submitted by the Contractor.

2.8.5 Concrete aggregates shall conform to IS: 383-1970.

2.8.6 The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials or other deleterious substances. Potable water is generally preferred.

2.8.7 Reinforcement shall conform to IS: 432-1966 for M.S bars and hard drawn steel wires and to IS: 1138-1966 and IS: 1786-1966 for deformed and cold twisted bars respectively. The grade of steel shall be Fe500. All reinforcement shall be clean and free from loose mill scales, dust, loose rust, and coats of paint, oil or other coatings, which may destroy or reduce bond. Contractor shall supply, fabricate and place reinforcement to shapes and dimensions as indicated or as required to carry out intent of drawings and specifications.

2.9 Measurement ,Unit Rates and Payment for Foundation

2.9.1 Measurement

2.9.1.1 The concrete volume and dimensions of the foundation shall be determined from the drawing approved. Measurement of concrete volume shall be in cubic meters and shall be worked out to the second place of decimal

2.9.1.2 The excavation volumes for each tower footing shall be estimated assuming the faces of surrounding earth as vertical keeping a distance of 150 mm clearances from the extreme edge of the base slab of footing. For footings with undercut, excavation volumes shall be calculated as per drawings without any side clearance.

2.9.1.3 The steel required for reinforcement of foundation shall be provided by the Contractor. Measurement will be based on the calculated weights of actually used in tonnes corrected to third place of decimal, no allowance being made for wastage. No payments will be made for wire required for binding the reinforcement, chairs, bolsters and spacers, as the cost of these is deemed to be included in the unit rate quoted for the item of reinforcement.

2.9.2 **UNIT RATE**

2.9.2.1. The unit rates of excavation for each type of soil shall include excavation along with all associated activities like shoring, shuttering, dewatering till completion of foundation work stock piling, dressing, back filling of foundations after concreting with excavated/borrowed earth (irrespective of lead) and consolidation of earth, carriage of surplus earth to the suitable point of disposal as required by the Employer or any other activity related to completion foundation work in all respect.

2.9.2.2 Form boxes shall be used for casting of foundations. The unit rate of concreting shall include the cost of supply, fabrication and placement of form boxes, cement, water, coarse and fine aggregates mixing and placing of concrete, curing of concrete and any other activities related to completion of concreting works of foundation.

2.9.2.3 The unit rate of 'Reinforcement Steel' shall include supply and placement of reinforcement steel, stirrups, wire for binding the reinforcement, chairs, bolsters and spacers etc. as required to complete the foundation work.

2.9.3 Payment for Foundation

2.9.3.1—— Excavation

The measurement for this item shall be made on the basis of design excavation volume arrived at considering dimension of pit leaving 150mm gap around

(except for under cut foundations) the base pad or actually excavated whichever is less and the unit rate of this item as indicated in Contract. The payment for excavation shall be made as per actual type of soil encountered at the time of excavation, but the total payment for excavation portion shall not exceed the amount as payable for excavation considering the soil type same as that of foundation classification. The decision of the Employer shall be final and binding with respect to classification of soil and foundations. In case unit rates for the same soil type under different tower types are different then the lowest rate among them shall be used for the payment purpose.

2.9.3.2 Concrete

The payment for this item shall be made as per the actual volumes of concreting but limited to design volume based on unit rates for these items indicated in Contract.

2.9.3.3 Reinforcement

The measurement of reinforcement steel for payments shall be made based on the calculated weight of reinforcement steel as per relevant Indian Standard actually used in tones corrected to third place of decimal as calculated weight of steel as per design / working drawing whichever is less. No allowance will be made for wastage and others.

2.10 CONSTRUCTION OF TOWER FOUNDATION

2.10.1 TESTING OF SOIL

2.10.1.1 The Contractor shall be required to undertake testing of soil for the tower and shall submit his report about the subsoil water table, type of soil encountered, bearing capacity of soil, possibility of submergence and other soil properties required for the design of foundations. The Contractor shall also furnish soil resistivity values to the Employer along the line alignment.

2.10.2 Excavation

2.10.2.1 The excavation work for foundations shall be taken up by the Contractor after obtaining approval from Employer for the proposed stretch wise / section wise tower schedule, profile etc. prepared during Check / Detailed survey along the approved route alignment.

