NEPAL ELECTRICITY AUTHORITY

(An Undertaking of Government of Nepal)

Transmission Directorate

Grid Operation Department

BALAJU SUBSTATION UPGRADATION PROJECT

BIDDING DOCUMENT
FOR

Procurement of
Plant for Design, Supply, Construction, Installation, Integration, Testing and Commissioning of 132 kV/11 kV Substation at Balaju

International Competitive Bidding (ICB)
Single Stage, Two -Envelope Bidding Procedure

Invitation for Bids (IFB) No.	**:**	**GOD/2080/081-05**
Employer	**:**	**Nepal Electricity Authority**
Country	**:**	**Nepal**

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CHAPTER 1

PROJECT SPECIFIC REQUIREMENTS

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CHAPTER 1: PROTECT SPECIFIC REQUIREMENT (PSR)

1. GENERAL

Nepal Electricity Authority (NEA) intends to upgrade existing 132/66/11 kV Balaju substation and now NEA intends to construct new double circuit 132kV GIS at existing substation and a 132/11 kV substation for the demand management of Kathmandu Valley.

The works are under the upgradation of the existing substation system and hence requires site clearance including the dismantling of existing building, outdoor gantry, BPI structures, transformers, firewalls and their foundation and replacement of 11 kV Switchgear panels; and proper storage of dismantled items in the nearby yard.

This specification describes the requirements for construction of the substation on a turnkey basis.

1.1 Associated Transmission System

The following transmission lines are associated with substation: -

i. Suichatar – Balaju 132 kV Single Circuit Transmission Line (along with OPGW)

2. INTENT OF SPECIFICATION

This specification covers design, engineering, manufacture, fabrication, testing at manufacturers works, delivery, unloading at site, storage, erection, testing and commissioning at site complete for the execution of substation works.

2.1 Balaju Substation

i. Upgrading existing 132/66/11 kV Balaju Substation. The work will involve dismantling and site clearance as mentioned above and the installation of new 132/11 kV, 3 X 45 MVA 3-phase Power Transformer along with new 132 kV GIS. The existing 132 kV Suichatar Overhead line, currently charged at 132 kV, shall be disconnected from existing 132 kV GIS and suitably connected to newly constructed 132 kV GIS.

ii. Connecting new 132 kV GIS with existing 132 kV GIS via 132 kV Three Phase GIS Bus Duct.

iii. Structures to be dismantled in proposed substation location and storage at a nearby depot as designated by NEA.

2.2 The Contractor is required to design and construct the substation as per the site condition based on the indicative layout drawings provided in **Chapter 22-Drawings (**DWG-EE-07).

2.3 It is the intent of this specification to describe primary features, materials, and design & performance requirements and to establish standard quality for the work.

2.4 The specification is not intended to specify the complete details of various practices of manufactures/ bidders, but to specify the requirements with regard to performance, durability and satisfactory operation under the specified site conditions.

2.5 The detailed scope of work is brought out in subsequent clauses of this section

Civil Works	**External Electrical Works**	**Transformers**	**Switchgear**	**Design and Integration**
Dismantling of Existing Building, civil structures and equipment as per site requirement	All equipment necessary to connect new 132 kV GIS	3 X 45 MVA, 132/11 kV Power Transformer Dismantling of existing civil structures and equipment as per site requirement and depot at designated by NEA	132 kV GIS switchgear as described in the specification	The substation shall be designed by the contractor and shall follow NEA requirements.
132 kV GIS Building				All the equipment and protection shall be integrated by the contractor and commissioned in conjunction/coordination with NEA.
Switchgear and Control Building (Battery room, control rooms etc.)		Station Transformer 315 kVA, 11/0.4 kV.	12 kV Switchgear as described in the specification. Dismantling of the existing 11 kV switchgear panel and installation of new ones and integration with new system.	The substation shall be constructed as fully integrated turnkey packages.
Transformer Bays and associated cable trench				
Other Facilities required by NEA and described in the specification				

3. SCOPE OF WORKS

3.1 The scope of this specification covers the following:

i. Dismantling of dilapidated building, outdoor switchyard structures, existing old transformers, site clearance and management of dismantled equipment, materials in nearby store/yard as designated by NEA.

ii. Truncate the existing Termination arrangement of existing 132 kV Suichatar line on the rooftop of the existing GIS switchgear building and connection to the line bay in the new substation (GIS) using bus duct for interconnection. Please refer to the attached SLD.

iii. Construction and Upgradation work at Balaju Substation with the provision of following bays as per Single Line Diagram and as indicated in Bid Price

Schedule.

iv. The specification includes design, engineering, manufacture, fabrication, testing at manufacturers works, supply and delivery, unloading at site, storage, erection, testing and commissioning at site of the complete 132 kV indoor SF6 gas insulated switchgear (GIS), 132 kV XLPE Copper cable for making connections with outdoor transformers, and outdoor equipment. Also included in the specification are control and protection, substation automation system, communication system and other electrical and mechanical auxiliary systems, associated civil works, internal roads, drains, necessary buildings etc. as described below:

3.2 132 kV GIS

The SF6 Gas Insulated Switchgear (GIS) of Double Bus Single Breaker Bus Scheme shall be 145 kV, 2000 A, 40 kA short circuit rating for 1 second and involves installation of following number of Bays:

i. One (1) no. of bays to terminate one 132 kV S/C line from Suichatar.

ii. One (1) no. of bay for interconnecting new 132 kV GIS with existing 132 kV GIS.

iii. 132 kV Transformer Bay: Three (3) nos. of bay 132/11 kV, 45 MVA 3-phase Outdoor Transformer.

iv. 132 kV Bus Coupler Bay: One (1) number

3.2.1 Busbar Interconnection

In Balaju Substation, there is an existing 132 kV GIS system with single busbar arrangement. The Single Line Diagram of existing system is presented drawing list. The existing busbar needs to be connected with new 132 kV GIS system. It is proposed to connect one bay of new 132 kV GIS with existing GIS via three phase busduct of similar rating to that of existing GIS. The connection at existing side will be made via bus bar extension link that has been shown in Figure 1.

Figure 1 : GIS Adaptor at Existing 132 kV GIS

3.2.2 11 kV System

11 kV Indoor Metal Clad Switchgear for 3 no. Transformer Incomer Bay 132/11 kV, 24 nos of outgoing feeder bays (in double tier arrangement), 2 no. Bus coupler or as per Bid Price Schedule. The 11 kV Indoor Switchgear shall be kept in existing 132 kV/66 kV GIS Building.

4. DETAILED SCOPE OF WORKS

The detailed scope of works is given in the following sections:

Design, engineering, manufacture, testing, supply including transportation and insurance, storage, erection, testing and commissioning of following equipment and items at 132/66/11 kV Balaju substation complete in all respects:

4.1 145 kV Gas Insulated Switchgear (GIS) System

145 kV SF6 gas insulated switchgear shall have double bus bar arrangement. The switchgear shall be complete with all necessary terminal boxes, SF6 gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment and piping and support structures along with base plate and foundation bolts for fixing the switchgear with raft foundations complete in all respects and consisting of the following major items.

4.1.1 The 145 kV, 40 kA for 1 second SF6 gas-insulated metal enclosed Bus Bar module each comprising of:

i. Three/Single (isolated) phase nos. of 2000 A, 40 kA for 1 second, SF6 gas-insulated metal enclosed bus bar of 145 kV each set comprising of the following: Three (3) individual 1-phase/one 3-phase bus bars enclosures running the length of the switchgear to interconnect each of the circuit breaker bay modules in Double Bus bar system.

ii. One (1) no. of 3-phase, group operated high speed safety-grounding switch, complete with manual and motor driven operating mechanisms.

iii. One (1) nos. of three-phase, 1250 A, 40 kA group operated isolator complete with manual and motor driven operating mechanism.

iv. One (1) no. three (3) Phase/ 3 number of single-phase potential transformers, complete with isolating switch and safety grounding switch suitable for double bus arrangement

v. One Bay Module Control Cabinet/Local Control Cubicle for Bus Bar System.

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

vii. End Piece module with the test link for Future extension of Bus bar module. 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. The contractor shall make available all the details such as cross section, gas pressure etc. required to design adopted in future extension of GIS during detailed engineering stage.

4.1.2 145 kV, 40 kA for 1 second, SF6 gas insulated metal enclosed, Transformer Bay module each set comprising of: -

i. One (1) set of three- phase, 1250 A, 40 kA, 1s SF6 gas insulated circuit breaker, complete with operating mechanism.

ii. Three (3) nos. 1-phase, 5-core, multi ratio, current transformers as per single line diagram.

iii. Three (3) nos. of three-phase, 1250 A, 40 kA group operated isolator complete with manual and motor driven operating mechanism.

iv. Two (2) no. 3-phase, group operated safety grounding switch complete with manual and motor driven operating mechanism

v. One (1) number 3-phase, high speed fault makes grounding switch complete with group operated manual and motor driven operating mechanism

vi. Local Control Cubicle (LCC).

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

viii. 145 kV, 1250 A three–phase SF6 to cable termination.

4.1.3 145 kV, 40 kA for 1 second, SF6 gas insulated metal enclosed Line feeder bay module, each set comprising of: -

i. One (1) set of three-phase, 2000 A, 40 kA, SF6 insulated circuit breaker complete with operating mechanism.

ii. Three (3) nos. of 1-phase, 5-core, multi ratio, current transformers as per single line diagram.

iii. Three (3) nos. of 2000 A, 40 kA group-operated disconnectors, each complete with manual and motor driven operating mechanism.

iv. Two (2) nos. 3-phase, group operated safety grounding switch complete with manual and motor driven operating mechanism.

v. One (1) number 3-phase, high speed fault make grounding switch complete with group operated manual and motor driven operating mechanism.

vi. Local Control Cubicle (LCC)

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

4.1.4 145 kV, 40 kA for 1 second, SF6 gas insulated metal enclosed bus interconnecting bay module, each set comprising of: -

i. One set of three-phase, 2000 A, 40 kA, SF6 insulated circuit breaker complete with operating mechanism.

ii. Six (6) nos. of 1-phase, 3-core, multi ratio, current transformers i.e., three on both sides of three phase bus duct as per single line diagram.

iii. Four (4) nos. of 3-phase of 2000 A, 40 kA group-operated disconnectors i.e., three on newly proposed bus and one on existing bus sides of three phase bus duct, each complete with manual and motor driven operating mechanism.

iv. Three single-phase SF6 gas insulated GIS Bus duct for interconnection between GIS hall (outer edge of wall) and existing GIS.

v. Three (3) nos. 3-phase, group operated safety grounding switch complete with manual and motor driven operating mechanism.

vi. One (1) number 3-phase, high speed fault make grounding switch complete with group operated manual and motor driven operating mechanism.

vii. Local Control Cubicle (LCC).

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

Note: The contractor shall make the connection with existing 132 kV GIS busbar. The connection shall consist of disconnector and current transformer towards the existing end. It is proposed to connect one bay of new 132 kV GIS with existing GIS via three phase busduct of similar rating to that of existing GIS. For the clarification on the interconnection scheme bidder should visit the site before bidding.

4.1.5 145 kV, 40 kA for 1 second, SF6 gas insulated metal enclosed **Bus Coupler Bay module** comprising of: -

i. One no. of three-phase, 2000 A, 40 kA SF6 gas-insulated circuit breaker complete with operating mechanism.

ii. Three (3) nos. 1-phase, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker as per single line diagram.

iii. Two Nos (2). 3-phase, 2000 A, 40 kA, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iv. Two (2) Nos. 3-phase, group operated safety-grounding switches, complete with manual and motor driven operating mechanisms.

v. Local Control Cubicle (LCC).

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

4.1.6 Surge Arrestor and Support Structure as required shall be part of the GIS.

4.1.7 Mandatory Spares as per BPS (Bid Price Schedule).

4.1.8 Other Equipment at Balaju Substation

i. Testing and Maintenance Equipment shall be required of 145 kV GIS as per BPS.

ii. SF6 gas ducts (including support structures, gas monitoring devices, gas barrier pressure switch) from outside (i.e., wall surface) of the GIS building to center line of SF6/Air Bushing shall be in the proposed scope. SF6 gas ducts inside GIS hall are part of GIS Module.

iii. SF6 to Air Bushing along with terminal connectors and support structure for outdoor connections to connect GIS with Transformers and overhead lines are part of GIS Module.

iv. 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, 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.

v. Supply, erection, testing and commissioning of 3 nos. 45 MVA, 132/11 kV 3-phase transformer. The scope also includes supply of transformer bushing end terminal connectors suitable for 132 and 11 kV cable connection. Transformer Bushing for voltage of 52 kV and above shall be Resin Impregnated Paper (RIP)/Resin Impregnated Synthetic (RIS) bushing with composite polymer insulator, which shall be manufactured and tested as per latest IEC Standards.

vi. One no. of 315 kVA, 11/0.4 kV LT Transformer.

vii. Sub-station automation system based on IEC 61850 including hardware and software for remote control station along with associated equipment for integration to existing SAS System of following bays (bay as defined in

Chapter 18 Control and Relay Panels):

- 132 kV: 1 Line and 1 Interconnecting Bays
- 132 kV: 3 Transformer Bays
- 132 kV: 1 Bus Coupler Bay
- 11 kV: 29 nos. of switchgear
- Auxiliary System: 1 Set (400 V AC system)

viii. The contractor shall also supply necessary BCU for monitoring and control of auxiliary supply with auxiliary transformer.

ix. Further, the upgraded Balaju substation shall be equipped with Substation Automation System (SAS System) based on IEC 61850. Integration of proposed scheme with the existing SAS system and communication with Load Dispatch Centre (LDC) and Master Control Centre (MCC) are in the present scope.

x. Complete relay and protection system for 132 kV bays (Line bays and Transformer Bays), 11 kV feeder, Auxiliary system are under present scope as per Chapter– 19 Control and Relay panels.

xi. Fire protection system (HVW spray and hydrant system) for 3 nos. of 45 MVA, 132/11 kV 3-phase transformer including extension of main water header. The HVWS system shall be tapped from the new fire water system. The tapping point location system piping layout shall be provided by the successful bidders during detail engineering to NEA. The firefighting of rest of the equipment shall be done as mentioned in Chapter 12- Fire Protection

xii. The earth mat for GIS earthing and the switchyard earthing, and lightning protection required as per specification is in the Bidder's scope. All the AIS/GIS equipment, Transformer shall be earthed.

xiii. Complete lighting and illumination of switchyard, access road, GIS building, control building, and guard house, pump house is under present scope of work.

xiv. EoT Crane (5 tone) as per Technical Specification is proposed in the GIS Buildings for handling and subsequent maintenance of GIS equipment. The bidder is required to keep the weight and size of the packages accordingly. Slings of required capacity for handling of GIS equipment/components shall be provided by the Contractor. 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.

xv. Ventilation system for GIS halls.

xvi. Air Conditioning system for control building.

xvii. Visual Monitoring System for substation premises.

xviii. LT switchgear (AC/DC Distribution boards)

xix. 1.1 kV grade Power and Control Cable along with complete accessories to complete the scope of works.

xx. 145 kV XLPE Copper Power Cables along with complete accessories to complete the scope of works.

xxi. 12 kV XLPE Copper Power Cables along with complete accessories to complete the scope of works.

xxii. 220 V Batteries and Battery Chargers (800 Ah Battery).

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

xxiv. Design, engineering, manufacture, testing, and supply on FOR destination basis including transportation and insurance, storage at site.

4.1.9 Civil works at Balaju Substation- The scope of work shall include but shall not be limited to the following based on design and drawings to be developed by the contractor:

i. PEB GIS Building for 132 kV: The size of 132 kV GIS Building shall be suitable to accommodate 6 number of bays in addition to the maintenance yard for future use. Necessary provision for future expansion shall be made in GIS Hall. EOT crane shall be provided in the 132 kV GIS Hall as per relevant Chapter of technical specification.

ii. Control Room Building complete as per technical specifications.

iii. Foundation for GIS Hall Building, AHU Room, Control Room Building.

iv. Foundation for GIS bus duct supporting structures inside and outside the GIS hall.

v. Foundation for 3 nos. of 132/11 kV, 45 MVA, 3-phase transformers etc. along with jack pad, rails, locking device, Oil catchment, soak pit to complete the scope of works.

vi. Fire resistant wall between Transformers as per enclosed General Arrangement (GA) drawing.

vii. Foundation for GIS equipment, GIS (SF6) to Air bushing, and supporting structure.

viii. Cable trenches inside GIS hall, control room building and 11 kV switchgears room.

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

x. All roads as shown in GA drawing including culverts. The roads shall be of RCC type.

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

xii. Drains along with drain crossings with cable trenches. Drain layout shall be developed by the contractor.

xiii. Fencing for switchyard and switchyard gates.

xiv. Soil investigation of substation location has been carried out by the Employer, the report of which will be made available for reference. The Contractor shall carry out further soil investigation works if required at no added cost to the

Employer.

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

xvi. Foundation for water tank, firefighting pump houses and fire hydrant system wherever required shall be as per design and drawings of contractor vendor drawings.

xvii. Dismantling of existing building structure, foundation, equipment etc. and depot at site storage as directed by the Employer. The dismantle cost shall be included with the bid prices in the price schedule.

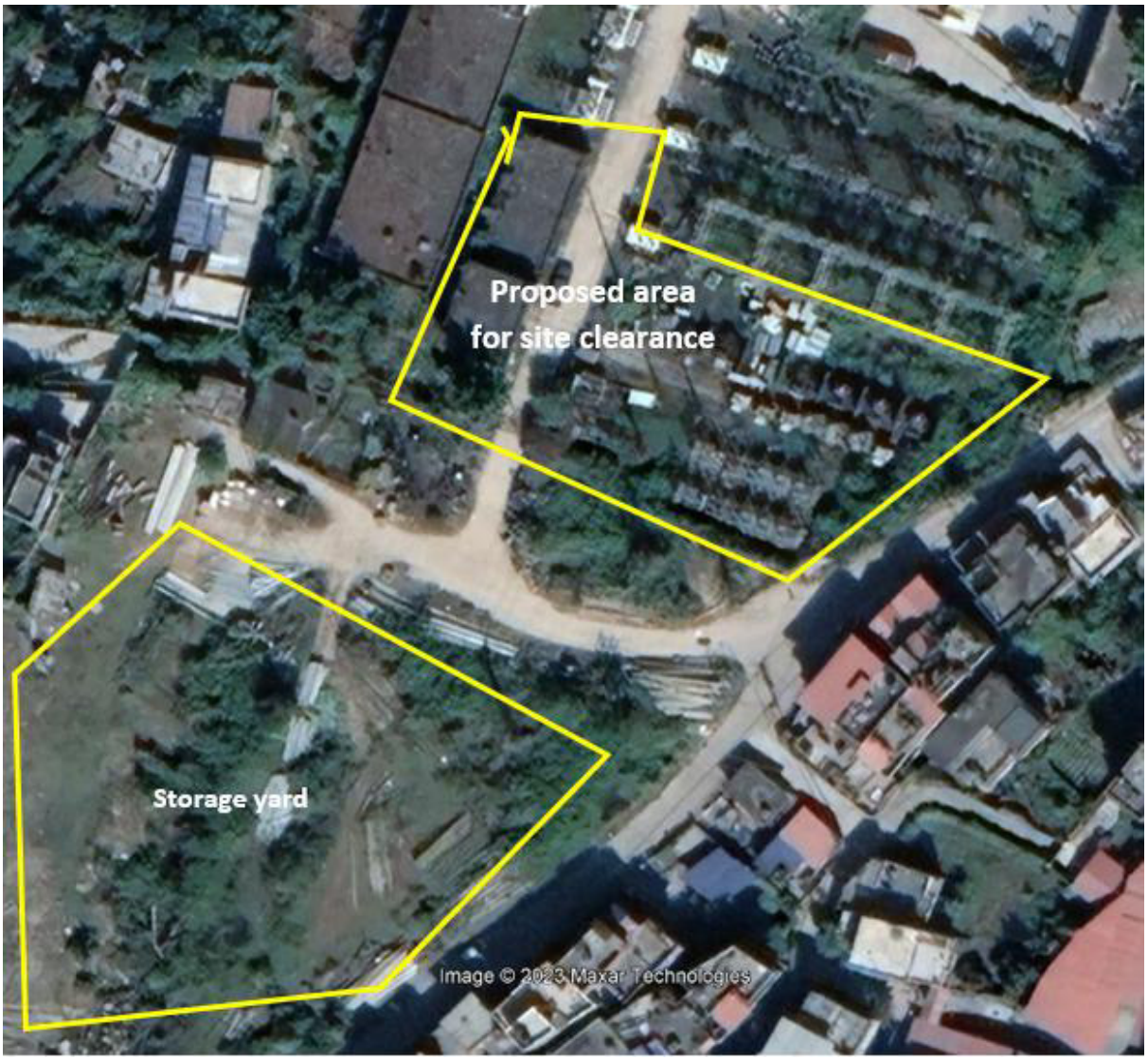

Figure 2: Tentative locations of site clearance and storage

4.2 Site Visit

The Bidders are advised to visit the substation site and acquaint themselves with the topography, infrastructure and also the design philosophy. Before proceeding with the construction, the Contractor shall fully familiarize himself with the site conditions. Though

the Employer shall endeavor to provide the required information, it shall not be binding 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 and 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.

4.3 Design and Coordination

4.3.1 The employer will provide the Substation Design Report (Feasibility Based) to the successful bidder. On the basis of the Employer's design, the Contractor shall review the design and make necessary changes wherever required based on the type of equipment supplied by him and submit to the Employer for approval.

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

4.3.3 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.

4.3.4 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 Contractor and deemed to be included in the Contract price. The Contractor shall carry out the route survey along with the transporter and submit the detail proposal and methodology for transportation of transformers for approval of Employer within three months from the date of award.

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

4.3.6 Contractor shall make his own arrangement at his own cost for the construction water supply along with all further distribution for the same. In any case, Employer shall not be responsible for any delay in works because of non-availability or inadequate availability of water.