2.10.2.2 Except as specifically otherwise provided, all excavation for footings shall be made to the lines and grades of the foundations. The excavation wall shall be vertical and the pit dimensions shall be based on an assumed clearance of 150mm on all sides of the foundation pad. For footings with undercut, care shall be taken to carry out excavation as per drawings without any side clearance. All

excavation shall be protected so as to maintain a clean sub grade and provide worker safety until the footing is placed, using timbering, shoring, shuttering, dewatering etc. as approved by the Employer. Contractor shall especially avoid disturbing the bearing surface of the pad. Any sand, mud, silt or other undesirable materials which may accumulate in the excavated pit or borehole shall be removed by Contractor before placing concrete.

2.10.2.3 The soil to be excavated for tower foundations shall be classified as follows depending upon the physical state of the soil at the time of excavation irrespective of the type of foundation installed:

a) Dry Soil

Soil removable either manually, means of a spade and shovel or mechanically by proclains, excavator etc. Excavation done in dry soil for wet and fully submerged type of foundations shall also be covered under this.

b) Wet Soil

Where the subsoil water table is encountered within the range of foundation depth or land where pumping or bailing out of water is required due to presence of surface water shall be treated as wet soil. The excavation done in wet soil in case of wet and fully submerged type of foundation shall also be covered under this.

c) Dry Fissured Rock

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

d) Wet Fissured Rock

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

e) Hard Rock

Any rock excavation, other than specified under fissured rock above, for which blasting, drilling, chiseling are required. The unit rate quoted for hard rock excavation shall be inclusive of all costs for such drilling (including drilling required for anchoring), chiseling and blasting, etc.

2.10.2.4 However, where soil is of composite in nature, classification of foundation shall be according to the type of soil predominant in the footing and payment shall be made accordingly.

2.10.2.5 No extra payment shall be admitted for the removal of fallen earth into a pit or borehole once excavated. Shoring and timbering / shuttering as approved by authorised representative of the Employer shall be provided by the Contractor when the soil condition is so bad that there is likelihood of accident due to the falling of earth.

2.10.2.6 Where rock is encountered, the holes for tower footings shall preferably be drilled. Blasting where resorted to as an economy measure, if permitted by the Employer shall be done with utmost care to minimise fracturing of rock and using extra concrete for filling the blasted area. All necessary precautions for handling and use of blasting materials shall be taken. In cases where unnecessarily large quantities are excavated / blasted, resulting in placement of large volumes of concrete, payment of concrete shall be limited to design volumes of excavation, concreting, reinforcement etc. In case where drilling is done, the stubs may be shortened suitably with the approval of the Employer or his authorised representatives.

2.10.2.7 The Contractor shall arrange & supply requisite blasting material, and be responsible for its storage and use, without any extra cost to the Purchaser.

2.10.3 Setting of Stubs

2.10.3.1 For all towers the Contractor shall submit for approval the proposed method for setting of stubs.

2.10.3.2 The stubs shall be set correctly and precisely in accordance with approved method at the exact location, alignment and levels with the help of stub setting templates and leveling instruments. Stubs setting shall be done in the presence of Employer's representative available at site where required and for which adequate advance intimation shall be given to Employer by Contractor. Tolerances as per provisions of IS: 5613 shall be allowed for stub setting.

2.10.3.3 Setting of stub at each location shall be approved by Employer.

2.10.3.4 However, in hilly region for towers with unequal leg extensions props may be used with complete accuracy and high skilled supervision, subject to prior approval from Employer.

2.10.3.5 As per the schedule testing of all four towers must be completed before the start of casting foundations. However, for any reason if the testing of tower gets delayed Contractor shall not hold the casting of foundation work and shall cast the foundations with the stub of untested tower as per the design at his own risk and cast. Accordingly Contractor shall keep enough safety while choosing the

section for the stub /leg of last panel of tower to ensure that that the section for stub / leg of last panel shall not change during completion of tower testing.

2.10.4 Stub Setting Templates / Props

2.10.4.1 Stub setting templates shall be designed and arranged by the Contractor at his own cost for all types of towers with or without body extension. Stub templates for standard towers and towers with body extension upto 9 M shall be of adjustable type. The Contractor shall also arrange for props for setting of stubs at specific locations where use of prop is approved by the Employer. Stub templates / props should be painted.

2.10.4.2 The Contractor shall deploy sufficient number of templates / props (where ever required) for timely completion of the line without any extra cost to Employer.