4.3.7 Contractor shall make his own arrangement at his own cost for the storage of the materials. In any case, Employer shall not be responsible for non-availability of storage area inside the substation boundary. Contractor shall maintain separate register for all certificates of Inspection (CIP) and Material Inspection Clearance Certificates (MICC)

issued by Employer/Consultant. For each issue of CIP/MICC a serial number will be given and it shall be recorded by inspection engineer on CIP clearances/MICC.

4.3.8 Design of substation and its associated electrical and mechanical auxiliaries systems includes preparation of single line diagrams, electrical layouts, Erection key diagrams, earthing system, direct stroke lightning protection, electrical and physical clearance diagrams, control and protection schematics, wiring and termination schedules, foundation and cable trench layout drawing including associated invert levels, civil designs (as applicable) and drawings, firefighting protection and ventilation, air conditioning system, lighting/illumination and other relevant drawings and documents required for engineering of all facilities within the fencing to be provided under this contract, are covered under the scope of the Contractor. However, the Employer has designed the substation and the Contractor can review the same and make changes wherever required.

4.3.9 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.

5. PHYSICAL AND OTHER PARAMETERS

5.1 **Location of the** Substation – The location of substation is indicated below:

The substation is located at Balaju of Kathmandu Metropolitan City.

5.2 Meteorological data: -

i. Altitude above sea level: 1320 m

ii. Ambient Air Temperature: 400 C (max) - 00 C (min)

iii. Average Humidity (in %): 40– 95 %

iv. The substation locations are lying in the wind speed Zone 4 (as per IS 875 i.e., 47 m/s).

v. Seismic Requirement for Substations shall be based on IS 1893.

The above specifications are applicable for all the equipment, structures and buildings.

6. SCHEDULE OF QUANTITIES

The requirement of various items/equipment and civil works are indicated in Bid Price Schedule **(Volume 3).**

All equipment/items and civil works for which bill of quantity has been indicated in Bid Price Schedule shall be payable on unit rate basis/quoted rate basis. During actual execution, any variation arises during the execution of the project shall be finalized by the mutual understanding of among client consultant and contractor.

Wherever the quantities of items/works are not indicated and quantified (i.e., Lump sum 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 Bid Price Schedule. For erection hardware items, Bidders shall estimate the total requirement of the works and

indicate module-wise lump sum price bay wise and include the same in relevant Bid Price Schedule 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 as per bid price Schedules are indicated at **Annex – IV** of this section.

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 Employer.

7. BASIC REFERENCE DRAWINGS

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 the Employer.

The auxiliary transformer shall be used to feed the substation auxiliaries. HT side of auxiliary transformer shall be connected through 11 kV HT cable to HT Panel. These auxiliary transformers should not be used for construction purpose. The detailed scheme is showed in the single line diagram.

8. DIFFERENT CHAPTERS OF TECHNICAL SPECIFICATION

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

1)	Chapter 1: Project Specification Requirement
2)	Chapter 2: General Technical Requirement
3)	Chapter 3: Gas Insulated Switchgear
4)	Chapter 4: Outdoor Switchgears
5)	Chapter 5: Transformer
6)	Chapter 6: Indoor 11 kV Switchgear
7)	Chapter 7: LT Switchgear
8)	Chapter 8: Battery and Battery Charger, UPS System
9)	Chapter 9: Lighting System

10)	Chapter 10: LT Transformer
11)	Chapter 11: Earthing and Lightning System
12)	Chapter 12: Fire Protection System
13)	Chapter 13: Power and Control Cable
14)	Chapter 14: HV Cables
15)	Chapter 15: Air Conditioning
16)	Chapter 16: Switchyard Erection
17)	Chapter 17: Structure
18)	Chapter 18: Civil Works
19)	Chapter 19: Control and Relay Panels
20)	Chapter 20: Substation Automation System
21)	Chapter 21: Technical Datasheet
22)	Chapter 22: Drawings

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

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

9. MANDATORY SPARES

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

No mandatory spares shall be used during the Commissioning of the equipment. Any spares required for Commissioning purpose shall be arranged by the Contractor. The unutilized spares if any brought for Commissioning purpose shall be taken back by the Contractor.

10. 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.

11. FACILITIES TO BE PROVIDED BY THE EMPLOYER

NEA shall make available the auxiliary HT power supply on chargeable basis at a single point in the substation. The prevailing energy rates of the NEA 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 its own necessary arrangements like diesel generator sets etc. at his own cost so that progress of work is not affected and NEA/Consultant shall in no case be responsible for any delay in works because of non-availability of power.

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.

12. SPECIFIC REQUIREMENT

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

12.2 The Contractor 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.

12.3 Augmentation and integration work related to SCADA System

12.4 In Chapter 2 GTR and other Technical Specifications, the term “Purchaser” and/or “Employer” may be read as “Owner”

12.5 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.

12.6 Erection, testing and commissioning of transformers, GIS, circuit breaker, isolators, relay and 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 Bid Price Schedule (BPS). Further, after operational acceptance of the facilities under the contract, Contractor shall provide the manufacturer warranty certificate with contact details of manufacturer in the name of Employer for the major critical components (Gas Insulated Switchgears, Power Transformers, control relays, SAS and communication equipment) for the period of five (5) years after the date of operational acceptance without any financial implication to the Employer.

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

SN	Voltage Level	Fault Level
1	132 kV	40 kA for 1 Sec
2	11 kV	31.5 kA for 1 Sec

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

12.8.1 **Training at Manufacturer's works**. The Contractor shall include in the training charges payment of per diem allowance to NEA trainees' as per NEA Financial Regulation per day per trainee for the duration of training abroad towards accommodation, meals, and other incidental expenses and to and from economy class flight ticket, local transportation, training materials and payment of USD 150 per Diem allowances per trainee per day for the duration of training.

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

i. Control and Protection, Substation Automation System and Communication System: 5 days (8 Nos. Trainees as per BPS)

ii. GIS Equipment and System (Circuit Breaker, Isolator, CT, CVT and LA) and HV GIS/AIS Substation Design: 5 Days (8 Nos. Trainees as per BPS)

iii. Transformer: 5 days (8 Nos. Trainees as per BPS)

Note: Above mentioned day of training shall be excluding the travel time.

12.9 On Job Training in Nepal: The traveling and living expenses of Employer's personnel for the training program conducted in Nepal shall be borne by the contractor. In addition, the contractor shall bear the per diem expense @ NRs. 2000.00 per person.

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

i. Control and Protection: 10 Days (10 Nos. Trainees as per BPS)

ii. Substation Automation System including integration aspect of existing SCADA (of Siemens supplied SINAUT spectrum) at Load Dispatch Centre: 10 days (10 Nos. Trainees as per BPS)

iii. Indoor GIS and Outdoor Switchyard Equipment (CT, CVT, Isolator and Circuit Breaker) Operation and Maintenance: 10 days (10 Nos. Trainees as per BPS)

iv. Operation and Maintenance of Transformer: 10 Days (10 Nos. Trainees as per BPS)

12.10 All RCC shall be of M-25 grade 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.

12.11 The frequency range for the earthquake spectra shall be as per IEC-62271-300.

12.12 One number of each Energy meter for the record purpose is to be provided for each 132 kV bays under present scope of contract, meeting the requirement as specified at Annex – V.

12.13 Non-CFC refrigerant shall be utilized for Air conditioning system, under the scope of Contract.

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

12.15 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.

12.16 In the Sub-station automation system, each gas tight compartments of 132 kV 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.

12.17 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 and statuary requirements as per the local laws for importing, handling and storage of SF6 gas in Nepal. For this purpose, Employer shall extend necessary assistance (documentation etc.) for obtaining such clearance and licenses, however the complete responsibility for submitting the application and co-ordination with authorities shall be in the scope of Contractor.

12.18 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.

12.19 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 132kV GIB (SF6 Gas insulated Bus Duct) of Line feeder module and interconnecting GIS bay 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.

12.20 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.

12.21 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, without any extra cost to NEA (If not mentioned specifically in the BPS). The contractor shall carry out the route survey along with the transporter and submit the detail proposal and methodology for transportation

13. PRE-COMMISSIONING, COMMISSIONING, TRIAL-RUN AND COMPLETION

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

i. Pre commissioning: As per relevant Chapters.

ii. Commissioning: Charging of the Facilities at rated voltage.

iii. 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.

iv. 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 or failure in the respective equipment, the Contractor shall rectify the problem and after rectification, continuous 72 (seventy-two) hours period start after such rectification.

v. Completion: Upon successful completion of Trial-run.

vi. 'Guarantee Test(s)' and/or 'Functional Guarantees' are applicable for all the equipment.

ANNEX-I

1. LIST OF PREFERRED (SHORTLISTED) MAKE

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

i. Main Protection Relays, Control and Relay Panel, Substation Automation System From: Hitachi ABB, 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: HITACHI ABB, SIEMENS, TOSHIBA, FUJI, GE or equivalent.

iv. VCB Switchgear from HITACHI ABB, 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 transformer and associated control equipment shall be from MR Germany or Hitachi or ABB Sweden or equivalent

vi. AVR: The AVR equipped on the RTCC shall be from MR Germany or Hitachi ABB or equivalent

vii. Temperature Indicators: shall be from AB Khilstrom, Sweden or equivalent

viii. Gas Insulated Substation: Hitachi ABB, GE or equivalent.

ix. Communication System: NOKIA, NOKIA SIEMENS, SIEMENS, HITACHI ABB, or equivalent

ANNEX - II

SPECIFICATION FOR DIGITAL PROTECTION COUPLER (AS APPLICABLE)

1. 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 HV systems and shall operate on 48 V DC (+10%, -10%). It shall provide minimum four commands. These commands shall be suitable for Direct tripping, Inter-tripping and Blocking protection schemes of HV lines.

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

1.2.1 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 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.

1.2.2 Loop testing

An automatic loop testing routine shall check the tele protection 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 signalling 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.

i. Shall work in conjunction with SDH terminal equipment.

ii. It shall communicate on G 703 (E1.2 Mbps)

iii. Full Duplex operation

iv. Auto loop facility shall be provided

v. Shall meet IEC 60834-1 standard

vi. Shall be able to transmit upto 4 commands with trip counter simultaneously or sequentially in one 2 Mbps channel

1.2.3 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 and all accessories to download events including carrier receipt and transmit shall be acceptable. Laptop for the above shall be supplied.

1.2.4 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.

1.2.5 The DPC can be either housed in offered Control and Protection Panel or in separate panel.

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

i. General equipment interface tests:

ii. Insulated voltage withstand tests

iii. Damped oscillatory waves disturbance test

iv. Fast transient bursts disturbance test

v. Electrostatic discharge disturbance test

vi. Radiated electromagnetic field test

vii. RF disturbance emission test

viii. Specific power supply tests

ix. Power supply variations

x. Interruptions

xi. LF disturbance emission

xii. Reverse polarity

xiii. Tele-protection system performance tests

xiv. Security

xv. Dependability

xvi. Jitter

xvii. Recovery time

xviii. Transmission time

xix. Alarm functions

xx. 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)

1.2.7 All the above tests (except temperature and humidity tests) shall be as per IEC 60834-1 and the standards mentioned therein.

i. Relays

- Impulse voltage withstand test as per IEC 60255.
- High frequency disturbance test as per IEC 60255.

ii. The protection signalling equipment shall be of modular construction and preferably mounted in the Relay panels. Cabling between the protection signalling equipment and protection relays and between protection signalling equipment and communication equipment shall be in the scope of contractor

iii. 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.

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

v. Major Technical Particulars

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

- Power supply 48 V DC +10%, -10%
- Number of commands 4 (four)
- Operating time < 7 ms
- Back-to-back operate time without propagation delay ≤ 8 ms
- Interface to Protection relays

Input:	:	Contact Rating
Rated voltage	:	220 Volts DC
Maximum current rating	:	5 Amps
Output:	:	Contact Rating
Rated voltage	:	220 Volts DC
Rated current	:	0.1 A DC
Other parameters	:	As per IEC-255-0-20

- Alarm contact

Rated voltage	:	220 Volts DC
Rated current	:	0.1 A DC
Other parameters	:	As per IEC-255-0-20

- Digital communication interface: G 703(E1)

ANNEX – III

1. TECHNICAL SPECIFICATIONS FOR VISUAL MONITORING SYSTEM

1.1 Visual monitoring system for watch and ward of Substation premises:

Visual monitoring system (VMS) for effective watch and ward of substation premises covering the areas of entire switchyard, Control Room cum Administrative building, Firefighting pump house, stores 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.

1.2 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:

i. All the Transformers (including future scope)

ii. All the Entrance doors of Control Room Building and Fire-fighting Pump House and Switchyard Panel room.

iii. Each bay of GIS Hall

iv. Main entrance Gate

v. All other Major Equipment (such as CB, CT, CVT, SA etc. for present and future)

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

2. TECHNICAL REQUIREMENTS OF MAJOR EQUIPMENT OF VISUAL MONITORING SYSTEM.

2.1 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.

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

2.3 The system shall use video signals from various types of indoor/outdoor CCD color 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.

2.4 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.

2.5 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.

3. SYSTEM REQUIREMENTS:

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

3.2 All cameras may be connected through a suitable LAN, which shall be able to perform in 132 kV class sub-station environment without fail.

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

3.4 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.

3.5 Facility of Camera recording in HD (1280 X 720p), D1, 4CIF, CIF, VGA, as well as in any combination i.e., any camera can be recorded in any quality.

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

3.7 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.

3.8 System shall be triplex i.e., it should provide facility of Viewing, Recording and Replay simultaneously.

3.9 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.

3.10 System shall have provision of WAN connectivity for remote monitoring.

3.11 The equipment should generally conform to Electromagnetic compatibility requirements for outdoor equipment in HV switchyards. The major EMC required for Cameras and other equipment shall be as under:

- Electrical Fast Transient (Level 4) – As per IEC 61000-4-4
- Damped Oscillatory (1 MHz and 100 KHz) (level 3)– As per IEC 61000-4-12
- AC Voltage Dips and Interruption/Variation (level 4)–As per IEC 61000-4-12
- Electrostatic Discharge (Level 4) As per IEC 61000-4-2

- Power Frequency Magnetic Field (level 4) - As per IEC 61000-4-8
- Ripple on DC Power Supply (level 4) As per IEC 61000-4-17

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

4. VIDEO SURVEILLANCE APPLICATION SOFTWARE

4.1 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.

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

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

4.4 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.

4.5 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.

4.6 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.

4.7 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.

4.8 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.

4.9 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.

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

5. NETWORK VIDEO RECORDER

The Network Video recorder shall include at least Server (min 3.0 GHZ, 4 GB RAM, 3000 GB 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:

Server Specification	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
Recording and Display Frame Rate	Real-time 25 frames per second per channel, manual select
Recording Resolution	(PAL): 1280X720 , 704(H) x 586(V) It should be possible to select lower resolutions
Compression Method	H.264/MPEG-4 or better and latest
Video Motion Detection Capable	Standard and built-in (selectable in menu)
Monitoring Options	Split screen 1, 2, 4, 8, 16, 32 or more cameras
Playback Options	Search, still image capture
Alarm/Event Recording Capable	To be provided with built-in external alarm input/ output ports minimum (8 in, 2 out)
Network Operation Capable	To be provided by using WAN or LAN router
Remote Internet Viewing Capable	Using WAN or LAN router
HDD Storage Consumption	1GB ~ per hour / channel variable based on frame speed and resolution settings, as well as compression
Operation	Triplex operation (simultaneous recording, playback, network operation)
Number of Video Channel	32
Audio Recording Capable	32
Input Voltage	230 V AC or equivalent with UPS as a backup for minutes (360 min.)

6. VMS CAMERA

6.1 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 fixed/PTZ controls are required for installation at gates of the NEA premises as per the direction of Engineer-In-Charge.

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

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

6.4 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.

6.5 The camera should be able to detect motion in day and night environments having light intensity of Color: 0.5 Lux; Band W:0.05 Lux

6.6 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 132 kV switchyard.

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

6.8 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.

7. OUTDOOR IP FIXED MEGAPIXEL CAMERA SPECIFICATIONS (FOR MAIN GATE)

SN	Particular	Details
1.	Image Sensor	2-megapixel Progressive, 1/3" CMOS/CCD sensor, Minimum illumination 0.1 Lux
2.	Min Luminous	0.5 LUX(Color) 0.05 Lux (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: 1600 x 1200, 1280 x 960, 1280 x 720, Secondary stream: 800x600,400x288,192x144
8.	Video Parameters	Brightness, hue, contrast, saturation and image quality
9.	Video Frame Rate	PAL: 1-25 frames/second NTSC:1-30 frames/second
10.	Video Compression BR	32 kbit/S – 6 Mbit/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°C
14.	Operating Humidity	10 ~ 90%

8. 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; BandW: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%

9. PTZ-KEYBOARDS

9.1 The features of PTZ shall include:

i. Fully functional dynamic keyboard/joystick controllers

ii. Controls all pan, tilt, zoom, iris, preset functions

iii. Control up to 255 units from a single keyboard

iv. Many preset options and advanced tour programming

v. Compatible with all connected cameras

9.2 Key Application

wired keyboard control operation of PTZ functions for weatherproof dome cameras

9.3 Pan / Tilt / Zoom Protocol Languages Supported

Selectable

9.4 PTZ Data Transfer Baud Rates Supported

selectable 1200 bps / 2400 bps / 4800 bps / 9600

9.5 Additional Features

dynamic joystick for smooth camera movements, preset location option for quick access to frequently monitored areas

ANNEX-IV

1. SPARE PARTS

	Description	Unit	Quantity
I)	**For 132/11 KV 3-Phase Transformer**		
a)	Bushing of each rating with metal parts & gaskets and lifting tools	Set	1
b)	Cooler fan with Motor	No.	1
c)	Buchholz Relay (Main Tank) complete with floats and contacts	Set	1
d)	Local and Remote WTI with sensing device and contact(each)	Set	1
e)	Magnetic oil level gauge	No.	1
f)	Starters, contactors, switches & Relays for Electrical control panels (One set of each type)	Set	1
g)	Remote Tap position Indicator	No.	1
h)	Spare insulating oil to be handed over to Owner after commissioning for O&M requirement	KL	10
i)	Oil flow indicator with flow switch		
II)	**145 KV GAS INSULATED SWITCHGEAR**		
A)	**General**		
a.	SF6 gas Pressure Relief Devices, 1 Nos. of each type	Set	1
b.	SF6 Pressure gauge cum switch OR Density monitors and pressure switch as applicable (1 no. of each type)	Set	1
c.	Coupling device for pressure gauge cum switch for connecting Gas handling plant	Set	1
d.	Rubber Gaskets, "O" Rings and Seals for SF6 gas of each type	Set	1
e.	Molecular filter for SF6 gas with filter bags(20% of total weight)	Set	1
f.	All types of Control Valves for SF6 gas of each type	Set	1
g.	SF6 gas (20 % of total gas quantity)	Set	1
h.	All types of coupling for SF6 gas (1 no. of each type)	Set	1
i.	Pipe length (Copper or Steel as applicable) for SF6 Circuit of each type	Set	1
j.	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		
j.1	For 3 Phase Enclosure if applicable	Nos.	1
j.2	For Single phase enclosure if applicable	**Nos.**	1

	Description	Unit	Quantity
k	Locking device to keep the Dis-connectors (Isolators) and Earthing switches in close or open position in case of removal of the driving Mechanism	Sets	1
l	Bus Support insulator of each type for 3 phase/single phase enclosure.	Nos.	1
m	SF6 to air bushing (145kV) as applicable	Sets	1
B)	**145 KV SF6 CIRCUIT BREAKER**		
a.	Complete Circuit Breaker pole of each type & rating complete with interrupter, main circuit enclosure and Marshalling Box with operating mechanism	Nos.	1
b.	Rubber gaskets, `O' rings and seals for SF6 gas (1 No. of each type)	Sets	1
c.	Trip coil assembly with resistor as applicable	Sets	1
d.	Closing coil assembly with resistor as applicable.	Sets	1
e.	Relays, Power contactors, push buttons, timers & MCBs etc. (1 No. of each type &rating)	Sets	1
f.	Closing coil assembly (including valve, if applicable)	Sets	1
g.	Trip coil assembly (including valve, if applicable)	Sets	1
h.	Auxiliary switch assembly of each type	Sets	1
C)	**145 KV ISOLATORS:**		
a.	Complete set of 3-phase dis-connector including main circuit, enclosure, driving mechanism (one no of each type)	Sets	1
b.	3-phase Earthing switch including main circuit, enclosure, driving mechanism.	Sets	1
c.	Copper contact fingers for dis-connector male & female contact for one complete (3-phase) dis-connector of each type and rating	Sets	1
d.	Copper contact fingers for earthing switch male & female contacts, for one complete(3-phase) earthing switch of each type and rating	Sets	1
e.	Open / Close contactor assembly, timers, key interlock for one complete (3 phase) dis-connector and (3 phase) earthing switch (1 No. of each type and rating)	Sets	1
f.	Push button switch - (1 No. of each type & rating) as applicable	Sets	1
g.	Limit switch and Aux. Switches for complete 3 phase equipment		
g.1	For isolator	Sets	1
g.2	For earth switch	Sets	1
D)	**145 KV CURRENT TRANSFORMER**		
a.	Gas insulated complete CT of each type and rating with enclosure.	Lot	1
b.	Secondary bushing of each type	Sets	1

	Description	Unit	Quantity
E)	**145 kV VOLTAGE TRANSFORMER**		
a.	Gas insulated complete PT of each type and rating with enclosure.	Nos.	1
(F)	120 kV SA		
i)	Complete LA	No.	1
ii)	Surge counter/monitor	Nos.	2
(III)	**C&R PANELS**		
i)	Transformer protection panel :		
a)	Transformer differential protection relay	No.	1
b)	REF protection relay with non-linear resistor	No.	1
c)	Directional over current & E/F Protection Relay	No.	1
ii)	Line protection panel (for interconnecting bay)		
a)	Differential Protection relay	No.	1
iii)	Breaker Relay panel: Part of CRP		
a)	Trip circuit supervision relay	Nos.	2
b)	Self-reset trip relay (relay of each type)	Set	1
c)	Hand reset trip relay (relay of each type)	Set	1
d)	Timer relay (relay of each type)	Set	1
e)	DC supervision relay (relay of each type)	Set	1
f)	Flag relays (relay of each type)	Set	1
g)	Auxiliary relays (relay of each type)	Set	1
(IV)	**SAS**		
i)	Bay Control Unit (IED) of each type	Set	1
ii)	Ethernet Switch of each type	Set	1
(V)	**LT TRANSFORMER**		
i)	Bushings (Each type)	Set	1
ii)	Diaphragm for pressure relief vent	No.	1
iii)	Silica gel container	No.	1
iv)	Set of Valves (Each Type)	Set	1
(VI)	**BATTERY CHARGER (220 V)**		
i)	Set of control cards	Set	1

	Description	Unit	Quantity
ii)	Set of relays	Set	1
iii)	Rectifier transformer	No.	1
iv)	Thyristor/diode	Set	1
v)	Fuses of Thyristor with indicators	Set	6
(VII)	**11 kV Switchgear**		
a)	11 kV Vacuum Interrupter for Incomer and Outgoing	No.	3
b)	Tripping Coils	No.	3
c)	Closing Coils	Set	3
d)	Spring Charging Motor	Set	1
e)	Protection Relays		
i)	3 phase Overcurrent Relay, for 11kV side one of each type	Nos.	1
ii)	Ground Fault Relay, for 11kV side, one of each type	Nos.	1
h)	Ammeter, Nos one of each rating	Nos.	1
i)	Voltmeter, Nos	Nos.	1
j)	kVA Meter, each	Nos.	1
k)	CTs of each type	set	1
l)	Operating Handle	No.	1
m)	Indicating lamps and fuses (100% of used), Lot	LS	1
n)	Breaker Trolley suitable for Double Tier System	LS	1

ANNEX –V

2. SPECIFICATION FOR METERING (INSTRUMENT) TRANSFORMER

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

2.1 Energy Meter

The Energy Meter shall have the following minimum requirement

Type	Electronic, 3 phase, 4 wire, Wye Connection, Bi-directional
Accuracy Class	0.2
Applicable Standard	IEC 60687 (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)	1 A
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.

CHAPTER 2
GENERAL TECHNICAL REQUIREMENTS

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CHAPTER 2: GENERAL TECHNICAL REQUIREMENT

1. FOREWORD

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

2. GENERAL REQUIREMENT

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

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

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

3. STANDARDS

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

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

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

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

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

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

4. SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

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

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

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

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

4.5 The equipment shall also comply to the following:

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

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

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

4.6.1 System Parameter - 132 kV and 11 kV System

SN	Description of parameters	132 kV System	11 kV System
1.	System operating voltage	132 kV	11 kV
2.	Maximum operating voltage of the system(rms)	145 kV	12 kV
3.	Rated frequency	50 Hz	50 Hz
4.	No. of phase	3	3
5.	Rated Insulation Levels		
i)	Full wave impulse withstand voltage (1.2/50 microsec.)	650 kVp	75 kVp
ii)	One minute power frequency dry and wet withstand voltage (rms)	275 kV	28 kV

SN	Description of parameters	132 kV System	11 kV System
6.	Corona extinction voltage	105 kV	
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 92 KV rms for 132 KV system	500 micro Volt	
8.	Minimum creepage distance (25 mm/kV)	3625 mm	300 mm
9.	Electrical Clearance		
i.	Phase to phase	1300 mm	280 mm Indoor
ii.	Phase to earth	1300 mm	140 mm
iii)	Sectional clearances	4000 mm	3000 mm
10.	Rated short circuit current	40 kA for 1 Sec	31.5 kA for 1 Sec
11.	System neutral earthing	Solidly earthed	Solidly earthed

Note:

The above parameters are applicable for installations up to an altitude of 1000 m above mean sea level. For **altitude exceeding 1000 m, necessary altitude correction factor shall be applicable.**

The insulation and RIV levels of the equipment shall be as per values given in the respective chapter of the equipment.

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

SN	Parameters	132 kV	11 kV
(a)	Max. System voltage Um(kV)	145	12
(b)	Impulse withstand voltage (dry & wet) (kVp)	±650	±75
(c)	Power frequency withstand voltage (dry and wet) (kV rms)	275	28
(d)	Total creepage distance (min) (mm)	3625	300

4.7 Major Technical Parameters

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

4.8 For 145 kV Circuit Breaker and Isolator

Rated voltage kV (rms)	145
Rated frequency (Hz)	50
No. of Poles	3

Design ambient temperature (°C) 50

Rated insulation levels:

1. Full wave impulse withstand voltage (1.2/50 micro sec.)	
between line terminals and ground	±650 kVp
between terminals with circuit breaker open	±650 kVp
between terminals with isolator open	±750 kVp
2. One minute power frequency dry and wet withstand voltage	
between line terminals and ground	275 kV (rms)
between terminals with circuit breaker open	275 kV (rms)
between terminals with isolator open	275 kV (rms)
Max. radio interference voltage (microvolts) for frequency between 0.5 MHz and 2 MHz in all positions of the equipment	500 (at 92 kV rms)
Minimum creepage distance	
Phase to ground (mm)	3625
Between CB Terminals (mm)	3625
System neutral earthing	Solidly earthed
Seismic acceleration	0.5g horizontal
Rating of Auxiliary Contacts	10 A at 220 V DC (as applicable)
Breaking capacity of Auxiliary Contacts	2 A DC with circuit time constant of not less than 20 ms.
Phase to phase spacing (mm)	3000 or 2700

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

4.9 FOR 145 kV CT/CVT/SA

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

Rated insulation levels:

1. Full wave impulse withstand voltage (1.2/50 micro sec.)	
between line terminals and ground for CT and CVT	±650 kVp
for arrester housing	±650 kVp
2. One minute power frequency dry and wet withstand voltage	
between line terminals and ground for CT and CVT	275 kV (rms)
for arrester housing	275 kV (rms)
Max. radio interference voltage (microvolts) for frequency between 0.5 MHz and 2 MHz in all positions of the equipment	500 (at 92 kV rms)
Minimum creepage distance	
Phase to ground (mm)	3625
System neutral earthing	Solidly earthed
Seismic acceleration	- 0.5g horizontal
Partial discharge for:	
-Surge arrester at 1.05 COV	- Not exceeding 50 pc.
-for CT/CVT	- Not exceeding 50 pc.-

4.10 For 11 kV Vacuum Circuit Breaker and Isolator:

Rated voltage kV (rms)	12
Rated frequency (Hz)	50
No. of Poles	3
Design ambient temperature (°C)	50

Rated insulation levels:

1. Full wave impulse withstand voltage (1.2/50 micro sec.)	
between line terminals and ground	±75 kVp
between terminals with circuit breaker open	±75 kVp
between terminals with isolator open	±75 kVp
2. One minute power frequency dry and wet withstand voltage	
between line terminals and ground	28 kV (rms)
between terminals with circuit breaker open	28 kV (rms)
between terminals with isolator open	28 kV (rms)
Minimum creepage distance	
Phase to ground (mm)	300
Between CB Terminals (mm)	300
System neutral earthing	Solidly earthed
Seismic acceleration	0.5 g

Rating of Auxiliary Contacts	10 A at 220 V DC
Breaking capacity of Auxiliary Contacts	2 A DC with circuit time constant of not less than 20ms.

4.11 FOR 11 kV CT/VT/SA

Rated voltage kV (rms)	12
Rated frequency (Hz)	50
No. of poles	1
Design ambient temperature (°C)	50

Rated insulation levels:

1. Full wave impulse withstand voltage (1.2/50 micro sec.)	
between line terminals and ground	±75 kVp
for arrester housing	±75 kVp
2. One minute power frequency dry and wet withstand voltage	
between line terminals and ground	28 kV (rms)
for arrester housing	28 kV (rms)
Minimum creepage distance	
Phase to ground (mm)	300
Between Terminals (mm)	300
System neutral earthing	Solidly earthed
Seismic acceleration	0.5g
Cantilever strength of bushing	350 kg (minimum)

4.12 Technical Parameters of Bushings/Hollow Column Insulators/support insulators for 11 kV (if applicable):

Rated Voltage	12
Impulse withstand voltage (Dry & Wet) (kVp)	±75 kVp
Power frequency withstand voltage (dry and wet) (kV rms)	28
Total creepage distance (mm)	300
Pollution Class-III Heavy (as per IEC 60071)	

The requirement of alternate long & short sheds stated in model technical specification shall not be applicable in case of 11 kV.

5. ENGINEERING DATA AND DRAWINGS

5.1 The list of drawings/documents which are to be submitted to the Employer shall be discussed and finalized by the Employer at the time of award. The Contractor shall necessarily submit all the drawings/ documents unless anything is waived.

5.2 The Contractor shall submit 4 (four) sets of drawings/ design documents /data / detailed bill of quantity and 1 (one) set of test reports for the approval of the Employer. The contractor shall also submit the softcopy of the above documents in addition to hardcopy.

5.3 Drawings

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

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

5.3.3 The review of these data by the Employer will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. This review by the Employer may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

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

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

5.6 Approval Procedure

The scheduled dates for the submission of the drawings as well as for, any data/information to be furnished by the Employer would be discussed and finalized at the

time of award. The following schedule shall be followed generally for approval and for providing final documentation.

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

NOTE:

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

ii. All drawings should be submitted in softcopy form, however substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version. SLD, GA & layout drawings shall be submitted for the entire substation in case of substation extension also.

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

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

v. The Contractor shall furnish to the Employer catalogues of spare parts.

vi. All As-built drawings/documents shall be certified by site indicating the

changes before final submission.

6. MATERIAL/ WORKMANSHIP

6.1 General Requirement

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

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

6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Employer.

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

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

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

6.2 Provisions for Exposure to Hot and Humid climate

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

6.3 Space Heaters

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

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

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

6.3.4 Fungi Static Varnish

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

6.3.5 Ventilation opening

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

6.3.6 Degree of Protection

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

i. Installed out door: IP- 55

ii. Installed indoor in air-conditioned area: IP-31

iii. Installed in covered area: IP-52

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

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

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

6.4 RATING PLATES, NAME PLATES AND LABELS

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

6.4.2 All such nameplates, instruction plates, rating plates of GIS, GIB, transformers, CB, CT, CVT, SA, Isolators, C & R panels, switchgears, SAS equipment shall be provided with English inscriptions.

6.5 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS

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

7. DESIGN IMPROVEMENTS / COORDINATION

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

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

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

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

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

8. QUALITY ASSURANCE PROGRAM

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

i. His organization structure for the management and implementation of the proposed quality assurance program:

ii. Documentation control system;

iii. Qualification data for bidder's key personnel;

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

v. System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;

vi. Control of non-conforming items and system for corrective actions;

vii. Inspection and test procedure both for manufacture and field activities.

viii. Control of calibration and testing of measuring instruments and field activities;

ix. System for indication and appraisal of inspection status;

x. System for quality audits;

xi. System for authorizing release of manufactured product to the Employer.

xii. System for maintenance of records;

xiii. System for handling storage and delivery; and

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

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

8.2 Quality Assurance Documents

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

9. TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

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

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

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

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

i. Lightning Impulse Test

ii. Switching Impulse Test

iii. Multiple Chopped Impulse Test (For CT)

iv. Chopped Impulse Test (For CVT)

In case the test reports are of these tests (for instrument transformers) as mentioned above are conducted earlier than 5 (five) years prior to the originally Scheduled date of bid opening, the contractor shall repeat these test(s) at no extra cost to the Employer.

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

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

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

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

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

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

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

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

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

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

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

10. TESTS

10.1 Pre-commissioning Tests

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

10.2 Commissioning Tests

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

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

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

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

11. PACKAGING & PROTECTION

11.1 All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Employer, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Employer to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes should be taken into account. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Employer takes no responsibility of the availability of the wagons.

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

12. FINISHING OF METAL SURFACES

12.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts & bolts and spring washers shall be electro galvanized to service condition 4. All steel

conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to Equivalent International Standards.

12.2 HOT DIP GALVANISING

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

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

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

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

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

i. Coating thickness

ii. Uniformity of zinc

iii. Adhesion test

iv. Mass of zinc coating

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

12.3 PAINTING

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

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

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

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

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

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

SN	Pipeline	Base color	Band color
Fire Protection System			
1	Hydrant and Emulsifier system pipeline	FIRE RED	-
2	Emulsifier system detection line – water	FIRE RED	Sea Green
3	Emulsifier system detection line –Air	FIRE RED	Sky Blue
4	Pylon support pipes	FIRE RED	
Air Conditioning System			
5	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-
6	Refrigerant gas pipeline – at compressor discharge	Canary Yellow	Red
7	Refrigerant liquid pipeline	Dark Admiralty Green	-
8	Chilled water pipeline	Sea Green	-
9	Condenser water pipeline	Sea Green	Dark Blue

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

Base Colour Direction of flow Band Colour

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

13. HANDLING, STORING AND INSTALLATION

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

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

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

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

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

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

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

13.8 Contractor shall be responsible for examining all the shipment and notify the Employer immediately of any damage, shortage, discrepancy etc. for the purpose of Employer's

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

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

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

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

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

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

13.14 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, the erected equipment does not meet the above minimum clearances, the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

13.15 Equipment Bases

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Employer. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

14. TOOLS AND TACKLES

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

15. AUXILIARY SUPPLY

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

Normal Voltage	Variation in Voltage	Frequency in Hz	Phase/Wire	Neutral connection
400 V	10	50 ± 2.5%	3/4 Wire	Solidly Earthed.
230 V	10	50 ± 2.5%	1/2 Wire	Solidly Earthed.
220 V	215 V to 230 V	DC	-	Isolated 2 wire System
48 V		DC		2 wire system (+) earthed

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

16. SUPPORT STRUCTURE

16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e., 4.0 meter from plinth level for 132 kV substations respectively. All equipment support structures shall be supplied along with brackets, angles, stools etc. for attaching the operating mechanism, control cabinets & marshalling box (wherever applicable) etc.

16.2 Support structure shall meet the following mandatory requirements:

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

17. CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

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

For connecting, ACSR conductors	Aluminum alloy casting conforming to BS:1490/ Equivalent International Standard
For connecting equipment terminals made of copper with ACSR conductors	Bimetallic connectors made from aluminum alloy casting conforming to BS:1490/ Equivalent International Standard with 2 mm thick bimetallic liner.
For connecting GI	Galvanized mild shield wire
i) Bolts nuts and plain washers	Electrogalvanized for washers below M12, for others hot dip galvanized.
ii) Spring washers for item 'a' to 'c'	Electrogalvanized mild steel

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

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

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

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

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

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

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

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

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

17.11 Tests

17.11.1 Clamps and connectors should be type tested as per NEMA CC1/ Equivalent International Standard and shall also be subjected to routine tests as per NEMA CC1/ Equivalent International Standard. Following type test reports shall be submitted for approval except for sl. no.(ii) & (iii) for which type test once conducted shall be applicable (i.e. the requirement of test conducted within last ten years shall not be applicable).

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

ii. Short time current test

iii. Resistance test and tensile test

18. CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

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

18.2 Control cabinets, junction boxes, marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be at least 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.6 mm thick stainless steel can also be used. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminum

enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

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

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

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

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

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

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

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

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

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

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

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

i. Check for wiring

ii. Visual and dimension check

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

19. TERMINAL BLOCKS AND WIRING

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

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

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

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

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

19.6 The terminal blocks shall be of extensible design.

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

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

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

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

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

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

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

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

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

20. LAMPS & SOCKETS

20.1 Sockets

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

20.2 Hand Lamp:

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

20.3 Switches and Fuses:

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

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

21. BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS

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

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

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

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

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

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

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

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

21.9 Tests

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

22. MOTORS

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

22.1 Enclosures

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

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

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

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

22.2 Operational Features

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

Motor shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system.

22.3 Starting Requirements:

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

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

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

22.3.4 Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions shall be capable of withstanding at least two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.

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

22.4 Running Requirements:

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

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

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

22.5 TESTING AND COMMISSIONING

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

i. Insulation resistance.

ii. Phase sequence and proper direction of rotation.

iii. Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

23. TECHNICAL REQUIREMENT OF EQUIPMENT

23.1 1.1 kV Grade Power & Control Cables

23.1.1 Applicable for PVC Control Cable

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

23.1.2 Applicable for PVC Power Cable

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

23.1.3 Applicable for XLPE Power Cables

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

23.2 LT Switchgear

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

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

23.3 Fire Fighting System

23.3.1 The bidder or his sub-vendor should have designed, supplied, tested, erected and commissioned at least one number fire protection system of each type described in (i), (ii) and (iii) below in installations such as power plants, substations, refineries, fertilizer plants or other industrial or commercial installations. Such systems must have been

designed and comply to International Standard code (FOC, LONDON or NFPA, USA etc.) executed during last ten (10) years and should have been in successful operation for at least 2 years as on the originally Scheduled date of bid opening.

i. Automatic hydrant type fire protection system.

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

iii. Smoke detection system.

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

ANNEXURE – A

LIST OF SPECIFICATIONS

1. GENERAL STANDARDS AND CODES

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

2. TRANSFORMERS AND REACTORS

IEC-60076 (Part 1 to 5)	-	Power Transformers
IEC-60214	-	On-Load Tap-Changers.
IEC-60289	-	Reactors.

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

3. CIRCUIT BREAKERS

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

4. CURRENT TRANSFORMERS, VOLTAGE TRANSFORMERS AND COUPLING CAPACITOR VOLTAGE TRANSFORMERS

IEC-60044-1	-	Current Transformer.
IEC-60044-2 /61869	-	Inductive Voltage Transformers.
IEC-60044-5/61869	-	Instrument Transformers - Part 5: Capacitor voltage transformers
IEC-60186	-	Voltage Transformers
IEC-60358	-	Coupling capacitors and capacitor dividers.
IEC-60044-4	-	Instrument Transformers: Measurement of Partial Discharges
IEC-60481	-	Coupling Devices for power Line Carrier Systems.
ANSI-C5713	-	Requirements for Instrument transformers
ANSIC92.2	-	Power Line Coupling Voltage Transformers
ANSI-C93.1	-	Requirements for Power Line Carrier Coupling Capacitors Bushing
IEC-60137	-	Insulated Bushings for Alternating Voltages above 1000V

5. SURGE ARRESTERS

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

6. CUBICLES AND PANELS & OTHER RELATED EQUIPMENTS

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

7. DISCONNECTING SWITCHES

IEC-62271-102	-	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches
IEC-60265 (Part 1 & 2)	-	High Voltage switches
ANSI-C37.32	-	Schedule of preferred Ratings, Manufacturing Specifications and Application Guide for high voltage Air Switches, Bus supports and switch accessories
ANSI-C37.34	-	Test Code for high voltage air switches
NEMA-SG6	-	Power switching equipment
IEC 62271-203		Gas Insulated metal-enclosed switchgear for rated voltages above 52 KV
IEC 62271-207		Seismic qualification for gas-insulated switchgear assemblies for rated voltages above 52 kV
IEC 60376		New sulphur hexafluoride

8. PROTECTION AND CONTROL EQUIPMENT

IEC-60051: (P1 to P9)	-	Recommendations for Direct Acting indicating analogue electrical measuring instruments and their accessories.
IEC-60255 (Part 1 to 23)	-	Electrical relays.
IEC-60297 (P1 to P4)	-	Dimensions of mechanical structures of the 482.6mm (19 inches) series.
IEC-60359	-	Expression of the performance of electrical & electronic measuring equipment.
IEC-60387	-	Symbols for Alternating-Current Electricity meters.
IEC-60447	-	Man machine interface (MMI) - Actuating principles.
IEC-60521	-	Class 0.5, 1 and 2 alternating current watt hour metres
IEC-60547	-	Modular plug-in Unit and standard 19-inch rack mounting unit based on NIM Standard (for electronic nuclear instruments)
ANSI-81	-	Screw threads
ANSI-B18	-	Bolts and Nuts
ANSI-C37.1	-	Relays, Station Controls etc.
ANSI-C37.2	-	Manual and automatic station control, supervisory and associated telemetering equipment
ANSI-C37.2	-	Relays and relay systems associated with electric power apparatus
ANSI-C39.1	-	Requirements for electrical analog indicating instruments

9. MOTORS

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

10. ELECTRONIC EQUIPMENT AND COMPONENTS

MIL-21B, MIL-833 & MIL-2750		
IEC-60068 (P1 to P5)	-	Environmental testing
IEC-60326 (P1 to P2)	-	Printed boards
		Material and workmanship standards
ASTM	-	Specification and tests for materials

11. CLAMPS & CONNECTORS

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

12. BUS HARDWARE AND INSULATORS

IEC-60120	-	Dimensions of Ball and Socket Couplings of string insulator units.
IEC-60137	-	Insulated bushings for alternating voltages above 1000 V.