2.10.4.3 One set of each type of stub setting template **/** props (if used) shall be supplied to the Employer, on completion of the project, at no extra cost to Employer.

2.10.4.4 Generally for a transmission line following number of stub setting templates shall be deployed by the Contractor:

Templates for tower type	**Nos. to be deployed**
For each type of DA, DB, DC and DD/DDS type	3 templates for each type of tower

However, if Employer feels that more templates are required for timely completion of the lines, the Contractor shall have to deploy the same without any extra cost to Employer.

The number of sets of prop (if permitted) to be supplied, will depend as per actual site condition and completion schedule of line.

2.10.5 Mixing, Placing and Compacting of Concrete

2.10.5.1 The concrete shall be mixed in the mechanical mixer. However, in case of difficult terrain, hand mixing may be permitted at the discretion of the Employer. The water for mixing concrete shall be fresh, clean and free from oil, acids and alkalis. salty or blackish water shall not be used.

Alternatively, Ready Mix concrete from batching plant as per IS 4925 can also be used used with no extra payment and without any recovery. However Cement content shall be as per IS 456. The ready mix concrete shall conform to IS:4926. The selection and use of Materials for the ready mix concrete shall be in accordance with IS:456. The concrete shall be of M20 grade design mix as per IS:456. The transport of concrete and transportation time shall be as per IS:4926.

2.10.5.2 Mixing shall be continued until there is uniform distribution of material and mix is uniform in colour and consistency, but in no case the mixing be carried out for

less than two minutes. Normal mixing shall be done close to the foundation but exceptionally, in difficult terrain**,** the concrete may be mixed at the nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.

2.10.5.3 To avoid the possibility of reinforcement rods being exposed due to unevenness of the bottom of the excavated pit, a pad of lean concrete 50mm thick and corresponding to a 1:3:6 nominal mix shall be provided at the bottom of the pad.

2.10.5.4 Form boxes shall be used for casting all types of foundations except at an undercut interface for which the adjoining subsurface material shall provide adequate support.

2.10.5.5 The concrete shall be laid down in 150mm layers and consolidated well, so that the cement cream works, up to the top and no honey-combing occurs in the concrete. A mechanical vibrator shall be employed for compaction of the concrete. However, in case of difficult terrain, manual compaction may be permitted at the discretion of the Employer. Monolithic casting of foundations must be carried out. However, in case of unavoidable circumstances, a key construction joint can be provided at the chimney-pad interface subject to approval of the Employer. However nothing extra shall be paid to the Contractor for providing such construction joints. After concreting the chimney portion to the required height, the top surface should be finished smooth with a slight slope towards the outer edge for draining rain water.

2.10.5.6 Wet locations shall be kept completely dewatered, both during and 24 hours after placing the concrete, without disturbance of the concrete.

2.10.5.7 If minor defects in concrete surface is found after the form work is removed, the damage shall be repaired with a rich cement sand mortar to the satisfaction of the Employer before the foundation is back filled.

2.10.6 Curing

The concrete shall be cured by maintaining the concrete wet continuously for a period of at least 10 days after placing. Once the concrete has set for 24 hours the pit may be backfilled with selected moistened soil and well consolidated in layers not exceeding 200mm thickness and thereafter both the backfill earth and exposed chimney shall be kept wet for the remainder of the prescribed 10 days. The exposed concrete chimney shall also be kept wet by wrapping empty gunny bags around it and wetting the bags continuously during the critical 10 days period.

2.10.7 Backfilling and Removal of Stub Templates

2.10.7.1 After opening of formwork and removal of shoring, timbering, etc., backfilling shall be started after repairs, if any, to the foundation concrete. Backfilling shall normally be done with the excavated soil, unless it is a clay type or it consists of large boulders/stones, in which case the boulders shall be broken to a maximum size of 80-mm. At locations where borrowed earth is required for backfilling, Contractor shall bear the cost irrespective of leads & lift.

2.10.7.2 The backfilling materials shall be clean and free from organic or other foreign materials. A clay type soil with a grain size distribution of 50% or more passing the number 200 sieve as well as a black cotton soil is unacceptable for backfilling. The earth shall be deposited in maximum 200mm layers, leveled, wetted if necessary and compacted properly before another layer is deposited. The moisture content for compaction shall be based on the Proctor compaction test results given in the Geo-technical Report, Clause 3.0 of section 3. The density of the compacted backfill material may further be verified to the satisfaction of the Employer based on the sand-cone method described in the ASTM D1556-82 standard.