IEC-60168	-	Tests on indoor and outdoor post insulators of ceramic material or glass for Systems with Nominal Voltages Greater than 1000 V.
IEC-62155	-	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V
IEC-60273	-	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
IEC-61462	-	Pressurized and un-pressurized insulator for use in electrical equipment with rated voltage greater than 1000V – Definitions, Test methods, acceptance criteria and design recommendations
IEC-60305	-	Insulators for overhead lines with nominal voltage above 1000V-ceramic or glass insulator units for a.c. systems Characteristics of String Insulator Units of the cap and pin type.
IEC-60372 (1984)	-	Locking devices for ball and socket couplings of string insulator units : dimensions and tests.
IEC-60383 (P1 and P2)	-	Insulators for overhead lines with a nominal voltage above 1000 V.
IEC-60433	-	Characteristics of string insulator units of the long rod type.
IEC-60471	-	Dimensions of Clevis and tongue couplings of string insulator units.
ANSI-C29	-	Wet process porcelain insulators
ANSI-C29.1	-	Test methods for electrical power insulators
ANSI-C92.2	-	For insulators, wet-process porcelain and toughened glass suspension type
ANSI-C29.8	-	For wet-process porcelain insulators apparatus, post-type
ANSI-G.8	-	Iron and steel hardware
CISPR-7B	-	Recommendations of the CISPR, tolerances of form and of Position, Part 1
ASTM A-153	-	Zinc Coating (Hot-Dip) on iron and steel hardware

13. STRAIN AND RIGID BUS-CONDUCTOR

ASTM-B 230-82	-	Aluminum 1350 H19 Wire for electrical purposes
ASTM-B 231-81	-	Concentric - lay - stranded, aluminum 1350 conductors
ASTM-B 221	-	Aluminum - Alloy extruded bar, road, wire, shape
ASTM-B 236-83	-	Aluminum bars for electrical purpose (Bus-bars)
ASTM-B 317-83	-	Aluminum-Alloy extruded bar, rod, pipe and structural shapes for electrical purposes (Bus Conductors)

14. BATTERIES AND BATTERIES CHARGER

Battery

IEC:60896-21&22	-	Lead Acid Batteries Valve Regulated types – Methods of Tests & Requirements
IEC: 60623	-	Vented type nickel Cadmium Batteries

IEC:60622	-	Secondary Cells & Batteries – Sealed Ni-Cd rechargeable single cell
IEC:60623	-	Secondary Cells & Batteries – Vented Ni-Cd rechargeable single cell
IEC:60896-11	-	Stationary Lead Acid Batteries – Vented Type – General requirements & method of tests
IEEE-485	-	Recommended practices for sizing of Lead Acid Batteries
IEEE-1115	-	Sizing of Ni-Cd Batteries
IEEE-1187	-	Recommended practices for design & installation of VRLA Batteries
IEEE-1188	-	Recommended practices for design & installation of VRLA Batteries
IEEE-1189	-	Guide for selection of VRLA Batteries
Battery Charger		
IEEE-484	-	Recommended Design for installation design and installation of large lead storage batteries for generating stations and substations.
IEEE-485	-	Sizing large lead storage batteries for generating stations and substations

15. WIRES AND CABLES

ASTMD-2863	-	Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)
IEC-60096 (part 0 to p4)	-	Radio Frequency cables.
IEC-60183	-	Guide to the Selection of High Voltage Cables.
IEC-60189 (P1 to P7)	-	Low frequency cables and wires with PVC insulation and PVC sheath.
IEC-60227 (P1 to P7)	-	Polyvinyl Chloride insulated cables of rated voltages up to and including 450/750V.
IEC-60228	-	Conductors of insulated cables
IEC-60230	-	Impulse tests on cables and their accessories.
IEC-60287 (P1 to P3)	-	Calculation of the continuous current rating of cables (100% load factor).
IEC-60304	-	Standard colors for insulation for low-frequency cables and wires.
IEC-60331	-	Fire resisting characteristics of Electric cables.
IEC-60332 (P1 to P3)	-	Tests on electric cables under fire conditions.
IEC-60502	-	Extruded solid dielectric insulated power cables for rated voltages from 1 kV up to 30 kV
IEC-754 (P1 and P2)	-	Tests on gases evolved during combustion of electric cables.

16. PAINTING

ANSI-Z551	-	Gray finishes for industrial apparatus and equipment
SSPEC	-	Steel structure painting council

17. HORIZONTAL CENTRIFUGAL PUMPS

API-610	-	Centrifugal pumps for general services
	-	Hydraulic Institutes Standards
BS:599	-	Methods of testing pumps
PTC-8.2	-	Power Test Codes - Centrifugal pumps

18. DIESEL ENGINES

ASME Power Test Code	-	Internal combustion engine PTC-17
	-	Codes of Diesel Engine Manufacturer's Association, USA

19. PIPING VALVES & SPECIALITIES

BS:5150	-	Specification for cast iron gate valves

20. PG TEST PROCEDURES

NFPA-13	-	Standard for the installation of sprinkler system
NFPA-15	-	Standard for water spray fixed system for the fire protection
NFPA-12A	-	Standard for Halon 1301 Fire Extinguishing System
NFPA-72E	-	Standard on Automatic Fire Detectors
NFPA-12	-	Standard on Carbon dioxide extinguisher systems

ELECTRICAL GENERATING AND DISTRIBUTING STATIONS CODE OF PRACTICE

21. STEEL STRUCTURES

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

NEMA-CG1	-	Manufactured graphite electrodes

22. PIPING AND PRESSURE VESSELS

ASME	-	Boiler and pressure vessel code
ASTM-A120	-	Specification for pipe steel, black and hot dipped, zinc-coated (Galvanized) welded and seamless steel pipe for ordinary use
ASTM-A53	-	Specification for pipe, steel, black, and hot-dipped, zinc coated welded and seamless
ASTM-A106	-	Seamless carbon steel pipe for high temperature service
ASTM-A284	-	Low and intermediate tensile strength carbon-silicon steel plates for machine parts and general construction.
ASTM-A234	-	Pipe fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures
ASTM-S181	-	Specification for forgings, carbon steel for general purpose piping
ASTM-A105	-	Forgings, carbon steel for piping components
ASTM-A307	-	Carbon steel externally threated standard fasteners
ASTM-A193	-	Alloy steel and stainless-steel bolting materials for high temperature service
ASTM-A345	-	Flat rolled electrical steel for magnetic applications
ASTM-A197	-	Cupola malleable iron
ANSI-B2.1	-	Pipe threads (Except dry seal)
ANSI-B16.1	-	Cast iron pipe flanges and ganged fitting. Class 25, 125, 250 and 800
ANSI-B16.1	-	Malleable iron threaded fittings, class 150 and 300
ANSI-B16.5	-	Pipe flanges and flanged fittings, steel nickel alloy and other special alloys
ANSI-B16.9	-	Factory-made wrought steel butt welding fittings
ANSI-B16.11	-	Forged steel fittings, socket-welding and threaded
ANSI-B16.14	-	Ferrous pipe plug, bushings and locknuts with pipe threads
ANSI-B16.25	-	Butt welding ends
ANSI-B18.1.1	-	Fire hose couplings screw thread.
ANSI-B18.2.1	-	Inch series square and hexagonal bolts and screws
ANSI-B18.2.2	-	Square and hexagonal nuts
NSI-B18.21.1	-	Lock washers
ANSI-B18.21.2	-	Plain washers
ANSI-B31.1	-	Power piping
ANSI-B36.10	-	Welded and seamless wrought steel pipe
ANSI-B36.9	-	Stainless steel pipe

23. GALVANISED STEEL EARTHWIRE

P5:1992)	overhead transmission/substation purposes

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ANNEXURE - B

SN	LIST OF DRAWINGS/DOCUMENTS TO BE SUBMITTED BY THE CONTRACTOR
1	Single Line Diagram
2	Electrical Layout – Plan and Sections
3	Tower, Equipment & cable trench layout drawing
4	Earthing system design calculation & layout drawing
5	Lighting protection system design & drawings
6	Structure Layout (Plan & Section) drawing
7	Cantilever Strength calculations (if applicable)
9	GTP and drawings for Bus-Post Insulator
10	Tension/suspension string insulator and Hardware Assembly GTP and drawing (as applicable)
11	Soil Investigation Report (if applicable)
12	Circuit Breakers (132kV, 11kV- As applicable) - GA drawing, GTP, Type test Reports
13	CTs, CVTs and LA (132 kV, 11kV- As applicable) - GA drawing, GTP, Type test Reports
14	Surge Arrestors (120kV, 20kV- As applicable) - GA drawing, GTP, Type test Reports
15	Isolators (132kV- As applicable) - GA drawing, GTP, Type test Reports
16	Control, Relay Panels and Substation Automation system - GTP, technical literature, type test reports
17	Communication Equipment, Digital Protection Coupler (If applicable) GTP and technical literature
18	**Civil Works (as applicable)** **a) GIS/Control Room Building** - Structure Design, Foundation Design & Drg., Plinth Beam Design & Drg. and column Design & Drg. Up to G.F. Level **b) Power Transformer Foundation Design/Drawings** **c) 132/11 kV Equipment support structure & foundation design/drawing**

NOTE:
The above list of drawing/document is only illustrative and not exhaustive. The contractor shall submit drawings/documents as per requirement of technical specification.

CHAPTER 3
GAS INSULATED SWITCHGEAR

Table of Contents

CHAPTER 3: GAS INSULATED SWITCHGEAR

1. GENERAL CHARACTERISTICS

1.1 The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of its constituent parts. It should be designed for indoor application with meteorological conditions at site as per Chapter 1 Project Specific Requirements.

1.2 All parts of the switchgear and the bus ducts (for both indoor and outdoor applications) shall be Single/three phase enclosed for 132 KV.

1.3 The design should be such that all parts subjected to wear and tear are easily accessible for maintenance purposes. The equipment offered shall be protected against all types of voltage surges and any equipment necessary to satisfy this requirement shall be deemed to be included.

1.4 The required overall parameters of GIS are as follows: -

SN	Technical particulars	132 kV system
1	Rated Voltage (RMS)	145 kV
2	Rated frequency	50 HZ
3	Grounding	Solidly earthed
4	Rated power frequency withstand Voltage (1 min) line to earth (rms)	275 kV
5	Impulse withstand BIL (1.2/50/mic. Sec) Line to earth	±650 kVp
6	Rated short time withstand current (1 sec) (As applicable)	40 kA (rms)
7	Rated peak withstand current (as applicable)	78.75kA (peak)
8	Rated current (at 50 degree C design ambient temperature)	2000 A for Bus Bar, Bus Coupler Bays and Line Bays / 1250 A for Transformer Bays.

2. REFERENCE STANDARDS

The metal-enclosed gas-insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the following International Electro-technical Commission (IEC) Publications including their parts and supplements as amended or revised as on date of bid opening:

IEC 62271-203	Gas Insulated metal-enclosed switchgear for rated voltages above 52 KV
IEC 62271-207	Seismic qualification for gas-insulated switchgear assemblies for rated voltages above 52 kV

IEC 60376	New sulphur hexafluoride
IEC 62271- 100	High voltage alternating current Circuit breakers
IEC 62271-1	Common clauses for high voltage Switchgear and control-gear standards
IEC 62271-102	Alternating current disconnectors(isolators) and earthing switches
IEC 60044-1/61869	Current transformers
IEC 60044-2 /61869	Voltage transformers
IEC 60137	Bushings for alternating voltages above 1000 V
IEC 62271-209	Cable connections for gas-insulated switchgear
IEC 60480	Guide to checking of sulphur hexafluoride taken from electrical equipment
IEC 60099 -1/4	Non-linear resistor type arresters for AC systems
IEC 60439	Factory-built assemblies of low-voltage switchgear and control Gear.
IEEE 80 (2000)	IEEE Guide for Safety in AC Substation grounding.
CIGRE-44	Earthing of GIS- an application guide. (Electra no.151, Dec'93).
IEC 61639	Direct connection between Power Transformers and gas insulated metal enclosed switchgear for rated voltage 72.5 kV and above.

The components and devices which are not covered by the above standards shall conform to, and comply with, the applicable standards, rules, codes and regulations of the internationally recognized standardizing bodies and professional societies as may be approved by the Employer/consultant and the manufacturer shall list all such applicable standards, codes etc.

In case the requirements laid down herein differ from those given in above standard in any aspect the switchgear shall comply with the requirements indicated herein in regard thereto.

3. DEFINITIONS

3.1 Assembly

Assembly refers to the entire completed GIS equipment furnished under contract.

3.2 Bay

Bay refers to the area occupied by one Circuit Breaker and associated equipment.

3.3 Compartment

When used in conjunction with GIS equipment, compartment refers to a gas tight volume bounded by enclosure walls and gas tight isolating barriers.

3.4 Enclosure

When used in conjunction with GIS equipment, enclosure refers to the grounded metal housing or shell which contains and protects internal Power system equipment (breaker, disconnecting switch, grounding switch, voltage transformer, current transformer, surge arresters, interconnecting bus etc.)

3.5 Manual Operation

Manual operation means operation by hand without using any other source of power.

3.6 Module

When used in conjunction with GIS equipment, module refers to a portion of that equipment. Each module includes its own enclosure. A module can contain more than one piece of equipment, for example, a module can contain a disconnecting switch and a grounding switch.

3.7 Reservoir

When used in conjunction with GIS equipment reservoir refers to a larger gas-tight volume.

4. GENERAL DESIGN AND SAFETY REQUIREMENT

4.1 The GIS shall be designed, manufactured and tested in accordance with the best international engineering practices under strict quality control to meet the requirement stipulated in the technical specification. Adequate safety margin with respect to thermal, mechanical, dielectric stress and insulation coordination etc. shall be maintained during design, selection of raw material, manufacturing process etc. so that the GIS provides long life with least maintenance.

4.2 The workmanship shall be of the highest quality and shall conform to the latest modern practices for the manufacture of high technology machinery and electrical switchgear

4.3 The GIS assembly shall consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled with SF6 Gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be such that maintenance on one feeder may be performed without de-energizing the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment.

4.4 The switchgear, which shall be of modular design, shall have complete phase isolation. The conductors and the live parts shall be mounted on high graded epoxy resin insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be free of any voids and free of partial discharge at a voltage which is at least 5% greater than the rated voltage. These shall be designed to have high structural and dielectric strength properties and shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF6 breakdown under arcing conditions.

4.5 Gas barrier insulators shall be provided so as to divide the GIS into separate compartments. These shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment. Due to safety requirement for working on this pressurized equipment, whenever the pressure of the adjacent gas compartment is reduced during maintenance, this compartment shall be designed so that it shall remain in service to perform its intended duty. The gas tight barriers shall be clearly marked on the outside of the enclosures.

4.6 The bus enclosure should be sectionalized in a manner that maintenance work on any bus disconnector (when bus and bus disconnector are enclosed in a single enclosure) can be carried out by isolating and evacuating the small effected section and not the entire bus. The design of 132 kV GIS shall be such that in case a circuit breaker module of a feeder is removed for maintenance, both busbars shall remain in service. For achieving the above requirements, adequate Mechanical support and number of intermediate gas tight compartments as required, shall be provided to ensure equipment and operating personnel's safety.

4.7 The material and thickness of the enclosures shall be such as to withstand an internal flash over without burn through for a period of 300 ms at rated short time withstand current. The material shall be such that it has no effect of environment as well as from the by-products of SF6 breakdown under arcing condition.

4.8 Each section shall have plug- in or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of the equipment. Inspection windows shall be provided for disconnectors and earth switches.

4.9 The material used for manufacturing the switchgear equipment shall be of the type, composition and have physical properties best suited to their particular purposes and in accordance with the latest engineering practices. All the conductors shall be fabricated of aluminum/ copper tubes of cross-sectional area suitable to meet the normal and short circuit current rating requirements. The finish of the conductors shall be smooth so as to prevent any electrical discharge. The conductor ends shall be silver plated and fitted into finger contacts or tulip contacts. The contacts shall be of sliding type to allow the conductors to expand or contract axially due to temperature variation without imposing any mechanical stress on supporting insulators.

4.10 Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC-62271-203.

4.11 The maximum SF6 gas leakage shall not exceed 0.5% (half percent) per year for the whole equipment and for any individual gas compartment separately. The leakage rate shall be guaranteed for at least 10 years. In case the leakage under the specified conditions is found to be greater than 0.5% after one year of commissioning, the manufacturer will have to supply free of cost, the total gas requirement for subsequent ten (10) years, based on actual leakage observed during the first year of operation after commissioning.

4.12 Each gas-filled compartment shall be equipped with static filters, density switches, filling valve and safety diaphragm. The filters shall be capable of absorbing any water vapour which may penetrate into the enclosures as well as the by-products of SF6 during

interruption. Each gas compartment shall be fitted with non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.

4.13 The switchgear line-up when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations up to the permissible servicing intervals under 100% rated and fault conditions shall not diminish the performance or significantly shorten the useful life of the switchgear. Any fault caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear.

4.14 The thermal rating of all current carrying parts shall be minimum for one sec. for the rated symmetrical short-circuit current.

4.15 The switchgear shall be of the free standing, self-supporting with easy accessibility to all the parts during installation & maintenance with all high-voltage equipment installed inside gas-insulated metallic and earthed enclosures, suitably sub-divided into individual arc and gas-proof compartments preferably for:

i. Bus bars

ii. Intermediate compartment

iii. Circuit breakers

iv. Line Disconnectors

v. Voltage Transformers

vi. Gas Insulated bus duct section between GIS and GIS/Overhead Conductor.

vii. Gas Insulated bus section between GIS & Oil filled Transformer (as applicable)

4.16 The arrangement of the individual switchgear bays shall be such so as to achieve optimum space-saving, neat and logical arrangement and adequate accessibility to all external components.

4.17 The layout of the substation equipment, bus bars and switchgear bays shall preferably be based on the principle of "phase grouping". Switchgear layout based on the "mixed phases" principle shall not be accepted without mutual agreement between supplier and employer/consultant. The arrangement of the equipment offered must provide adequate access for operation, testing and maintenance.

4.18 All the elements shall be accessible without removing support structures for routine inspections. The removal of individual enclosure parts or entire breaker bays shall be possible without disturbing the enclosures of neighboring bays.

4.19 It should be impossible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force. All interlocks that prevent potentially dangerous mal-operations, shall be constructed such that they cannot be operated easily, i.e., the operator must use tools or brute force to over-ride them.

4.20 In general, the contours of energized metal parts of the GIS and any other accessory shall be such, so as to eliminate areas or points of high electrostatic flux concentrations. The surfaces shall be smooth with no projection or irregularities which may cause visible corona. No corona shall be visible in complete darkness which the equipment is

subjected to specified test voltage. There shall be no radio interference from the energized switchgear at rated voltage.

4.21 The GIS shall be designed, so as to take care of the VFT over voltages generated as a result of pre-strikes and re-strikes during isolator operation. Maximum VFT over voltages peak shall not be higher than rated lightning impulse withstand voltage (LIWV) of the equipment. Necessary measures shall be under taken by GIS manufacture to restrict maximum VFT over voltages lower than the LIWV. Manufacturer shall submit the study report of VFTO generated for GIS installation.

4.22 The enclosure shall be of continuous design and shall meet the requirement as specified in clause no. 10 (special considerations for GIS) of IEEE- 80, Year- 2000.

4.23 The enclosure shall be sized for carrying induced current equal to the rated current of the Bus. The conductor and the enclosure shall form the concentric pair with effective shielding of the field internal to the enclosure.

4.24 The fabricated metal enclosures shall be of Aluminum alloy having high resistance to corrosion, low electrical loses and negligible magnetic losses. All joint surfaces shall be machined and all castings shall be spot faced for all bolt heads or nuts and washers. All screws, bolts, studs and nuts shall conform to metric system.

4.25 The elbows, bends, cross and T-sections of interconnections shall include the insulators bearing the conductor when the direction changes take place in order to ensure that live parts remain perfectly centered and the electrical field is not increased at such points.

4.26 The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electro-dynamic stresses even under short circuit conditions. The average intensity of electromagnetic field shall not be more than 50 micro –Tesla on the surface of the enclosure. The contractor shall furnish all calculations and documents in support of the above during detailed engineering.

4.27 The switchgear shall have provision for connection with ground mat risers. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment.

4.28 The ladders and walkways shall be provided wherever necessary for access to the equipment.

4.29 Wherever required, the heaters shall be provided for the equipment in order to ensure the proper functioning of the switchgear at specified ambient temperatures. The heaters shall be rated for 230 V AC supply and shall be complete with thermostat, control switches and fuses, connected as a balanced 3-phase 4-wire load. The heaters shall be so arranged and protected as to create no hazard to adjacent equipment from the heat produced.

4.30 The enclosure & support structure shall be designed that person of 1780 mm in height and 80 Kg in weight is able to climb on the equipment for maintenance.

4.31 The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.

4.32 Alarm circuit shall not respond to faults for momentary conditions. The following indications including those required elsewhere in the specifications shall be generally provided in the alarm and indication circuits.

A. Gas Insulation System:

i) Loss of Gas Density.
ii) Loss of Heater power (if required)
iii) Any other alarm necessary to indicate deterioration of the gas insulating system.

B. Operating System:

i) Low operating pressure.
ii) Loss of Heater power.
iii) Loss of operating power.
iv) Loss of control supply.
v) Pole Discordance.

4.33 The equipment will be operated under the following ambient conditions (or as defined in the Chapter 1 Project Specific Requirement):

i. The ambient temperature varies between 0 degree-C and 50 degree-C. However, for design purposes, ambient temperature should be considered as 50 degree-C.

ii. The humidity will be about 95% (indoors)

iii. The elevation as per Chapter 1 Project Specific Requirement.

4.34 Temperature-rise of current carrying parts shall be limited to the values stipulated in IEC-62271-1, under rated current and the climatic conditions at site. The temperature rise for all enclosures shall not exceed 20 degree C above the ambient temperature of 50-degree C. These conditions shall be taken into account by the supplier in the design of the equipment

4.35 Bellows or Compensating Units

4.35.1 Adequate provision shall be made to allow for the thermal expansion of the conductors & enclosures and of differential thermal expansion between the conductors and the enclosures. The bellows metallic (preferably stainless steel) with suitable provision for permitting the movement during expansion and contraction may be provided and shall be of following types:

i. Lateral / Vertical mounting units: These shall be inserted, as required, between sections of busbars, on transformer and XLPE cable etc. Lateral mounting shall be made possible by a sliding section of enclosure and tubular conductors.

ii. Axial compensators: These shall be provided to accommodate changes in length of busbars due to temperature variations.

iii. Parallel compensators: These shall be provided to accommodate large linear expansions and angle tolerances.

iv. Tolerance compensators: These shall be provided for taking up manufacturing, site assembly and foundation tolerances.

v. Vibration compensators: These bellow compensators shall be provided for absorbing vibrations caused by the transformers when connected to SF6 switchgear by oil- SF6 bushings.

4.35.2 The electrical connections across the bellows or compensating units shall be made by means of suitable connectors. For sliding type compensators, markers/pointers shall be provided to observe expansion or contraction during climatic conditions.