2.10.7.3 The backfilling and grading shall be carried to an elevation of about 75mm above the finished ground level to drain out water. After backfilling 50mm high, earthen embankment (Bandh) will be made along the sides of excavation pits and sufficient water will be poured in the backfilling earth for at least 24 hours. After the pits have been backfilled to full depth the stub template can be removed.

2.10.8 Benching

When the line passes through hilly / undulated terrain, leveling the ground may be required for casting of tower footings. All such activities shall be termed benching and shall include cutting of excess earth and removing the same to a suitable point of disposal as required by Employer. Benching shall be resorted to only after approval from Employer. Volume of the earth to be cut shall be measured before cutting and approved by Employer for payment purposes. Further, to minimize benching, unequal leg extensions shall be considered and provided if found economical. If the levels of the pit centers be in sharp contrast with the level of tower centre, suitable leg extensions may be deployed as required. The proposal shall be submitted by the Contractor with detailed justification to the Employer.

2.10.9 Protection of Tower and Tower Footing

2.10.9.1 Tower shall be spotted such that the quantity of revetment is optimum. For tower locations in undulated terrain such as hill / mountain slopes, options like use of unequal leg extensions for towers, unequal chimney extensions etc. shall be explored by the contractor for optimizing the need for revetment & benching.

2.10.9.2 The work shall include all necessary stone revetments, concreting and earth filling above ground level, the clearing from site of all surplus excavated soil, special measures for protection of foundation close to or in small water streams (Nalas), river bank / bed, undulated terrain, protection of up hill / down hill slopes required for protection of tower etc., including suitable revetment or galvanised wire netting and meshing packed with boulders. The top cover of stone revetment shall be sealed with M-15 concrete (1:2:4 mix). Contractor shall recommend protection at such locations wherever required. Details of protection of tower/tower footing are given in drawing enclosed with these specifications for reference purpose only.

2.10.9.3 In protection of tower footings works the backfilling shall generally be done using soil excavated at site unless deemed unsuitable for backfilling. In the latter case, backfilling shall be done with borrowed earth of suitable quality irrespective of leads and lift. The unit rate for backfilling quoted in Price Schedules shall include the required lead and consolidation and leveling of earth after backfilling.

2.10.9.4 The provisional quantities for protection work of foundations are furnished in Price Schedule of Bid . The unit rates shall also be applicable for adjusting the actual quantities of protection works done. These unit rates shall hold good for protection work carried out on down hills or up hills slopes applicable for the tower locations.

2.10.9.5 The unit rates for random rubble masonry revetment quoted in price schedule shall also include excavation & (1:5) random masonry and unit rate for top sealing with M-15 concrete. For payment purposes the volume of random rubble masonry revetment shall be measured from bottom to top sealing coat and paid at the quoted rates indicated in price schedule.

No extra rates shall be paid for allied work such as excavation, for revetment, packed stone at head of weep holes etc. However, no deduction shall be made for the volume enclosed by weep holes. The locations where both benching and protection of tower footing are envisaged, an economy got to be established against providing unequal leg extension.

2.10.9.6 For some of the locations in small water streams (Nalas), river bed or undulated terrain etc., boulders of minimum. 150mm size bounded and packed in galvanised wire net / mesh of 8 SWG wire and 152 square (maximum) mesh are to be provided. These stones shall be provided in crates size of 2.0mx2.0m or as deemed suitable for a particular location. Measurement shall be taken in cubic meters and 15% deduction will be made for void from cage / stack measurements.

3.0 Tower Erection, Stringing and Installation of Line Materials

3.1 General

3.1.1 The scope of erection work shall include the cost of all labour, tools and plant such as tension stringing equipment and all other incidental expenses in connection with erection and stringing work. The bidders shall indicate in the offer the sets of stringing equipment he would deploy exclusively for this transmission line package. The stringing equipment shall be of sufficient capacity to string simultaneously a bundle of QUAD MOOSE Conductors.

3.1.2 The Contractor shall be responsible for transportation to site of all the materials to be provided by the Contractor as per the scope of work to site, proper storage and preservation at his own cost, till such time the erected line is taken over by the Employer.

3.1.3 Contractor shall set up required number of stores along the line and the exact location of such stores shall be discussed and agreed upon with the Employer. Purchaser supplied items shall be dispatched to nearest store set up by the Contractor. At the store receipt, unloading and further transportation to the site shall be the entire responsibility of the Contractor.

3.1.4 Payment for Tower Erection and Conductor stringing works shall be done as mentioned in Chapter-1, PSR

3.2 Treatment of Minor Damage in Galvanisation

Minor defects in hot-dip galvanised members shall be repaired by applying zinc rich primer and two coats of enamel paint to the satisfaction of the Employer before erection.

3.3 Assembly of Tower

The Contractor shall give complete details of the erection procedures he proposes to follow.

3.3.1 The method for the erection of towers shall ensure the following:

a) Straining of the members shall not be permitted for positioning. It may, however, be necessary to match hole positions at joints using Tommy bars not more than 450 mm in length.

b) Prior to erection of an upper section, the lower sections shall be completely braced, and all bolts provided tightened adequately in accordance with approved drawings to prevent any mishap during tower erection.

c) All plan diagonals, oblique bracings etc for relevant section of tower shall be in place prior to assembly of an upper Section.

d) The bolt positions in assembled towers shall be as per IS: 5613 (Part II/Section 2).

e) Tower shall be fitted with number plates, danger plates, phase plates, Circuit Plates and anti-climbing device as described.

f) After complete erection of the tower, all blank holes, if any, are to be filled by bolts and nuts of correct size.

3.4 Tightening of Bolts and Nuts

3.4.1 All nuts shall be tightened properly using correct size spanner and torque wrench. Before tightening, it will be verified that filler washers and plates are placed in relevant gap between members, bolts of proper size and length are inserted, and one spring washer is inserted under each nut. In case of step bolts, spring washers shall be placed under the outer nuts. The tightening shall progressively be carried out from the top downwards, care being taken that all bolts at every level are tightened simultaneously. The threads of bolts projecting outside the nuts shall be punched at their position on the diameter to ensure that the nuts are not loosened in course of time. If, during tightening, a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall be replaced.

3.4.2 The threads of all the bolts except for Anti-theft bolts, projected outside the nuts shall be welded at two diametrically opposite places, the circular length of each welding shall be at least 10 mm. The welding shall be provided from ground level to bottom cross arm for double circuit towers. However, for towers, with +18 meter, +25 meter extensions and river crossing towers, the welding shall be provided from ground level to 30m height from stub level. After welding zinc-rich primer having approximately 90% zinc content shall be applied to the welded portion. At least two coats of the paint shall be applied. The surface coated with zinc rich primer shall be further applied with two finish coats of high build enamel of the grade recommended by the manufacturer of the zinc rich primer. The cost of welding and paint including application of paint shall be deemed to be included in the erection price.

3.4.3 In addition to the tack welding of nuts with bolts, as described above, the Contractor can also propose some alternative arrangements, like use of epoxy resin adhesive which can serve the purpose of locking the nut permanently with the bolt and thus preventing pilferage of the tower members.

3.5 Insulator Hoisting

Suspension insulator strings shall be used on Suspension towers (DA) and double tension insulator strings on angle and dead end towers. These shall be fixed on all the towers just prior to the stringing. Damaged insulators and strings, if any, shall not be employed in the assemblies. Prior to hoisting, all insulators shall be

cleaned in a manner that will not spoil, injure or scratch the surface of the insulator, but in no case shall any oil be used for that purpose. For checking the soundness of insulators, IR measurement using 5 kV (DC) Meger shall be carried out on 100% insulators. Corona control rings/arcing horn shall be fitted in an approved manner. The yoke arrangements be horizontal for tension string and vertical (parallel to transverse face of tower) for suspension strings. Torque wrench shall be used for fixing various line materials and components, such as suspension clamp for conductor and earth wire, etc., whenever recommended by the manufacturer of the same.

3.6 Handling of Conductor and Earth wire

3.6.1 Running Out of the Conductors

3.6.1.1 The conductors shall be run out of the drums from the top in order to avoid damage. The Contractor shall be entirely responsible for any damage to tower or conductors during stringing.

3.6.1.2 A suitable braking device shall be provided to avoid damaging, loose running out and kinking of the conductors. Care shall be taken that the conductors do not touch and rub against the ground or objects which could scratch or damage the strands.