4.36 Indication and verification of switch positions

4.36.1 Indicators shall be provided on all circuit breakers, isolators and earth-switches, which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkages and shall be mounted in a position where they are clearly visible from the floor or the platform in the vicinity of the equipment.

4.36.2 Inspection windows shall also be provided with all isolators and earth switches so that the switch contact positions can be verified by direct visual inspection.

4.37 Pressure relief device

4.37.1 Pressure relief devices shall be provided in the gas sections to protect the gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably in downward direction).

4.37.2 Pressure relief shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction.

4.37.3 If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided. Contractor shall submit to the employer the detailed criteria/ design regarding location of pressure relief devices/rupture diaphragms.

4.38 Pressure vessel requirements

4.38.1 The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the pressure vessel code (ASME/CENELEC code for pressure Vessel.)

4.38.2 The bursting strength of Aluminum castings has to be at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure.

4.38.3 Each enclosure has to be tested as a routine test at 1.5 times the design pressure for one minute.

4.39 Grounding

4.39.1 The grounding system shall be designed and provided as per IEEE-80-2000 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences.

4.39.2 The GIS supplier shall define clearly what constitutes the main grounding bus of the GIS. The contractor shall supply the entire material for grounding bus of GIS viz conductor, clamps, joints, operating and safety platforms etc. The contractor is also required to supply all the earthing conductors and associated hardware material for connecting all GIS equipment, bus ducts, enclosures, control cabinets, supporting structure, GIS surge arrestor etc. to the ground bus of GIS.

4.39.3 The enclosure of the GIS may be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections

should be provided for each of circuit breaker, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected externally with Copper /Aluminum bonds of suitable size to bridge the flanges. Subassembly to subassembly bonding shall be provided to bridge the gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.

4.39.4 Each marshaling box, local control panel, power and control cable sheaths and other non-current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.

4.39.5 The grounding connector shall be of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating. At least two grounding paths shall be provided to connect each point to the main grounding bus. Necessary precautions should be under taken to prevent excessive currents from being induced into adjacent frames, structures of reinforcing steel and to avoid establishment of current loops via other station equipment.

4.39.6 All flexible bonding leads shall be tinned copper. All connectors, for attaching flexible bonding leads to grounding conductors and grounding conductors to support structures shall be tinned bronze with stainless steel or tinned bronze hardware.

4.39.7 The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrestor, phase to earth fault and discharges between contacts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures.

4.40 UHF sensors for PD detection

4.40.1 Contractor shall provide adequate number of UHF sensors in the offered GIS for detection of Partial discharge (of 5 pC and above) as per IEC 60270 through Partial Discharge (PD) monitoring system and the number and location of these sensors shall be subject to approval of the employer/consultant. Further UHF sensors shall necessarily be provided in close proximity to VT compartments provided that at least two UHF device shall detect PD happening within the GIS.

4.40.2 However, adequacy of number of sensors and their location shall be verified by doing the modeling of complete GIS during Detail Engineering Design phase as per recommendations of CIGRE task force TF 15/33.03.05 (**Task force on *Partial discharge detection system for GIS: Sensitivity verification for the adequate UHF method and the acoustic method***).

4.41 Gas Insulated Bus (GIB) layout:

GIB shall be designed based on the following criteria

i. Maximum weight of gas in a gas tight section of GIB shall not exceed 250 kg for 132 kV.

ii. GIS bus ducts of each circuit shall be arranged in preferably horizontal formation and the clearance (outer to outer) between nearest bus ducts of two adjacent circuits shall be minimum one (1) meter.

iii. GIB shall be generally in only one horizontal layer. However, in exceptional circumstance two horizontal GIB layers can be provided with the approval of

Employer/consultant and the vertical clearance between layers shall be minimum one (1) meter in such case.

iv. The minimum outer to outer horizontal clearance between each GIS bus duct shall 0.5 meter for 132 kV voltage level.

v. The minimum vertical ground clearance of GIB at road crossing shall be 5.5 meters

vi. The horizontal clearance between GIB and GIS building /any other building wall shall be minimum three (3) meters.

vii. The GIB route inside the GIS Hall shall not obstruct easy access to GIS and control room buildings and shall not obstruct movement of crane, equipment including HV test equipment for maintenance works.

viii. The GIB height outside the GIS hall in switchyard area shall not obstruct easy access to GIB, movement of crane for maintenance work.

ix. Optimization of outdoor GIB length using overhead AIS connection with Bus Post Insulator of respective voltage class is generally acceptable subject to meeting the electrical clearances as stipulated.

x. For the maintenance of GIB of one circuit, only that circuit shall be isolated.

xi. In case of exceptional cases of GIB layout, work shall be finalized during detail engineering.

4.42 A portable ladder with adjustable height shall be supplied to access the GIS equipment for O&M purpose.

4.43 Extension of GIS

4.43.1 The arrangement of gas sections or compartments shall be such as to facilitate future extension of any make without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays.

4.43.2 As the GIS is likely to be extended in future, the contractor shall make available during detailed engineering stage, the complete design detail of interface module such as cross section, enclosure material, enclosure dimensions (inner & outer), Flange diameter (inner & outer), conductor connection arrangement, bolt spacing & dimension, rated gas pressure etc. Further GIS manufacturer supplying GIS under present scope shall furnish all the required details in addition to mentioned above necessary for design and successful implementation of an interface module during later stage while extending GIS by any other GIS manufacturer, without any help of GIS manufacturer who has supplied the GIS equipment in present scope.

4.43.3 The Interface module shall be designed to provide Isolating link with access hole on enclosure. The Isolating link shall be provided in such a way so that HV test can be performed on either side of the interface module separately, keeping other side of GIS remain isolated.

4.43.4 Further the contractor who is extending the existing GIS installation shall optimally utilize the space inside the GIS hall (including the extension portion) for accommodating the interface module being supplied under the contract and the space (along the length of

the hall) inside the GIS hall for interface module shall preferably be limited to 1 meter for 132kV.

4.44 SF6 GAS

4.44.1 The SF6 gas insulated metal-clad switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC 376, 376A & 376B, at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC as above as a minimum & should be suitable in all respects for use in the switchgear under all operating conditions.

4.44.2 The high-pressure cylinders in which SF6 gas is supplied & stored at site shall comply with the requirements of following standards & regulations:

a. IS : 4379 Identification of the contents of industrial gas cylinders.

b. IS : 7311 Seamless high carbon steel cylinders for permanent & high pressure liquefiable gases. The cylinders shall also meet Indian Boilers Regulations. (Mandatory)

4.44.3 SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water contents as per IEC:376, 376A & 376B and test certificates shall be furnished to the employer indicating all test results as per IEC standards for each lot of SF6 gas. Further site tests for moisture, air content, flash point and dielectric strength to be done during commissioning of GIS. Gas bottles should be tested for leakage during receipt at site.

4.44.4 The contractor shall indicate diagnostic test methods for checking the quality of gas in the various sections during service. The method proposed shall, as a minimum check the moisture content & the percentage of purity of the gas on annual basis.

4.44.5 The contractor shall also indicate clearly the precise procedure to be adopted by maintenance personnel for handling equipment that are exposed to the products of arcing in SF6 Gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, method of disposal of cleaning utensils and other relevant matters.

4.44.6 The contractor shall also indicate the details and type of filters used in various gas sections, and should also submit the operating experience with such filters.

4.45 SF6 gas monitoring devices and alarm circuits

4.45.1 Dial type temperature compensated gas density monitoring devices with associated pressure gauge will be provided. The devices shall provide continuous & automatic monitoring of gas density & a separate device shall be provided for each gas compartment so that each compartment can be monitored simultaneously as follows: -

SN	Compartments except CB	Circuit Breaker compartments
1	**"Gas Refill level:** This will be used to annunciate the need for the gas refilling. The contractor shall provide a contact for remote indication.	**'Gas Refill' level: This** will be used to annunciate the need for gas refilling. The contractor shall provide a contact for remote indication.
2	**"SF6 low level":** This will be used to annunciate the need for urgent gas	**"SF6 low level":** This will be used to annunciate the need for urgent gas filling. A

	filling. A contact shall be provided for remote indication	contact shall be provided for remote indication
3	**'Zone Trip' level:** This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly.	**Breaker Block' level:** This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker. At this level the breaker block contact shall operate and the closing & tripping circuit shall be blocked
4	**Not Applicable**	**'Zone Trip' level:** This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly.

The density monitor/pressure switch contacts shall be in accordance with the above requirement.

4.45.2 The contractor should furnish temperature v/s pressure curves for each setting of density monitor along with details of the monitoring device.

4.45.3 It shall be possible to test all gas monitoring relays/devices without de-energizing the primary equipment & without reducing pressure in the main section. Plugs & sockets shall be used for test purposes. It shall also damp the pressure pulsation while filling the gas in service, so that flickering of the pressure switch contacts does not take place.

4.46 Gas Supply

The contractor shall include the supply of all SF6 gas necessary for filling & putting into operation the complete switchgear installation being supplied. The empty gas cylinders shall be returnable to the contractor.

5. CIRCUIT BREAKERS

5.1 General

5.1.1 SF6 gas insulated metal enclosed circuit breakers shall comply with the latest revisions of IEC- 62271-100 & relevant IEC except to the extent explicitly modified in the specification and shall meet with requirements specified

5.1.2 Circuit breakers shall be equipped with the operating mechanism. Circuit breakers shall be of single pressure type. Complete circuit breaker with all necessary items for successful operation shall be supplied. The circuit breakers shall be designed for high-speed single and three phase reclosing with an operating sequence and timing as specified.

5.2 Duty Requirements

5.2.1 Circuit breaker shall be C2 - M2 class as per IEC 62271-100.

5.2.2 Circuit breaker shall meet the duty requirements for any type of fault or fault location also for line charging and dropping when used on effectively grounded system and perform make and break operations as per the stipulated duty cycles satisfactorily.

5.3 The circuit breaker shall be capable of Interrupting the steady and transient magnetizing current shall be as follows:

Voltage Level	Type of Transformer	Rating in MVA
132 kV	132/11kV	10 to 50

5.4 Interrupting line/cable charging current as per IEC without re-strikes and without use of opening resistors. The breaker shall be able to interrupt the rated line charging current as per IEC-62271-100 with test voltage immediately before opening equal to the product of U/√3 and 1.4

5.4.1 Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.

5.4.2 Breaking 25% the rated fault current at twice the rated voltage under phase opposition condition.

5.4.3 The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energization of shunt reactor and/or series capacitor compensated lines with trapped charges.

5.4.4 Withstanding all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e., shall be designed for 2 p.u. across the breaker continuously, for validation of which a power frequency withstand test conducted for a duration of at least 15 minutes is acceptable).

5.5 Total Break Time

5.5.1 The total break time shall not be exceeded under any of the following duties:

a) Test duties T10, T30, T60, T100 (with TRV as per IEC- 62271-100)

b) Short line fault L90, L75 (with TRV as per IEC-62271-100)

5.5.2 The Contractor may please note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage (70-110%), pneumatic/hydraulic pressure and SF6 gas pressure etc. While furnishing the proof for the total break time of complete circuit breaker, the contractor may specifically bring out the effect of non-simultaneity between poles and show how it is covered in the total break time.

The values guaranteed shall be supported with the type test reports.

5.6 Constructional features

The features and constructional details of breakers shall be in accordance with requirements stated hereunder:

5.6.1 **Contacts:** All making and breaking contacts shall be sealed and free from atmospheric effects. Contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacement due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

5.6.2 Any device provided for voltage grading to damp oscillations or, to prevent re-strike prior to the complete interruption of the circuit or to limit over voltage on closing, shall have a life expectancy comparable of that of the breaker as a whole.

5.6.3 Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life for the material used. The temperature rise shall not exceed that indicated in IEC-62271-100 under specified ambient conditions.

5.6.4 The gap between the open contacts shall be such that it can withstand at least the rated phase to ground voltage for eight hours at zero pressure above atmospheric level of SF6 gas due to its leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lockout pressure continuously (i.e., 2 pu. power frequency voltage across the breaker continuously)

5.6.5 In the interrupter assembly there shall be an adsorbing product box to minimize the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as to be fully compatible with SF6 gas decomposition products.

5.6.6 Provisions shall be made for attaching an operational analyzer to record travel, speed and making measurement of operating timings etc. after installation at site. The contractor shall supply three set of transducers for each substation covered under the scope.

5.6.7 Circuit Breaker shall be supplied with auxiliary switch having additional 8 NO (normally open) and 8 NC (normally closed) contacts for future use over and above those required for switchgear interlocking and other control and protection function. These spare NO and NC contacts shall be wired up to the local control cubicle.

5.7 Operating mechanism

5.7.1 General Requirements:

i. Circuit breaker shall be operated by spring charged mechanism or electro hydraulic mechanism or a combination of these. The mechanism shall be housed in a dust proof cabinet and shall have IP: 42 degrees of protection.

ii. The operating mechanism shall be strong, rigid, not subject to rebound or to critical adjustments at site and shall be readily accessible for maintenance.

iii. The operating mechanism shall be suitable for high-speed reclosing and other duties specified. During reclosing the breaker contacts shall close fully and then open. The mechanism shall be anti-pumping and trip free (as per IEC definition) under every method of closing.

iv. The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operating devices.

v. A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided.

vi. Working parts of the mechanism shall be of corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

vii. The contractor shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker.

5.7.2 Control

i. The close and trip circuits shall be designed to permit use of momentary-contact switches and push buttons.

ii. Each breaker pole shall be provided with two (2) independent tripping circuits and trip coils which may be connected to a different set of protective relays.

iii. The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose, a local/remote selector switch and close and trip control switch/push buttons shall be provided in the breaker control cabinet.

iv. The trip coil shall be suitable for trip circuit supervision during both open and close position of breaker.

v. Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip and associated circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage.

vi. Densimeter contacts and pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail-safe logic/schemes are to be employed. DC supplies shall be monitored for remote annunciations and operation lockout in case of dc failures.

vii. The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

5.7.3 Spring operated Mechanism

i. Spring operated mechanism shall be complete with motor in accordance with Section GTR. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.

ii. As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.

iii. After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.

iv. Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it required preferably not more than 90 seconds for full charging of the closing

spring.

v. Closing action of circuit breaker shall compress the opening spring ready for tripping.

vi. When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local control cabinet & SAS.

vii. Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition.

viii. Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in the closed position.

ix. The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

5.8 The technical parameters of Circuit breakers are as per Annexure -1

5.9 Additional data to be furnished during detailed engineering:

i. Drawing showing contacts in close, arc initiation, full arcing, arc extinction and open position.

ii. Data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100 fault currents to load currents of the lowest possible value without requiring any maintenance or checks.

iii. Curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and hydraulic pressure.

5.10 Tests

5.10.1 Type Tests

In accordance with the requirements stipulated under Chapter 2 GTR the circuit breaker along with its operating mechanism shall conform to the type tests as per IEC-62271-100.

The type test report of Electromagnetic Compatibility Test (EMC) of CSD shall be submitted for approval

5.10.2 Routine Tests

Routine tests as per IEC: 62271-100 shall be performed on all circuit breakers.

5.10.3 In addition to the mechanical and electrical tests specified by IEC, the following shall also be performed.

Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto-reclosing and trip free operation under normal as well as limiting operating conditions (control voltage, pneumatic pressure etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time,

shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console etc. shall be provided.

5.10.4 Functional tests are to be carried out on circuit breaker along with Control Switching device (CSD).

5.10.5 DCRM (Dynamic Contact Resistance Measurement) to be carried out for all CBs during routine test.

6. DISCONNECTORS (ISOLATORS)

6.1 Disconnectors shall be three-pole group operated or Single-pole individual operated (as per single line diagram of the substation/Chapter Project Specific Requirements) and shall be installed in the switchgear to provide electrical isolation. The disconnectors shall conform to IEC- 62271-102 and shall have the ratings as specified in BPS.

6.2 Construction & Design.

6.2.1 The disconnectors shall be operated by electric motor suitable for use on DC system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit.

6.2.2 Disconnectors shall be suitable to switch the bus charging currents during their opening and closing and shall confirm to all three test duties viz TD1, TD2 and TD3 as per Annexure –F of IEC: 62271- 102.They shall also be able to make and break rated bus transfer current at rated bus transfer voltage which appears during transfer between bus bars in accordance with Annexure –B of IEC: 62271-102. The contact shielding shall also be designed to prevent restrikes and high local stresses caused by transient recovery voltages when these currents are interrupted.

6.2.3 The disconnecting switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.

6.2.4 It shall be possible to operate the disconnecting switches manually by cranks or hand wheels. The contacts shall be both mechanically and electrically disconnected during the manual operation.

6.2.5 The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.

6.2.6 The opening and closing of the disconnectors shall be achieved by either local or remote control. The local operation shall be by means of a two-position control switch located in the Local Control Cabinet (LCC) .

6.2.7 Remote control of the disconnectors from the control room/SAS shall be made by means of remote/ local transfer switch.

6.2.8 The disconnector operations shall be inter-locked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.

6.2.9 Each disconnector shall be supplied with auxiliary switch having additional 4 NO (Normally Open) and 4 NC (Normally Closed) contacts for future use over and above those required for switchgear interlocking and automation purposes. These spare NO and NC contacts shall be wired up to the local control cabinet.

6.2.10 The signaling of the closed position of the disconnector shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current, peak withstand current and short-time withstand current can be carried safely.

6.2.11 The signaling of the open position of the disconnector shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.

6.2.12 The disconnectors and safety grounding switches shall have a mechanical and electrical inter-lock to prevent closing of the grounding switches when isolator switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position. Integrally mounted lock when provided shall be equipped with a unique key for such three-phase group. Master key is not permitted.

6.2.13 The local control of the Isolator and high-speed grounding switches from the Local Control Cabinet (LCC) should be achieved from the individual control switches with the remote/local transfer switch set to local.

6.2.14 All electrical sequence interlocks will apply in both remote and local control modes.

6.2.15 Each disconnector shall have a clearly identifiable local, positively driven mechanical position indicator, together with position indicator on the local control cubicle (LCC) and provisions for taking the signals to the control room. The details of the inscriptions and colouring for the indicator are given as under:

Position	**Inscription**	**Colour**
Open Position	OPEN	GREEN
Closed Position	CLOSED	RED

6.2.16 All the disconnecting switches shall have arrangement allowing easy visual inspection of the travel of the switch contacts in both open and close positions, from the outside of the enclosure.

6.2.17 The disconnecting switches shall be provided with rating plates and shall be easily accessible.

6.2.18 The mechanical endurance class shall be M2 as per IEC for 765 kV, 400 kV and 220 kV and it shall be M1 class for 132 kV disconnectors

6.2.19 Mechanical position indication shall be provided locally at each disconnector and Electrical indication at each Local Control Cabinet (LCC) / SAS.

6.2.20 The technical parameters of disconnectors are as per **Annexure-2**

6.3 Tests:

Disconnector (Isolator) shall conform to type tests and shall be subjected to routine test in accordance with IEC.

7. SAFETY GROUNDING SWITCHES

7.1 Safety grounding switches shall be three-pole group operated or single-pole individual operated (as per single line diagram of the substation/Chapter 1 Project Specific Requirement). It shall be operated by DC electric motor and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over-current and short circuit.

7.2 Each safety grounding switch shall be electrically interlocked with its associated disconnectors and circuit breaker such that it can only be closed if both the circuit breaker and disconnectors are in open position. Safety grounding switch shall also be mechanically key interlocked with its associated disconnectors.

7.3 Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the Local Control Cabinet (LCC) and provision for taking the signal to Control room.

7.4 The details of the inscription and coloring for the indicator are given as under:

Position	**Inscription**	**Color**
Open Position	OPEN	GREEN
Closed Position	CLOSED	RED

7.5 Interlocks shall be provided so that manual operation of the switches or insertion of the manual operating device will disable the electrical control circuits.

7.6 Each ground switch shall be fitted with auxiliary switches having 4 NO (Normally Open) and 4 NC (Normally Closed) contacts for use by others over and above those required for local interlocking and position indication purposes.

7.7 Provision shall be made for padlocking / suitable locking arrangement for the ground switches in either the open or closed position.

7.8 All portions of the grounding switch and operating mechanism required for grounding shall be connected together utilizing flexible copper conductors having a minimum cross-sectional area of 100 sq. mm.

7.9 The main grounding connections on each grounding switch shall be rated to carry the full short circuit current for 1 sec. and shall be equipped with a silver- plated terminal connector suitable for steel strap of adequate rating for connection to the grounding grid.

7.10 The safety grounding switches shall conform to the requirements of IEC- 62271- 102 and shall have electrical endurance class: E0 & shall have mechanical endurance class M1 for 132 kV voltage level.

7.11 Combined Disconnectors & Safety grounding switch arrangement shall also be acceptable.

7.12 Mechanical position indication shall be provided locally at each switch and Electrical indication at each Local Control Cabinet (LCC) / SAS.

7.13 Continuous current rating of the grounding switches (not less than 100A) shall be specified by the manufacturer, which can be safely injected for Bay/ Bus equipment testing.

8. HIGH SPEED MAKE PROOF GROUNDING SWITCHES:

8.1 Grounding switches located at the beginning of the line feeder bay modules shall be of the high speed, make proof type and will be used to discharge the respective charging currents, trapped charge in addition to their safety grounding function. These grounding switches shall be capable of interrupting the inductive and capacitive currents and to withstand the associated TRV. These shall confirm to class B and electrical endurance class E1 as per annexure – C of IEC: 62271-102

8.2 High Speed Grounding switches shall be provided with individual/three pole operating mechanism suitable for operation from DC.

8.3 The switches shall be fitted with a stored energy closing system to provide fault making capacity.

8.4 The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating. The switches shall have inductive/ capacitive current switching capacity as per IEC-62271-102.

8.5 Each high speed make proof grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the Local Control Cabinet (LCC) and provision for taking the signal to Control Room/SAS.

8.6 The details of the inscription and coloring for the indicator shall be as under: -

Position	**Inscription**	**Colour**
Open Position	OPEN	GREEN
Closed Position	CLOSED	RED

8.7 High speed ground switch operation should be possible locally from Local Control Cabinet (LCC)

8.8 These high-speed grounding switches shall be electrically interlocked with their associated circuit breakers and disconnectors so that the grounding switches cannot be closed if disconnectors are closed. Interlocks shall be provided so that the insertion of the manual operating devices will disable the electrical control circuits.

8.9 Each high-speed ground switch shall be fitted with auxiliary switches having 4 NO (Normally Open) and 4 NC (Normally Closed) contacts for use by others, over and above these required for local interlocking and position indication. All contacts shall be wired to terminal blocks in the Local Control Cabinet. Provision shall be made for padlocking the ground switches in their open or closed position.

8.10 All portion of the grounding switches and operating mechanism required for connection to ground shall be connected together utilizing copper conductor having minimum cross-sectional area of 100 sq. mm.

8.11 The main grounding connection on each grounding switch shall be rated to carry the peak withstand current rating of the switch for 1 sec. and shall be equipped with a silver-plated terminal connector suitable for steel strap of adequate design for connection to the grounding grid.

8.12 The high speed make proof grounding switches shall confirm to the requirements of IEC-62271-102.

8.13 Continuous current rating of the High-speed grounding switches (not less than 100A) shall be specified by the manufacturer, which can be safely injected for Bay/ Bus equipment testing.

9. INSTRUMENT TRANSFORMERS

9.1 Current Transformers

The current transformers and accessories shall conform to IEC: 60044-1/61869 and other relevant standards except to the extent explicitly modified in the specification.

9.1.1 Ratios and Characteristics:

The CT core distribution for various voltage levels shall be as per annexure 3. Further the numbers of cores, rating, ratios, accuracy class, etc. for the individual current transformers secondary cores shall be in accordance with annexure 3.

Where multi-ratio current transformers are required, the various ratios shall be obtained by changing the effective number of turns on the secondary winding.

9.1.2 Rating and Diagram Plates

Rating and diagram plates shall be as specified in the IEC specification incorporating the year of manufacture. The rated extended current rating voltage and rated thermal current shall also be marked on the name plate.

The diagram plates shall show the terminal markings and the relative physical arrangement of the current transformer cores with respect to the primary terminals (P1 & P2).

The position of each primary terminal in the current transformer SF6 gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer.

9.1.3 Constructional Details

i. The current transformers incorporated into the GIS will be used for protective relaying and metering purposes and shall be of metal- enclosed type.

ii. Each current transformer shall be equipped with a secondary terminal box with terminals for the secondary circuits, which are connected to the Local Control Cubicle. The star/ delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle.

iii. Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

iv. For 145 kV class CTs, the rated extended primary current shall be 120% (or 150% if applicable) on all cores of the CTs as specified in the Chapter 1 – Project Specific Requirement.

v. For 145 kV current transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over a range of 5% to 120%(or specified rated extended current whichever is higher) of rated current in case of metering CTs and up to the accuracy limit factor/knee point voltage in case of relaying CTs.

vi. The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably built-in construction of the CTs.

vii. The wiring diagram, for the interconnections of the three single phase CTs shall be provided inside the Secondary terminal box.

viii. The current transformers shall be suitable for high-speed auto-reclosing.

ix. Provisions shall be made for primary injection testing either within CT or outside.

x. All the current transformers shall have effective electromagnetic shields to protect against high frequency transients. Electromagnetic shields to be provided against high frequency transients typically 1-30 MHz.

9.2 VOLTAGE TRANSFORMERS

9.2.1 The voltage transformers shall conform to IEC- 60044-2/61869 and other relevant standards except to the extent explicitly modified in the specification.

9.2.2 Voltage transformers shall be of the electromagnetic type with SF6 gas insulation. The earth end of the high voltage winding and the ends of the secondary winding shall be brought out in the terminal box.

9.2.3 Ratios and Characteristics

The rating, ratio, accuracy class, connection etc. for the voltage transformers shall be in accordance with annexure -4.

9.2.4 Rating and diagram plates

Rating and diagram plate shall be provided complying with the requirements of the IEC specification incorporating the year of manufacture and including turns ratio, voltage ratio, burden, connection diagram etc.

9.2.5 Secondary Terminals, Earthing

The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of the SF6 switchgear.

All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.

9.2.6 The transformer shall be able to sustain full line to line voltage without saturation of transformer.

9.2.7 Constructional Details of Voltage Transformers:

i. The voltage transformers shall be located as a separate bay module and will be connected phase to ground and shall be used for protection, metering and synchronization.

ii. The voltage transformers shall be of inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients. The supplier shall ensure that there is no risk of Ferro resonance due to the capacitance of the GIS.

iii. The voltage transformers shall have three secondary windings.

iv. Voltage transformers secondary shall be protected by Miniature Circuit breakers (MCBs) with monitoring contacts for all the windings. The secondary terminals of the VT's shall be terminated to preferably stud type non-disconnecting terminal blocks in the secondary boxes via the fuse.

v. The voltage transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.

vi. The accuracy of 0.2 on secondary III should be maintained throughout the entire burden range up to 50 VA on all the three windings without any adjustments during operation.

vii. The diagram for the interconnection of the VTs shall be provided inside secondary terminal box.

9.3 Tests:

Current and voltage transformers shall conform to type tests and shall be subjected to routine test in accordance with IEC.

10. SURGE ARRESTORS (AS APPLICABLE)

10.1 The surge arrestors shall confirm in general to latest IEC –60099-4.

10.2 Insulation co-ordination and selection of surge arrestor:

10.2.1 The contractor shall be fully responsible for complete insulation co-ordination of switchyard including GIS. Contractor shall carry out detailed studies and design calculations to evolve the required parameters, locations, energy capability etc. of surge arrestors such that adequate protective margin is available between peak impulse, surge and power frequency discharge voltages and BIL of the protected requirement. The locations of surge arrestors shown in single line diagram is indicative only. If the contractor feels that at some more locations the surge arrestors are required to be provided the same should also be deemed included in the offer.

10.2.2 The contractor shall perform all necessary studies and the report shall detail the limits of all equipment parameters which could affect the insulation co-ordination. The report shall also detail the characteristics of the surge arrestor and shall demonstrate that the selected arrestor's protective and withstand levels, discharge and coordinating currents and arrestor ratings and comply with the requirement of this specification.

10.2.3 The contractor shall also consider in the studies the open circuit breaker condition, fast transients generated by slow operation of disconnecting switches. The study report and design calculations shall be submitted for Employer's approval.

10.3 Duty requirements of GIS Surge Arrestor

10.3.1 The surge arrester shall be of heavy-duty station class and gapless (Metal oxide) type without any series or shunt gaps.

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

10.3.3 145 kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for 132 kV system respectively on two successive operations.

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

10.3.5 The surge arresters are being provided to protect the followings whose insulation levels are indicated in the table given below: -

Equipment to be protected	**145 kV system**	**12 kV System**
	Lightning impulse (kVp)	Lightning impulse (kVp)
Power Transformer	±550	75
Instrument Transformer	±650	75
CB/Isolator Phase to ground	±650	75
CB/Isolator Across open contacts	±750	75

10.3.6 Constructional Features

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

The arrestor enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear as suggested by the supplier and each arrestor shall be fitted with a Online continuous resistive leakage current monitoring system. The system shall be provided with an interface to integrate with the substation automation system.

The main grounding connection from the surge arrestor to the earth shall be provided by the contractor. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.

10.4 Tests

10.4.1 In accordance with the requirements stipulated, the surge arrestors shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with IEC document.

10.4.2 Each metal oxide block shall be tested for the guaranteed specific energy capability in addition to the routine/acceptance test as per IEC-60099.

10.4.3 Test on Surge Monitors: The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstand tests to verify efficacy of the same. Additional routine/functional tests with one 100A and 10 kA current impulse, (8/20 micro sec.) shall also be performed on the surge monitor.

10.5 Technical Parameters: Technical parameters are as per Annexure 5

11. OUTDOOR BUSHINGS:

11.1 Outdoor bushings, for the connection of conventional external conductors to the SF6 metal enclosed switchgear, shall be provided where specified and shall conform to the requirements given in GTR.

11.2 The dimensional and clearance requirements for the metal enclosure will be the responsibility of the manufacturer and their dimensions must be coordinated with the switchgear. The adequate altitude correction factor shall be considered.

11.3 Bushings shall generally be in accordance with the requirements of IEC -60137.

11.4 Insulation levels and Creepage distances:

All bushings shall have an impulse and power frequency withstand level that is greater than or equal to the levels specified for GIS.

The creepage distance over the external surface of outdoor bushings shall not be less than 25 mm/kV and in highly polluted area it shall not be less than 31mm/kV (as per Chapter 1-Project Specific Requirement).

11.5 **Bushing types** and **fitting**: The details of bushing shall be as follows:

SF6 to air Bushing shall be of Polymer / composite type and shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition, substation layout. The electrical and mechanical characteristics of bushings shall be in accordance with IEC: 60137. All details of the bushing shall be submitted for approval and design review.

Polymer / composite insulator shall be seamless sheath of a silicone rubber compound. The housing & weather sheds should have silicon content of minimum 30% by weight. It should protect the bushing against environmental influences, external pollution and humidity. The hollow silicone composite insulators shall comply with the requirements of the IEC publications IEC 61462 and the relevant parts of IEC 62217. The design of the composite insulators shall be tested and verified according to IEC 61462 (Type & Routine test)

11.6 **Mechanical forces on bushing terminals:** Outdoor bushings must be capable of withstanding cantilever forces due to weight of bus duct (GIB) on one side & AIS conductor/Al tube on the other side and short circuit forces. Design calculations in support of the cantilever strength chosen shall be submitted for employer's review and approval.

11.7 Type test reports as per applicable IEC including radio interference voltage (RIV) test shall be submitted in line with the requirement as specified in Chapter GTR for approval.

11.8 The technical parameters of Bushing are as per Annexure -6.

12. SF6 GIS TO XLPE CABLE TERMINATION (AS APPLICABLE)

12.1 The underground cables shall be connected to GIS by the interfacing of XLPE cable sealing end to GIS Cable termination enclosure.

12.2 The SF6 GIS to XLPE cable termination shall conform to IEC-62271-209.

12.3 The rating of XLPE cables for different voltages are specified in the Chapter 1 Project Specific Requirement.

12.4 Cable termination kit shall be in the scope of the contract. The ducts and the casing shall be suitable for the requirements for which it is designed. This interface section shall be designed in a manner which will allow ease of operation and maintenance.

12.5 The provision shall be made for a removable link. The gap created when the link is removed should have sufficient electric strength to withstand the switchgear high voltage site tests. The contractor may suggest alternative arrangements to meet these requirements. The corona rings/stress shields for the control of electrical field in the vicinity of the isolation gap shall be provided by the GIS manufacturer.

12.6 All supporting structures for the SF6 bus-duct connections between the XLPE cable sealing ends and the GIS shall be the scope of the contract. The supplier may specify alternative connecting & supporting arrangements for approval of the employer.

12.7 The opening for access shall be provided in each phase terminal enclosures as necessary to permit removal of connectors to isolate the XLPE cables to allow carrying out the insulation tests. The general arrangement drawing of interconnecting bus-duct from GIS bay module to XLPE cable termination end shall also be submitted.

12.8 Type test reports of radio interference voltage (RIV) level shall be submitted for approval

13. TRANSFORMER TERMINATION MODULE (IF APPLICABLE)

13.1 The transformer termination module enables a direct transition from the SF6 gas insulation to the bushing of an oil-insulated transformer / reactor. For this purpose, the transformer/reactor bushing must be oil-tight, gas-tight and pressure resistant. Any temperature related movement and irregular setting of the switchgears or transformer's/reactor's foundations are absorbed by the expansion fitting.

13.2 The oil filled transformers and reactors are as shown in the substation SLD. The oil to air bushings of the transformers and reactors shall be supplied by the respective supplier's and the same shall be connected to the SF6 ducts thru air to SF6 bushings to be provided under present scope.

13.3 Terminal connection arrangement to connect GIS duct to bushing and duct mounting arrangement details shall be submitted during detailed engineering for Employer's/consultant approval and for co-ordination with transformer supplier. Any modification suggested by transformer supplier shall have to be carried out by the supplier to facilitate proper connection with the bushings of the transformer and reactors.

14. LOCAL CONTROL CUBICLE (LCC)

14.1 Functions

i. Each circuit-breaker bay shall be provided with a local control cubicle containing local control switches and a mimic diagram for the operation and semaphore for status indication of the circuit-breaker and all associated isolators and earth switches together with selector switches to prevent local and remote and supervisory controls being in operation simultaneously

ii. Status indications in the LCC shall be semaphore type or LED type.

iii. Closing of the circuit- breaker from the local control unit shall only be available when the breaker is isolated for maintenance purposes. Circuit-breaker control position selector, operating control switch and electrical emergency trip push button shall be installed in the Local Control Cubicle. Circuit-breaker control from this position will be used under maintenance and emergency conditions only. The emergency trip push buttons shall be properly shrouded.

iv. If Disconnector or earth switch is not in the fully open or closed position a "Control Circuit Faulty" alarm shall be initiated, and electrical operation shall be blocked.

14.1.1 20% spare terminals shall be provided in each LCC apart from terminals provided for the termination and interconnection of all cabling associated with remote and supervisory control, alarms, indications, protection and main power supply etc.

14.1.2 Where plugs and sockets connect control cabling between the local control cubicle and the switchgear these shall not be interchanged.

14.1.3 Hydraulic/pneumatic and SF6 auxiliary equipment necessary for the correct functioning of the circuit breaker, isolators and earth switches shall be located in a separate cubicle compartment.

14.1.4 LCC shall be suitable for remote operation from substation automation system (SAS). Each gas tight compartment shall be monitored individually per phase basis through SAS

14.2 Constructional features

14.2.1 Local Control cubicle shall be either mounted on the GIS with front access or free standing, floor mounting type. It shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.

14.2.2 Access to all compartments shall be provided by doors. All fastenings shall be integral with the panel or door and provision made for locking. Cubicles shall be well ventilated through vermin-proof louvers having anti insect screen. All doors shall be gasketed all around with suitably profiled Neoprene/EPDM gaskets conforming with provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors.

14.2.3 Each LCC panel should have its own separate AC supply source feed from the ACDB. The DC supply shall be from respective relay & protection panel power, control, interlocking, signaling. Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately

provided with Fuses. All fuses shall be HRC cartridge type mounted on plug-in type fuse bases. The short time fuse rating of Fuses shall be not less than 9 KA. Fuse carrier base shall have imprints of the fuse 'rating' and 'voltage'.

14.2.4 Each LCC Panel shall be provided with the following

i. **Plug Point**: 230V, Single phase 50Hz, AC socket with switch suitable to accept 5 Amps and 15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.

ii. **Interior Lighting**: Each panel shall be provided with a fluorescent lighting fixture rated for 230 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch. Adequate lighting shall also be provided for the corridor in Duplex panels.

iii. **Space Heater**: Each panel shall be provided with a thermostatically connected space heater rated for 230V, single phase, 50 Hz AC supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit

14.2.5 Operating mechanisms, auxiliary switches and associated relays, control switches, control cable terminations, and other ancillary equipment shall be accommodated in sheet steel vermin proof cubicles.

14.2.6 Local control cubicles shall be provided to be free standing and shall be equipped with anti-condensation heaters. A suitable humidity stat and thermostat shall be included in the heater circuit.

14.2.7 The interior of each cubicle shall be finished with a semi-gloss white surface. An interior lamp suitable for the local LVAC supply, controlled by a door-operating switch, shall be fitted at the top of each panel.

14.2.8 The arrangement of equipment within cubicles shall be such that access for maintenance or removal of any item shall be possible with the minimum disturbance of associated apparatus. All the control switches shall be internal i.e., installed behind a lockable glass door.

14.2.9 An interlocking scheme shall be provided that takes into account the following basic requirements.

i. To safeguard maintenance personnel who may be working on one section of the equipment with other sections live.

ii. prevent incorrect switching sequences that could lead to a hazardous situation to plant, equipment and personnel.

14.2.10 Electrical bolt interlocks shall be energized only when the operating handle of the mechanism is brought to the working position. Visible indication shall be provided to show whether the mechanism is locked or free. Means, normally padlocked, shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies.

14.2.11 Where key interlocking is employed tripping of the circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism. Any local emergency-tripping device shall be kept separate and distinct from the key interlocking.

14.2.12 Disconnecting switches shall be so interlocked that they cannot be operated unless the associated circuit-breaker is open except that where double bus bar arrangements are specified, on-load transfer of feeder circuits from one bus bar to another shall be made possible by interlocks which ensure that the associated bus coupler and its isolators are closed.

14.2.13 Bus coupler circuit breaker shall be interlocked so that it shall not be possible to open a bus coupler circuit breaker while on load change over on that side of the breaker is in progress.

14.2.14 All isolating devices shall be interlocked with associated circuit-breakers and isolators in the same station so that it shall not be possible to make or break current on an isolating device unless a parallel circuit in that station is already closed.

15. GIS BUILDING

15.1 The buildings shall house Gas Insulated Switchgear (GIS) and other associated equipment inside the GIS buildings. GIS building shall be constructed for the specified number of bays/diameters as per section project

15.2 Wherever GIS Hall of proposed voltage is already existing, then the existing GIS hall of respective class shall be suitably extended (wherever applicable) to accommodate the number of bays/diameters as specified in the Section Project.

15.3 The contractor shall submit the design & construction proposal of the building along with necessary information, data, and drawings during the detailed engineering according to the complete requirements.

15.4 The area for GIS hall(s) is indicated in the enclosed General Arrangement drawing. The area given is for reference only and may vary according to requirement of the equipment to be installed inside. The contractor shall finalize the dimensions according to the equipment offered by them providing enough space & access for erection, operation and maintenance.

15.5 The contractor shall place their panels i.e., Bay level units, bay mimic, relay and protection panels, RTCC panels, SAS panels etc. in a separate room in the GIS building. The size of the room shall be such that all the panels for the future bays/ diameters shall be accommodated in the above room. The panel room shall be air-conditioned. Further, the temperature of the room shall be monitored through substation automation system by providing necessary temperature transducers. The Switchyard panel room as detailed in Chapter Sub-station Automation System is not required for GIS station.

16. ELECTRIC OVERHEAD CRANE:

16.1 One EOT Crane each for GIS hall of suitable capacity shall be provided for erection & maintenance of largest GIS component/assembly. The crane shall consist of all special requirements for erection & maintenance of GIS equipment.

16.2 The capacity of the crane shall be sized to lift the heaviest GIS switchgear component crane.

16.3 The Crane shall be used for the erection and maintenance of the GIS switchgear component and all plant installed in the GIS switchgear room. On completion of erection

of the switchgear, the Contractor shall completely service the crane before the Taking Over Certificate is issued.

16.4 Crane hook approaches shall be of the minimum possible dimensions to ensure maximum coverage of the plant area.

16.5 The crane(s) shall be capable of lifting and accurately positioning all loads ranging from full crane rated capacity to at least 10% rated capacity.

16.6 The crane shall have following minimum speeds under full load for the following functions:

i. Hoisting 9 meters/minute

ii. Cross Travel 20 meters/minute

iii. Long Travel 20 meters/minute

iv. Creep speed shall be of 25% of operating speed

16.7 The electric overhead cranes shall be provided with walkways, platforms. Guard hand rails shall be provided along the bridge rails and on the crab of EOT crane to facilitate cleaning/maintenance of the crane and to give access to the GIS room high bay lighting and ventilation duct and grilles.

16.8 The platform and walkways shall be designed to support any weight to be imposed upon them during crane overhaul.

16.9 An access platform shall be provided together with a guarded ladder on the crane to allow access to the bridge rails.

16.10 The crane shall be possible to be operated through the cable, through the pendant control and which shall be easily accessible from the floor of GIS building and through remote control device.

16.11 Contractor shall submit the capacity calculation of crane for GIS hall considering a factor of safety of 5.

16.12 The crane for 132kV GIS shall have capacity of minimum 5T safe working load & hoisting height of crane have shall be 8.0 meters or as per actual requirement whichever is higher.

16.13 In case the GIS hall is to be extended, the scope of work also involves extension of EOT crane girders to facilitate movement of EOT crane in the extended portion of GIS hall.

16.14 The following tests shall be performed for EOT Crane.

The crane shall be tested at manufacturer work under full load and 25 percent overload of hoisting and cross transverse motions as a routine test.

i. Further the following tests may be done at site after installation of the crane at site

ii. Check all the accessories for proper function

iii. No load tests

iv. Load test as per site conditions

17. VENTILATION SYSTEM FOR GIS HALL

17.1 Each GIS Hall shall have an independent ventilation system. Each Ventilation system shall consist of two 100% capacity systems, one operating and one stand-by.

17.2 To ensure that the air being supplied to the GIS hall is free from dust particles, a minimum two stage dust filtration process shall be supplied. This shall consist of at least the following:

17.2.1 Pre-Filters: To remove dust particles down to 10 microns in size with at least 95% efficiency.

17.2.2 Fine Filters: To remove dust particles down to 5 microns in size with at least 99% efficiency.

17.3 All the filters shall be panel type. Easy access should be available to the filters for replacement/cleaning.

17.4 The ventilation of the GIS hall shall be of a positive pressure type with minimum 4 air changes per hour. The pressure inside the GIS hall shall be maintained 5 mm of water above the atmospheric pressure. Fresh outdoor air shall be filtered before being blown into the GIS hall by the air fans to avoid dust accumulation on components present in the GIS hall. GIS hall shall be provided with motorized exhaust dampers with local control.

18. SEISMIC DESIGN CRITERIA:

18.1 The equipment shall be designed for operation in seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act on concurrently. Seismic Qualification requirements shall be as per IEC 62271-207 for the design of equipment. The equipment along with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from the forces in normal operation, but in case of abnormal condition shall also resist with forces superimposed due to earthquakes. The copies of type test reports for similar rated equipment, if tested earlier, should be furnished. If the equipment has not been type tested earlier, Test Report/Analysis Report should be furnished.