3.6.1.3 The sequence of running out shall be from the top to downwards i.e. the earth wire shall be run out first followed in succession by the conductors. Unbalanced loads on towers shall be avoided as far as possible.

3.6.1.4 The Contractor shall take adequate steps to prevent clashing of sub conductors until installation of the spacers/spacer dampers. Care shall be taken that sub conductors of a bundle are from the same Contractor and preferably from the same batch so that creep behavior of sub conductors remains identical. During sagging, care shall be taken to eliminate differential sag in sub-conductors as far as possible. However, in no case shall sag mismatch be more than 25mm.

3.6.1.5 Though towers shall be designed for one side stringing condition, towers shall be well guyed and all necessary steps shall be taken by the Contractor to avoid damage tower / conductor during stringing operations. Guying proposal along with necessary calculations shall be submitted by the Contractor to Employer for approval. All expenditure related to this work is deemed to be included in the Price quoted for stringing and no extra payment shall be made for the same.

3.6.1.6 When the line under construction runs parallel to existing energised power lines, the Contractor shall take adequate safety precautions to protect personnel; from the potentially dangerous voltage built up due to electromagnetic and electrostatic coupling in the pulling wire, conductors and earth wires during stringing operations.

3.6.1.7 The Contractor shall also take adequate safety precautions to protect personnel from potentially dangerous voltage build up due to distant electrical storms.

3.6.2 Running Blocks

3.6.2.1 The groove of the running blocks shall be of such a design that the seat is semicircular and larger than the diameter of the conductor / earth wire and it does not slip over or rub against the sides. The grooves shall be lined with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.

3.6.2.2 The running blocks shall be suspended in a manner to suit the design of the cross-arm. All running blocks, especially at the tensioning end will be fitted on the cross-arms with jute cloth wrapped over the steel work and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work.

3.6.3 Repairs to Conductors

3.6.3.1 The conductor shall be continuously observed for loose or broken strands or any other damage during the running out operations.

3.6.3.2 Repairs to conductor if necessary, shall be carried out with repair sleeve.

3.6.3.3 Repairing of the conductor surface shall be carried out only in case of minor damage, scuff marks, etc. The final conductor surface shall be clean, smooth and free from projections, sharp points, cuts, abrasions, etc.

3.6.3.4 The Contractor shall be entirely responsible for any damage to the towers during stringing.

3.6.4 Crossings

Derricks or other equivalent methods ensuring that normal services need not be interrupted nor cause damage to property, shall be used during stringing operations where roads, channels, telecommunication lines and power lines have to be crossed. However, shut down shall be obtained when working at crossings of overhead power lines. The Contractor shall be entirely responsible for the proper handling of the conductor, earth wire and accessories in the field.

3.7 Stringing of Conductor and Earth wire

3.3.1 The stringing of the conductor for 400 kV line shall be done by the control tension method. The equipment shall be capable of maintaining a continuous tension per bundle such that the sag for each conductor is about twenty percent greater than the sags specified in the stringing sag table.

3.3.2 The bidder shall give complete details of the stringing methods he proposes to follow. Prior to stringing the Contractor shall submit the stringing charts for the

conductor and earth wire showing the initial and final sags and tension for various temperatures and spans along with equivalent spans in the lines for the approval of the Employer.

3.3.3 A controlled stringing method suitable for simultaneous stringing of the sub conductors shall be used. The two conductors making one phase bundle shall be pulled in and paid out simultaneously. These conductors shall be of matched length. Conductors or earth wires shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

3.3.4 Conductor creep are to be compensated by over tensioning the conductor at a temperature of $26^{O}C$ lower than the ambient temperature or by using the initial sag and tensions indicated in the tables.

3.8 Jointing

3.8.1 When approaching the end of a drum length at least three coils shall be left in place when the stringing operations are stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the recommendations of the accessories manufacturer.

3.8.2 Conductor splices shall not crack or otherwise be susceptible to damage in the stringing operation. The Contractor shall use only such equipment / methods during conductor stringing which ensures complete compliance in this regard.

3.8.3 All the joints on the conductor and earth wire shall be of the compression type, in accordance with the recommendations of the manufacturer, for which all necessary tools and equipment like compressors, dies etc., shall be obtained by the Contractor. Each part of the joint shall be cleaned by wire brush till it is free of dust or dirt etc. and be properly greased with anti-corrosive compound, If required and as recommended by the manufacturer, before the final compression is carried out with the compressors.