18.2 To prevent the movement of GIS sub-assemblies i.e., various bay modules during the earthquake, suitable devices shall be provided for fixing the sub-assemblies to the foundation. The contractor shall supply necessary bolts for embedding in the concrete foundation. The fixing of GIS sub-assemblies to the foundation shall be designed to with-stand the seismic events. It will also be ensured that the special devices as well as bolts shall not be over stressed. The details of the devices used and the calculations for establishing the adequacy shall be furnished by the supplier and shall be subject to the employer's/consultant approval.

19. DESIGN REVIEW

19.1 Design reviews shall be conducted by Employer/consultant or an appointed consultant during the detailed Engineering of the GIS; however, the entire responsibility of design shall be with the supplier.

19.2 Employer/consultant may also visit to the supplier's works to inspect design, manufacturing and test facilities.

19.3 The design review will commence after placement of award with the successful contractor and shall be finalized before commencement of manufacturing activity. These design reviews shall be carried out in detail to the specific design with reference of the GIS under the scope of this specification. Employer/consultant reserve the right to waive off the design review during detailed engineering.

19.4 The design review shall be conducted generally following the, "User Guide for the application of Gas Insulator Switchgear (GIS) rated voltage of 72.5kV and above" – CIGRE report No. 125 prepared by CIGRE Working Group 23.10.

19.5 The manufacturer will be required to demonstrate the use of adequate safety margins for thermal, mechanical, dielectric, insulation coordination and vibration etc. design to take into the account the uncertainties of his design and manufacturing processes.

19.6 The scope of such a design review shall at least include the following:

1.	Dielectric Stress of Solid Insulation like Gas Barrier, support insulator etc.
2.	Dielectric stress of SF6 Gas Volume.
3.	Mechanical strength of enclosure, expansion joints etc.
4.	Criteria for providing expansion joint.
5.	Sealing system
6.	Insulation coordination
7.	Thermal stress and resulting increase in gas pressure during short circuit condition.
8.	Earthing of enclosure w.r.t circulating current.
9.	Seismic design, as per IEC 62271-207
10.	Circuit Breaker.
11.	Isolator and Earth switch.
12.	Voltage transformer.
13.	Current Transformer.
14.	Surge Arrester.
15.	Bushing.
16.	Ducting.
17.	Corrosion protection.
18.	Electrical and physical Interfaces with substation.
19.	Testing capabilities.
20.	Inspection and test plan.
21.	Transport and storage.
22.	Maintainability.

23.	Site Test.

19.7 Further, the manufacturer shall furnish the following information:

i. Details regarding the loosely distributed metallic particles within the GIS encapsulation and calculations of critical field strength for specific particles of defined mass and geometry.

ii. Study report of VFTO generated for GIS installation.

iii. The methodology and all the equipment for electrical partial discharge (PD) detection, including that mentioned in the specification elsewhere.

iv. The calculations and documents in support of the average intensity of electromagnetic field on the surface of the enclosure above during detailed engineering.

v. The detailed criteria/ design regarding location of pressure relief devices/rupture diaphragms

vi. Calculations to show that there is no Ferro resonance due to capacitance of GIS for the voltage transformers

vii. Design calculation for simulated parameters for Seismic level as applicable

viii. Insulation Coordination studies including studies to recommend for additional surge arrestor

ix. Calculation in support of touch & step voltages in all enclosures and earthing of complete GIS installation.

x. Measures to mitigate transient enclosure voltage by high frequency currents.

xi. Calculation for providing bus duct supports.

20. TYPE TESTS

20.1 The offered GIS equipment shall conform to the type tests as per IEC-62271-203. Contractor shall submit type test reports for the following type tests & additional type tests.

SN	Description of the Type Test for GIS
1	Tests to verify the insulation level of the equipment and dielectric test on auxiliary circuits
2	Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit
3	Tests to prove the ability of the main and earthing circuits to carry the rated peak and rated short time withstand current
4	Tests to verify the making and breaking capacity of the included switching devices
5	Tests to prove the satisfactory operation of the included switching devices
6	Tests to prove the strength of the enclosures
7	Gas tightness tests

8	Tests on partitions
9	Tests to prove the satisfactory operation at limit temperatures
10	Tests to assess the effects of arcing due to internal fault
11	Verification of the degree of protection of the enclosure
12	Tests to prove performance under thermal cycling and gas tightness tests on insulators
13	Additional tests on auxiliary and control circuits
14	Test to demonstrate the Power frequency withstand capability of breaker in open condition at lock out pressure.
15	Electromagnetic compatibility tests (if applicable)
16	Radio inference voltage tests (RIV), if applicable

20.2 The test reports of the above type tests for GIS (including type test report on Circuit breaker, Disconnectors, Grounding switches, Current and Voltage transformers) as per relevant IEC and type tests of SF6/Air & Oil bushing as per IEC 60137 shall be submitted for approval as per Chapter- GTR, Technical Specification. In addition of type test following routine test/ FAT acceptance test shall be performed by the contractor and for field test the test schedule and scheme shall be finalized during detail engineering design phase.

20.3 Routine Test:

i. Test for Breaker (DCRM,CRM,Timing,Drives Current and Auxiliary Check)

ii. Drive Timing /Current for all Drives.

iii. Density Monitoring Test.

iv. Gas Purity and Dew point measurement.

v. Gas Leakage Test.

vi. CT Testing (Ratio, Polarity, Accuracy, Knee point Voltage)

vii. VT (Ratio, Polarity, Accuracy etc.)

viii. Isolator and Earth Switch (CRM)

ix. HV Test

20.4 Beside the above-mentioned test contractor shall preform the other required test as per approved MQP (approved by the employer during detail engineering design).

21. GENERAL

21.1 **Painting of enclosure**: All enclosures shall be painted externally as per manufacturer's painting procedure. The painting procedures as followed shall be submitted during detailed engineering.

21.2 **Heaters:** Wherever required, heaters shall be provided to prevent moisture condensation. Heaters are not allowed inside the main circuit**.**

21.3 Identification & rating plate

Each bay shall have a nameplate showing

i. A listing of the basic equipment (such as a breaker, Disconnector's grounding switches, current transformers, voltage transformers, and bushings etc.).

ii. A schematic diagram indicating their relative locations.

iii. NEA Contract Number.

iv. Each module will have its own Identification & rating plate. The rating plate marking for each individual equipment like Circuit breaker, Disconnectors Grounding switches, Current transformer, Voltage transformers, Surge arrester etc. shall be as per their relevant IEC.

22. TRANSPORT OF EQUIPMENT TO SITE

The contractor shall be responsible for the loading, transport, handling and offloading of all equipment and materials from the place of manufacture or supply to site. The contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities as well as determining any transport restrictions and regulations imposed by the government and other local authorities. All transport packages containing critical units viz Circuit breakers and Voltage transformers shall be provided with sufficient number of electronic impact recorders (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted by the contractor during detailed engineering. The recording shall commence in the factory and must continue till the units reach site. The data of electronic impact recorders shall be downloaded at site and a soft copy of it shall be handed over to Engineer – in –charge. Further, contractor shall communicate the interpretation of the data within three weeks.

23. PACKING, STORAGE AND UNPACKING

23.1 All the equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and the variations in such conditions that will be encountered enroute from the manufacturer's works to the site.

23.2 The SF6 metal clad equipment shall be shipped in the largest factory assembled units that the transport and loading limitations and handling facilities on site will allow to reduce the erection and installation work on site to a minimum.

23.3 Where possible all items of equipment or factory assembled units shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner. Should the units be considered too large for packing in crates, they shall be suitably lagged and protected to prevent damage to any part, particularly small projections, during transport and handling. Special lugs or protective supports shall be provided for lifting to prevent slings and other lifting equipment from causing damage. Each crate, container or shipping unit shall be marked clearly on the outside to show where the weight is bearing and the correct position for the slings.

23.4 Each individual piece to be shipped, whether crate, container or large unit, shall be marked with a notation of the part or parts contained therein.

23.5 Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the metal clad equipment of which each gas section shall be sealed and pressurized prior to shipping. Either dry nitrogen/air or dry SF6 gas shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment. The type of gas, the maximum pressure to which sections will be filled prior to shipment and the minimum allowable pressure during shipment shall be advised prior to dispatch.

23.6 All blanking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site shall be provided as part of the contract and shall remain the property of NEA. If considered necessary, blanking plates or other sealing devices shall be provided with facilities for measuring the gas pressure and recharging at any time during the transport period. Any seals, gaskets, 'O' rings, etc. that may be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Identification serial numbers shall be stamped into the blanking plates, etc., and on the switchgear equipment to which they are fitted so that they can easily be identified and refitted should it ever be necessary to ship sections of the switchgear back to the manufacturer's works for repair.

23.7 Valves and other gas couplings associated with the switchgear gas systems shall be adequately protected against damage from any bumps or physical blows. They shall also be capped to prevent ingress of dirt or moisture or damage to any coupling, pipes, threads or special fittings. Any explosion vents and other pressure relief devices, shall be suitably sealed and protected to prevent accidental exposure of the sealed sections during shipment to site.

23.8 For bus ducts involving male and female joints of the current carrying conductor, the same shall be transported in disassembled condition to avoid any damage during transit. All bright parts liable to rust shall receive a coat of anti-rusting composition and shall be suitably protected.

23.9 The contractor will be able to use the available storage areas at site. The contractor shall ensure that during the period between arrival at site and erection, all materials and parts of the contract works are suitably stored in such approved manner as to prevent damage by weather, corrosion, insects, vermin or fungal growth. The scope of providing the necessary protection, storing off the ground, as required etc. is included in the works to be performed by the contractor.

23.10 The equipment shall only be unpacked or removed from the containers immediately prior to being installed. They shall not be left lying unnecessarily in open crates or containers. Special precautions shall be taken when gas sections which have been sealed and pressurized for shipping are opened up to reduce the ingress of dirt and atmospheric moisture to a minimum. Whenever possible this shall only be done immediately prior to installation and if any section is to be left outside for any length of time after being

opened, it shall be resealed and pressurized with either dry nitrogen/air or SF6 gas until required.

24. INSTALLATION OF GIS

24.1 Civil works of GIS Hall shall be completed in all respects for taking up the installation and it shall be ensured that all dust and dirt in the hall are removed. All openings (including Bus Duct) except entry door should be closed and proper sealed

24.2 The installation area shall be secured against entry of unauthorized personnel. Only certified manufacturer's engineer and supervisor shall supervise critical & important erection works. The help of local technicians can be taken only for material handling and non-critical erection works. Engineers and supervisors of the manufacturer shall submit authorization and competency certificate.

24.3 Assembly drawing for GIS erection for the section under progress shall be available and displayed in GIS hall at the time of work.

24.4 Proper power supply shall be ensured by installing UPS of proper rating and frequency if required prior to commencement of erection work so that assembly work is not interrupted in the middle which is critical for GIS installation.

24.5 Working personnel shall clean their shoes or apply covers on shoes before entering the immediate working area. The working clothes of authorized personnel shall be made of non-fluffy material.

24.6 GIS hall door shall have automatic close facility after entry of personnel to avoid dust and moisture entry. Walls and ceiling shall be in a condition so that neither dirt nor plaster might fall or rub off and formation of condensation water in ceiling shall be prevented under any circumstances.

24.7 Floor in the installation area shall have a firm surface and shall be kept dust free with a vacuum cleaner. Vacuum cleaning to be done at regular interval throughout the day with separate team of persons assigned for cleaning work only.

24.8 Only T&P and consumables required for GIS erection shall be kept in GIS during erection.

24.9 In case of outdoor installation of GIS or of GIS components open, gas compartments shall be protected from dust and moisture ingress (by tarpaulin covers etc.)

24.10 Bus duct exit in the GIS hall wall shall be kept covered by suitable means until permanent cover is provided after installation of bus ducts.

24.11 A separate room shall be identified in consultation with NEA/consultant for carrying out repair works/ small part assembly and the room shall be weather protected and lockable. All excess material (not required for immediate installation works) test equipment and tools and tackles to be stored separately from GIS hall in the separate room for rework

24.12 All assembly work shall be done by qualified personnel only who are to be identified before starting of erection work.

24.13 Erection agency shall submit method statement and make available formats for checking during each stage of hall preparation, assembly process and final checks to be approved before start of erection. Method statement shall include record of shock/ impact recorder

at the time of unpacking. Shock recorder down loaded data and analysis shall be submitted before commencement of erection work. In case of violation of shock limits, expert form manufacturer shall visit and do the internal inspection before giving clearance for erection.

24.14 Cleaning is of utmost importance and hence before assembly, all the loose metal parts, subassemblies and all contact& sealing surfaces shall be cleaned before installation. Cleaning shall be e carried out with specified cleaning agents of the manufacturer in no condition water is to be used except for external surfaces. Further, Prior to opening, gas compartment shall be thoroughly cleaned and vacuum cleaning of the installation area shall also be done specially the immediate vicinity of the flanges to be connected. Dust disturbance in the area to be avoided

24.15 Also, before closing a flange connection clean the immediate vicinity and all accessible parts of the components shall be connected with a vacuum cleaner

24.16 Once the transport covers are removed installation of flanges shall be done without any interruptions, if interruptions cannot be avoided open flanges are to be covered with clean plastic foil. Transport covers, O-rings and other packing material shall be taken out of GIS after immediately after removal.

24.17 O Rings shall be properly stored and taken out only before installation. O Rings are also to be cleaned before use with manufacturer authorized cleaning agent.

24.18 At all points of time during installation authorized personnel shall use disposable gloves to avoid contamination.

24.19 Cable termination work shall commence only after completion of GIS equipment as during GIS installation period laying and termination of cables interferes with the GIS erection work and affects cleanliness.

24.20 Approved Field Quality Plan shall be followed strictly during site work.

25. ON SITE TESTING

After the switchgear has been completely installed on site and filled with SF6 gas, the complete assembly shall be subjected to the site tests as per IEC – 62271-203 and with the test voltages specified below: -

25.1 The adequacy of number of UHF sensors and their location shall be verified as per recommendations of CIGRE task force TF 15/33.03.05 (Task force on Partial discharge detection system for GIS: Sensitivity verification for the UHF method and the acoustic method). In case during site testing additional UHF sensors are required, the same shall also be supplied and installed to complete the technical requirement.

25.2 Application of AC voltage equal to 1.2 times the service voltage in order to condition the GIS whilst at the same time permitting measurement of Partial discharge and detection of conductive particles by UHF method.

25.3 In case of a disruptive discharge in the gas as outlined in IEC: 62271-203, and a repeat test is performed due to failure during the AC voltage test, then the test shall be carried out at 1.2 times the service voltage.

25.4 The analysis of PD measured during High voltage test shall done very carefully and presence of PD measured by any sensor shall be attended and HV test shall be repeated after the rectification work. Calibration of PD sensors shall be completed before start of HV test to establish reference for detection of PD above 5 pc

25.5 Method statement/ procedure of onsite high voltage testing and PD measurement shall be submitted by contractor in advance.

26. TESTING & MAINTENANCE EQUIPMENT

All testing and maintenance equipment shall be offered, if specified as per relevant schedule of BPS.

26.1 SF6 Gas leakage detector.

The detector shall be portable, battery operated with built in battery charger, hand held type and having a minimum SF6 gas leakage sensitivity of 5gm/year. The sensor shall be connected through a flexible wand for easy accessibility to joints, seals and couplings in GIS equipment and provided with a protection filter. The equipment shall have on/off switch & suitable indicating lamps/LEDs, variable pitch audible signal for leakage indication, and a head phone jack. The equipment shall have automatic zeroing of background signals suitable for detecting SF6 gas leakage in charged switchyard. The test kit shall be compatible for EMI/EMC environment as per IEC 1000.

26.2 Gas filling and evacuating plant:

26.2.1 The plant necessary for filling and evacuating the SF6 gas in the switchgear shall be supplied to enable any maintenance work to be carried out. This shall include all the necessary gas cylinders for temporarily storing the evacuated SF6 gas. The capacity of the temporary storage facilities shall at least be sufficient for storing the maximum quantity of gas that could be removed from at least one phase of one complete bay (switchgear and associated equipment).

26.2.2 Where any item of the filling and evacuating plant is of such a weight that it cannot easily be carried by maintenance personnel, it shall be provided with lifting hooks for lifting and moving with the overhead cranes.

26.2.3 The minimum capacity of evacuation plant will be as under:

Vacuum Pump: 60 M^3/Hour (Nominal suction pressure)
Compressor : 15 M^3/Hour (Delivery)

26.2.4 The evacuation equipment shall be provided with all the necessary pipes, couplings, flexible tubes and valves for coupling up to the switchgear for filling or evacuating all the gases.

26.2.5 The gases compartments shall preferably be fitted with permanent non-return valves through which the gas is pumped into or evacuated form the compartments.

26.2.6 Details of the filling and evacuating plant that will be supplied, as well as the description of the filling and evacuating procedures shall be furnished

26.3 SF6 gas analyzer:

i. The SF6 gas analyser should be of portable type and instruments shall have following features:

ii. In-built calibration facility.

iii. Sensitivity of the equipment shall not be affected by any atmospheric conditions like dust, humidity, heat, wind etc.

iv. Equipment shall work on zero gas loss principle i.e.; gas should be pumped back to the compartment after measurement without any exposure to the atmosphere.

v. Equipment shall be supplied with suitable regulator which can be used to connect SF6 cylinder if required.

26.4 Following acidic/impurities products should be detected as per IEC 60480 and IEC 60376

i. SF6 purity – Range: 0-100 % & Accuracy: +/- 0.5 %

ii. Dew point - Range: -60 to +20 deg C & Accuracy: +/- 0.5 deg C

iii. SO2 - Range: 0-150 ppm & Accuracy: +/- 2 %

iv. CF4 – Range: 0-60% vol & Accuracy: +/- 1 %

v. HF - Range: 0-200ppm & Accuracy: +/- 5 %

26.4.1 Instrument should work on AC source as well as on rechargeable battery

26.4.2 Input pressure: upto 10 bar

26.4.3 It should be housed in a robust IP67 case with wheels

26.5 Portable Partial Discharge (PD) monitoring system

26.5.1 The equipment shall be used for detecting different types of defects in Gas Insulated Stations (GIS) such as Particles, Loose shields and Partial Discharges as well as for detection of Partial discharges in other types of equipment such as Cable Joints, CTs and PTs.

26.5.2 It shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 100 MHz–2GHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principle of operation shall be based on UHF principle of detection. The instrument should also be able to detect partial discharges in cable joints and terminations.

26.5.3 Detection and measurement of PD and bouncing particles shall be displayed on built in large LCD display and the measurement shall be stored in the instrument and further downloadable to a PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc. Software for display and diagnosis of PD signals and an expert software system for accurate interpretation of cause of PD shall also be supplied and installed by the contractor.

26.5.4 The equipment shall meet the following requirements

i. Measurement shall be possible in noisy environment.

ii. Stable reading shall be possible in presence of vibrations within complex GIS assemblies, which can produce signals similar to PD.

iii. Equipment should have necessary synchronizing circuits to obtain PD

correlation with power cycle and power frequency.

iv. The equipment shall be battery operated with built-in-battery charger. It shall also be suitable for 230V AC/50 Hz input.

v. Measurement shall be possible in the charged switchyard in the presence of EMI/EMC. Supplier should have supplied similar detector for GIS application to other utilities. Performance certificate and the list of users shall be supplied along with the offer.

vi. Instrument shall be supplied with standard accessories i.e., re-locatable sensors with mounting arrangements, connecting cables (duly screened) to sensors, Lap-top PC, diagnostic and expert interpretation software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50Hz supply connecting cables (duly screened) to view in storage.

26.5.5 The function of software shall be covering the following:

i. Data recording, storage and retrieval in computer

ii. Data base analysis

iii. Template analysis for easy location of fault inside the GIS

iv. Evaluation of PD measurement i.e., Amplitude, Phase Synchronization etc.

v. Evaluation of bouncing/loose particles with flight time and estimation on size of particle.

vi. Expert software system for accurate interpretation of cause of PD.

vii. Report generation.

26.5.6 To prove the suitability in charged switchyard condition, practical demonstration shall be conducted before acceptance.

26.5.7 Supplier shall have "Adequate after sales service" facility.

26.5.8 Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS

26.5.9 Instrument shall be robust and conform to relevant standard.

26.6 Calibration:

26.6.1 The UHF Couplers have to be first calibrated as per CIGRE procedure TF 15/330305 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better. The GIS of same design shall be used as test specimen during the coupler calibration. The pulse injection level determined through above factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of PDM system. The data sheet/frequency response characteristics shall be submitted for reference.

26.6.2 Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory.