3.8.4 All the joints of splices shall be made at least 30 meters away from the tower structures. No joints or splices shall be made in spans crossing over main roads and small rivers with tension spans. Not more than one joint per sub conductor per span shall be allowed. The compression type fittings shall be of the self centering type or care shall be taken to mark the conductors to indicate when the fitting is centered properly. During compression or splicing operation, the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After compressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.

3.8.5 During stringing of conductor to avoid any damage to the joint, the Contractor shall use a suitable protector for mid span compression joints in case they are to be passed over pulley blocks / aerial rollers. The pulley groove size shall be such that the joint along with protection can be passed over it smoothly.

3.9 Tensioning and Sagging Operations

3.9.1 Tensioning and Sagging operations shall be done in accordance with the `approved stringing charts or sag tables before conductors and earth wire are finally attached to the towers through insulator strings and earth wire clamps respectively. The "initial" stringing chart shall be used for the conductor and final stringing chart for the earth wire. The conductors shall be pulled up to the desired sag and left in running blocks for at least one hour after which the sag shall be rechecked and adjusted, if necessary, before transferring the conductors from the running blocks to the suspension clamps. The conductor shall be clamped within 96 hours of sagging in.

3.9.2 Dynamometers shall be employed for measuring tension in the conductor and earthwire. Dynamometers employed shall be periodically checked and calibrated with the standard Dynamometer.

3.9.3 The sag will be checked in the first and the last section span for sections up to eight spans, and in one additional intermediate span for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps.

3.9.4 The running blocks, when suspended from the transmission structure for sagging, shall be so adjusted that the conductors on running blocks will be at the same height as the suspension clamp to which it is to be secured.

3.9.5 At sharp vertical angles, conductor and earth wire sags and tensions shall be checked for equality on both sides of the angle tower and running block. The suspension insulator assemblies will normally assume vertical position when the conductor is clamped.

3.9.6 Tensioning and sagging operations shall be carried out in calm weather when rapid changes in temperature are not likely to occur.

3.10 Clipping In

3.10.1 Clipping of the conductors into position shall be done in accordance with the manufacturer's recommendations. Conductor shall be fitted with armor rods where it is made to pass through suspension clamps.

3.10.2 Jumpers at section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements. Pilot suspension insulator strings shall be used, if found necessary, to restrict jumper swing to design values.

3.10.3 Fasteners in all fittings and accessories shall be secured in position. The security clip shall be properly opened and sprung into position.

3.11 Fixing of Conductors and Earth wire Accessories

Conductor and earth wire accessories including Spacers (for bundle conductor) and Vibration Dampers shall be installed by the Contractor as per the design requirements and manufacturer's instruction within 24 hours of the conductor / earthwire clamping. While installing the conductor and earth wire accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and that no damage occurs to any part of the accessories or conductors. Torque wrench shall be used for fixing the Spacers, Vibration Dampers & Suspension Clamps etc. and torque recommended by the manufacturer of the same shall be applied.

3.12 Replacement

If any replacement is to be effected after stringing and tensioning or during maintenance, leg member and bracing shall not be removed without reducing the tension on the tower by proper guying techniques or releasing of the conductor. For replacement of cross arms, the conductor shall be suitably tied to the tower at tension points or transferred to suitable roller pulleys at suspension points.

3.13 Final checking, Testing and Commissioning

3.13.1 After completion of the works, final checking of the line shall be carried out by the Contractor to ensure that all foundation works, tower erection and stringing have been done strictly according to the specifications and as approved by the Employer. All the works shall be thoroughly inspected in order to ensure that :

a) Sufficient backfilled earth covers each foundation pit and is adequately compacted;

b) Concrete chimneys and their copings are in good condition and finely shaped.

c) All tower members are used strictly according to final approved drawing and are free from any defect or damage whatsoever.

d) All bolts are properly tightened, punched, tack welded and painted with zinc rich paint.

e) The stringing of the conductors and earth wire has been done as per the approved sag and tension charts and desired clearances are clearly available;

f) All conductor and earth wire accessories are properly installed;

g) All towers are properly grounded.

h) Any defect found as a result of testing shall be rectified by the contractor forthwith to the satisfaction of the Employer without any extra charges.

3.14.2 The contractor should also fulfill the requirements of pre-commissioning