ANNEXURE 1

TECHNICAL PARAMETERS FOR CIRCUIT BREAKER

SN	Parameters	132 kV system
1.	Rated voltage kV (rms)	145
2.	Rated frequency (Hz)	50
3.	No. of poles	3
4.	Type of circuit breaker	SF6 insulated.
5.	Rated continuous current (A) at an ambient temperature of 50^0C	1250/2000 (as applicable)
6.	Rated short circuit capacity with percentage of DC component as per IEC-62271-100 corresponding to minimum opening conditions as specified.	40 kA (As applicable)
7.	Symmetrical interrupting capability kA (rms) (As applicable)	40
8.	Rated short circuit making current kAp (As applicable)	80
9.	Short time current carrying capability for one second kA (rms) (As applicable)	80
10.	Rated line charging interrupting current at 90 deg. Leading power factor angle (A rms) (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	As per IEC
11.	First pole to clear factor	As pr IEC
12.	Rated break time as IEC (ms)	60
13.	Total break time (ms)	65
14.	Total closing time (ms)	Not more than 200
15.	Rated operating duty cycle	O-0.3s-CO-3min-CO
16.	Reclosing	Single phase and Three phase auto reclosing
17.	**Rated insulation levels**	
	Full wave impulse withstand (1.2 /50 µs) between line terminals and ground:	±650 kVp
	Full wave impulse withstand (1.2 /50 µs) Between terminals with circuit breaker open:	±750kVp
	Rated switching impulse withstand voltage (250/2500 µs) Dry & wet.	NA
	Rated switching impulse withstand voltage (250/2500 µs) Dry &wet Between terminals with circuit breaker open:	NA
	One minute power frequency withstand voltage between line terminals and ground	275 kV rms

SN	Parameters	132 kV system
	One minute power frequency withstand voltage between terminals with circuit breaker open	315 kV rms
18.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 266 kV (Micro volts)	500µV
19.	Max. difference in the instants of closing/opening of contacts (ms) between poles	As per IEC
20.	Trip coil and closing coil voltage with variation as specified in Sec. GTR	220 V DC
21.	Rating of Auxiliary contacts	10 A at 220 V DC
22.	Breaking capacity of Aux. Contacts less than 20 ms.	10A at 220 V DC
23.	System neutral earthing	Solidly Grounded

ANNEXURE 2

TECHNICAL PARAMETERS FOR DISCONNECTORS/ ISOLATORS

SN	Particulars	132 kV
1.	Rated voltage (rms) Un	145 kV
2.	Rated frequency	50 Hz
3.	System earthing	Solidly earthed
4.	Type	SF6 insulated
5.	Rated continuous current (A) at 50^0C ambient temp. (as applicable)	1250/2000 (for line / transformer / bus coupler)
6.	Rated short time withstand current of isolator and earth switch (as applicable)	40 kA for 1 second
7.	Rated dynamic short circuit withstand current withstand current of isolator and earth switch (As applicable)	80 kAp
8.	Rated insulation level:	
	One minute power freq. Withstand voltage-To earth:	275 kV rms.
	One minute power freq. Withstand voltage: Across isolating distance	315 kV rms.
	1.2/50 micro sec. Lighting impulse withstand voltage (+ve or – ve polarity) To earth:	±650 kVp
	1.2/50 micro sec. Lighting impulse withstand voltage (+ve or – ve polarity) : Across Isolating distance	±750 kVp
	Rated switching impulse withstand voltage (250/2500 micro-sec.) Dry & wet: between line terminals and ground:	NA
	Rated switching impulse withstand voltage (250/2500 micro-sec.) Dry & wet: Between terminals with Isolator open:	NA
9.	Mechanical Endurance clause as per IEC	M1
10.	No. of spare auxiliary contacts on each isolator	4 NO and 4 NC
11.	No. of spare auxiliary contacts on each earthing switch	4 NO and 4 NC

ANNEXURE 3

TECHNICAL PARAMETERS FOR CURRENT TRANSFORMERS

SN	Particulars	132 kV
1.	Rated voltage Un	145 KV (rms)
2.	Rated frequency	50 Hz
3.	System neutral earthing	Solidly earthed
4.	Rated short time thermal current for 1 second (as applicable)	40 kA
5.	Rated dynamic current	78.75kA
6.	Rated insulation levels	
	1.2/50 micro second impulse voltage	±650 kVp
	one minute power frequency withstand voltage	275 kV (rms)
7.	Maximum temperature-rise over an ambient temperature of 40^0C	As per IEC 60044-1 or 61869
8.	Radio interference voltage at 1.1 Un/√3 and frequency range 0.5 to 2 MHz	500µV
9.	One minute power frequency withstand voltage between sec. Terminal & earth	3 kV (rms)
10.	Partial discharge level	5 pico coulombs

REQUIREMENTS FOR 132 kV CURRENT TRANSFORMER FOR LINE BAYS

No. of cores	Core no.	Application	Current ratio	Output Burden (VA)	Accuracy Class as Per IEC: 44-1	Min. Knee pt. Voltage Vk	Max. CT Sec. Wdg. Resistance (ohm)	Max. Excitation current at Vk (in mA)
5	1	BUS DIFF CHECK	1600-800/1	-	PS*	1600/ 800	8/4	25 on 1600/1tap 50 on 800/1tap.
	2	BUS DIFF MAIN	1600-800/1	-	PS*	1600/ 800	8/4	25 on 1600/1tap 50 on 800/1tap.
	3	METERING	1600-800/1	20	0.2S	-	-	-
	4	TRAN BACKUP/ LINE PRTN.	1600-800/1	-	PS*	1600/ 800	8/4	25 on 1600/1tap 50 on 800/1tap.
	5	TRAN. DIFF/ LINE PRTN.	1600-800/1	-	PS*	1600/ 800	8/4	25 on 1600/1tap 50 on 800/1tap.

*All protection Cores shall be of accuracy class PS as per IEC: 60044-6. However, if accuracy class CT required for protection, the same CT Shall be provided.

The CT ratios given above is basic information to the bidder which shall be optimized during details engineering subject to approval from the engineer.

REQUIREMENTS FOR 132 kV CURRENT TRANSFORMER FOR TRANSFORMER BAYS

No. of cores	Core no.	Application	Current ratio	Output Burden (VA)	Accuracy Class as Per IEC: 44-1	Min. Knee PointVoltage Vk	Max. CT Sec. Wdg. Resistance (ohm)	Max. Excitation current at Vk (in mA)
5	1	BUS DIFF CHECK	600-400-200/1	-	PS*	600/400/200	3/2/1	2 on 600/1 tap. 4 on 400/1 tap. 10 on 200/1 tap.
	2	BUS DIFF MAIN	600-400-200/1	-	PS*	600/400/200	3/2/1	2 on 600/1 tap. 4 on 400/1 tap. 10 on 200/1 tap.
	3	METERING	600-400-200/1	20	0.2S			
	4	TRAN BACKUP/ LINE PRTN.	600-400-200/1	-	PS*	600/400/200	3/2/1	2 on 600/1 tap. 4 on 400/1 tap. 10 on 200/1 tap.
	5	TRAN. DIFF/ LINE PRTN.	600-400-200/1	-	PS*	600/400/200	3/2/1	2 on 600/1 tap. 4 on 400/1 tap. 10 on 200/1 tap.

*All protection Cores shall be of accuracy class PS as per IEC: 60044-6. However, if accuracy class CT required for protection, the same CT Shall be provided.

The CT ratios given above is basic information to the bidder which shall be optimized during details engineering.

REQUIREMENTS FOR 132 kV CURRENT TRANSFORMER FOR BUS COUPLER BAYS

Core no.	Application	Current Ratio	Output Burden (VA)	Accuracy class as per IEC: 60044-1	Min knee point voltage V_K	Max. CT sec. Wdg resistance (ohms)	Max. Excitation current at V_K (in mA)
1	Protection	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 tap, 60 on 1000/1 tap.
2	Protection	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 tap, 60 on 1000/1 tap.
3	Metering	2000-1000/1	20	0.2S	-	-	-
4	Protection	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 tap, 60 on 1000/1 tap.
5	Protection	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 tap. 60 on 1000/1 tap.

*All protection Cores shall be of accuracy class PS as per IEC: 60044-6. However, if accuracy class CT required for protection, the same CT Shall be provided.

The CT ratios given above is basic information to the bidder which shall be optimized during details engineering.

REQUIREMENTS FOR 132 kV CURRENT TRANSFORMER FOR INTERCONNECTING BAYS

Core No.	Application	Current Ratio	Output Burden (VA)	Accuracy class as per IEC: 60044-1	Min knee point voltage V_K	Max. CT sec. Wdg resistance (ohms)	Max. Excitation current at V_K (in mA)
1	Protection	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 tap., 60 on 1000/1 tap.
2	Protection	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 tap. 60 on 1000/1 tap.
3	Metering	2000-1000/1	20	0.2S	-	-	-

*All protection Cores shall be of accuracy class PS as per IEC: 60044-6. However, if accuracy class CT required for protection, the same CT Shall be provided.

The CT ratios given above is basic information to the bidder which shall be optimized during details engineering.

ANNEXURE 4

TECHNICAL PARAMETERS FOR VOLTAGE TRANSFORMERS

SN	Particulars	132 kV
1	Rated system voltage (Un)	145 KV (rms)
2	Rated frequency	50 Hz
3	System neutral earthing	Solidly earthed
4	System fault level	40 kA
5	Rated insulation levels	
i.	1.2/50 micro second impulse voltage	±650 kVp
ii.	one minute power frequency withstand voltage	275 kV (rms)
6	One minute power frequency withstand voltage for secondary winding	3 kV(rms)
7	Radio interference voltage at 1.1 Un/√3 and frequency range 0.5 to 2 MHz	500µV
8	Rated total thermal burden	100 VA
9	Partial discharge level	10 pico Coloumbs

REQUIREMENT OF VOLTAGE TRANSFORMERS

SN	Particulars	132 kV		
1	Rated primary voltage	132/√3 kV		
2	Type	Electromagnetic		
3	No. of secondaries	3		
4	Rated voltage factor	1.2 continuous		
		1.5 for 30 seconds		
5	Phase angle error	± 10 minutes (for metering core)		
		Sec I	Sec II	Sec III
6.	Rated secondary voltage (V)	110/√3	110/√3	110/√3
7.	Application	Protection	Protection	Metering
8.	Accuracy	3P	3P	0.2
9.	Output burden (VA) (minimum)	50	50	50

ANNEXURE 5

TECHNICAL PARAMETERS FOR SURGE ARRESTER

SN	Particulars	132 kV
1	Rated system voltage	132kV
2	System neutral earthing	Solidly earthed
3	Rated arrestor voltage	120 kV
4	Nominal discharge current	10 kA of 8/20 µs wave
5	Rated frequency	50 Hz
6	Minimum discharge capability voltage corresponding to minimum discharge characteristics	6 KJ/kV (referred to rated arrestor)
7	Continuous operating voltage at 50^0C	102 kV
8	Min. switching surge residual voltage	
	Max. switching surge residual voltage	280kVp
9	Max. residual voltage at 5 kA	310kVp
11	Max. residual voltage at 10 kA nominal discharge current	330 kVp
12	Long duration discharge class	3
13	High current short duration test value (4/10 micro second wave)	100 kAp
14	Current for pressure relief test	40 kA
15	Prospective symmetrical fault current	As per IEC
16	Pressure relief class:	A
17	RIV at 1.1 $U_n/\sqrt{3}$ kV rms (micro volts)	Less than 500
18	Partial discharge at 1.05 COV (pC)	Not more than 5
19	Reference ambient temp.	50 ^{0}C

ANNEXURE 6

TECHNICAL PARAMETERS FOR SF6/AIR BUSHING

SN	Particulars	132kV
1	Rated Voltage (kV)	145 kV (rms)
2	Rated Current (Amp)	600
3	1.2/50 micro second impulse voltage (Lightning impulse withstand voltage)	630 kVp
5	One minute power frequency withstand voltage	275 kV (rms)
6	Minimum total Creepage distance in mm	3625
7	Minimum Cantilever strength (kN)	5

CHAPTER 4
OUTDOOR SWITCHGEARS

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CHAPTER 4: OUTDOOR SWITCHGEARS

SECTION 1: CAPACITIVE VOLTAGE TRANSFORMER

1. GENERAL FOR CAPACITIVE VOLTAGE TRANSFORMER:

The instrument transformers and accessories shall conform to the latest version of the standards specified below except to the extent explicitly modified in the specification and shall be in accordance with the requirements in Chapter 2-GTR.

2. CAPACITIVE VOLTAGE TRANSFORMER IEC: 60044-5/IEC-60358

2.1 The instrument transformers shall be complete with its terminal box and a common marshalling box for a set of 3 instrument transformers.

2.2 The proposed CVT shall be placed on the existing steel structure available at site.

2.3 The external surface of instrument transformer, if made of steel, shall be hot dip galvanized or painted as per Chapter 2-GTR

2.4 The impregnation details along with tests/checks to ensure successful completion of impregnation cycle shall be furnished for approval.

2.5 The instrument transformers shall be designed for use in geographic and meteorological conditions as given in Chapter 2-GTR.

3. CONSTRUCTION FEATURES:

3.1 The features and constructional details of instrument transformers shall be in accordance with requirements stipulated hereunder:

3.2 Instrument transformers shall be of 145 kV class, oil filled/ SF6 gas filled, suitable for outdoor service and upright mounting on steel structures.

i. 145 kV Instrument transformers shall be with shedded porcelain / polymer bushings/Insulators.

ii. Oil filling and drain plugs, oil sight glass shall be provided for electromagnetic unit of CVT etc. For CVT with polymer housing, the cantilever strength shall not be less than 150 kg.

iii. Instruments transformers shall be hermetically sealed units. Bidder/Manufacturer shall furnish details of the arrangements made for the sealing of instrument transformers during detailed engineering. Bidder/ Manufacturer shall also furnish the detail of site test to check the effectiveness of hermetic sealing for approval.

iv. Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block

3.3 Terminal Box/Marshalling Box:

Terminal Box shall conform to the requirements of Chapter 2-GTR.

3.4 Insulating Oil:

3.4.1 Insulating oil to be used for instrument transformers shall be of EHV grade and shall conform to IEC - 60296 (required for first filling). Non–PCB based synthetic insulating oil conforming to IEC 60867 can also be used in the capacitor units of CVT with specific approval from the owner, the proposal for which shall be submitted during detailed engineering stage.

3.4.2 Oil filling and drain plugs, oil sight glass shall be provided for electromagnetic unit of CVT etc. For CVT with polymer housing, the cantilever strength shall not be less than 150kg.

3.5 Name Plate:

Name plate shall conform to the requirements of IEC incorporating the year of manufacture. The rated voltage, voltage factor of voltage transformers shall be clearly indicated on the name plate. The intermediate voltage of capacitor voltage transformer shall be indicated on the name plate.

4. VOLTAGE TRANSFORMER:

4.1 145 kV Voltage transformers shall be capacitor voltage divider type with electromagnetic units and shall be suitable for carrier coupling.

4.2 Voltage transformers secondaries shall be protected by HRC cartridge type fuses for all the windings. In addition, fuses/MCBs shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the VTs shall be terminated to the stud type non - disconnecting terminal blocks in the individual phase secondary boxes via the fuse/MCB.

4.3 VTs shall be suitable for high frequency (HF) coupling required for power line carrier communication. Carrier signal must be prevented from flowing into potential transformer (EMU) circuit by means of a RF choke/reactor suitable for effectively blocking the carrier signals over the entire carrier frequency range i.e. 40 to 500 KHz. Details of the arrangement shall be furnished along with the bid. H.F. terminal of the VT shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling filters of the carrier communication equipment, when utilised. Further, earthing link with fastener to be provided for HF terminal.

4.4 The electromagnetic unit comprising compensating reactor, intermediate transformer and protective and damping devices should have separate terminal box with all the secondary terminals brought out.

4.5 The electromagnetic unit comprising compensating reactor, intermediate transformer and protective and damping devices should have separate terminal box with all the secondary terminals brought out.

4.6 The accuracy of 0.2 on secondary III for all VTs should be maintained throughout the entire burden range up to 50 VA on all the windings without any adjustments during operation.

4.7 145 kV CVTs shall be suitable for mounting on tubular GI pipe in accordance with stipulations of Chapter 2-GTR.

4.8 145 kV CVTs shall be suitable for mounting on tubular GI pipe in accordance with stipulations of Chapter 2-GTR.

4.9 A protective surge arrester shall be provided if required, to prevent breakdown of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor/primary winding, tuning reactor/RF choke etc. due to short circuit in transformer secondaries. In case of an alternate arrangement, bidder shall bring out the details in the bid.

4.10 The wiring diagram for the interconnection of the three single phase CVTs shall be provided inside the marshalling box in such a manner that it does not deteriorate with time.

5. TERMINAL CONNECTORS:

The wiring diagram for the interconnection of the three single phase CVTs shall be provided inside the marshalling box in such a manner that it does not deteriorate with time.

6. TESTS:

6.1 In accordance with the requirements in Section-GTR, Cu Voltage Transformers should have been type tested and shall be subjected to routine tests in accordance with IEC: 60044-5/60044-2 respectively.

6.2 The test reports of the type tests and the following additional type tests (additional type tests are required for Instrument Transformers, rated above72.5 kV only) shall also be submitted for the Purchaser's review.

i. High frequency capacitance and equivalent series resistance measurement (as per IEC -60358) for CVT.

ii. Seismic withstand test.

iii. Stray capacitance and stray conductance measurement of the low voltage terminals (as per IEC -60358) for CVT.

iv. Determination of temperature coefficient test (as per IEC-60358)

v. Radio interference voltage test as per IEC-60044-5/IEC-60044-2.However, the RIV level shall be as specified in clause Major Technical Parameters in Section-GTR.

vi. Apart from the above, report of all special tests mentioned in IEC-60044-5 for capacitive voltage transformer shall also be submitted for approval.

6.3 Routine tests on capacitive voltage transformer shall be done in line with IEC-60044-5.

7. TECHNICAL PARAMETERS:

1	System fault level	40 kA for 1 second
2	Standard reference range of frequencies for which the accuracies are valid	96% to 102% for protection and 99% to 101% for measurement
3	High frequency capacitance for entire carrier frequency range	Within 80% to 150% of rated capacitance
4	Equivalent series resistance (for CVT only) over the entire carrier frequency range	Less than 40 ohms

5	Stray capacitance and stray conductance of the LV terminal over entire carrier frequency range	As per IEC:358
8	Number of secondaries	2
9	Rated Frequency	50
10	Rated output of each secondary winding (VA)	50-50
11	Rated Total Thermal Burden	300
12	Highest System Voltage	145
13	Rated voltage factor and corresponding rated time	1.2 continuous & 1.5 for 30 sec of primary voltage
14	Accuracy class of each secondary winding	3P-0.2
15	Capacitance	
i)	of high voltage capacitance	10000
ii)	of intermediate voltage capacitor	58000
15	Carrier frequency coupling	8800
16	Natural frequency of coupling	>1 MHz
17	Self-tuning frequency of CVT	40 kHz to 500 kHz
18	One minute power frequency test voltage of secondary winding	5
19	One minute power frequency test voltage of H.F terminal	4
20	One minute power frequency test voltage of capacitor (dry and Wet)	275
21	1.2/20 micro sec impulse withstand test voltage of capacitor	650
22	Corona extinction voltage	142

8. PRE-COMMISSIONING TEST:

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

8.2 Capacitive Voltage Transformers:

i. Insulation Resistance test for primary (if applicable) and secondary winding.

ii. Polarity Test.

iii. Ratio Test.

iv. Dielectric test of oil (Wherever applicable)

v. Tan delta capacitance measurement of individual capacitor stacks

vi. Secondary winding resistance measurement

SECTION 2: SURGE ARRESTER

1. GENERAL FOR SURGE ARRESTER:

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

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

1.3 The proposed LA for 132 kV suichatar line shall be placed on the existing steel structure available at site.

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

1.5 The instrument transformers shall be designed for use in geographic and meteorological conditions as given in Chapter 2-GTR.

2. DUTY REQUIREMENTS:

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

2.2 The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers and line.

2.3 145 kV class arrester shall be capable for discharging energy equivalent to class 3 OF IEC for 145 kV system on two successive operations.

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

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

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

SN	Equipment to be protected	Lightning surge for 145 kV System (kVp)	Lightning surge for 12 kV System (kVp)
	Power transformer	±550	75
	Instrument transformer	±650	75
	CB / Isolator phase to ground	±650	75
	CB / isolator across open contact	±750	75

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

3. CONSTRUCTION FEATURES:

3.1 The features and constructional details of instrument surge arrester shall be in accordance with requirements stipulated hereunder:

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

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

3.4 The arresters shall not fail due to arrester porcelain contamination.

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

3.6 Outer insulator shall be porcelain/polymer conforming to requirements stipulated in Chapter 2-GTR. Terminal connectors shall conform to requirements stipulated under Chapter 2-GTR.

3.7 The outer insulator housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage up to the maximum design value for arrester

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

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

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

3.11 The manufacturer will submit Data for rejection rate of ZnO blocks during manufacturing/operation for the past three years.

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

3.13 The Surge arrester with porcelain housing shall have a cantilever strength of not less than 350 kg for 120 kV surge arresters respectively or as per the value obtained vide Chapter 2-GTR, whichever is higher. For Surge arrester with polymer housing, the cantilever strength shall not be less than 150 kg.

4. FITTINGS AND ACCESSORIES:

4.1 120 kV Arresters shall be complete with insulating base and Surge monitor having provision for bolting to flat surface of structure.

4.2 9 kV Arresters shall be complete with complete mounting equipment and accessories.

4.3 Self-contained discharge counters, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided

for each single pole unit along with necessary connection. Suitable leakage current meters should also be provided. The reading of milliameter and counters shall be visible through an inspection glass panel. The terminals shall be robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends.

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

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

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

5. TESTS:

5.1 In accordance with the requirements stipulated under Chapter 2-GTR, the surge arresters should have been type tested as per IEC and shall be subjected to routine and acceptance tests in accordance with IEC document for contamination test, procedures outlined in 60099-3 shall be followed.

The test reports of the type tests and the following additional type tests (additional type tests are required for Surge Arresters above 72.5 kV class only) shall also be submitted for the Purchaser's review.

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

ii. Seismic withstand test.

iii. Contamination test.

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

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

5.2 Acceptance Tests:

i. Measurement of power frequency reference voltage of the arrester units.

ii. Lightning Impulse Residual voltage on arrester units. (IEC clause 6.3.2).

iii. Internal Ionisation or partial Discharge test.

5.3 Special Acceptance Test:

i. Thermal stability test on three sections. (IEC Clause 7.2.2).

ii. Aging & Energy Capability test on blocks (procedure to be mutually agreed)

iii. Wattloss test.

5.4 Routine Tests:

i. Sealing test: Water dip test at 1.5m depth from top of Surge Arrestor for 30 minutes shall be performed during assembly of Surge Arrester stacks (followed by other routine tests, i.e., P.D. Measurement, Reference Voltage, Residual Voltage & IR measurement).

ii. Measurement of reference voltage.

iii. Residual voltage test of arrester unit.

iv. Internal Ionization test or partial discharge test.

v. Verticality checks on completely assembled Surge arresters as a sample test on each lot.

5.5 Test on Surge Monitor

i. The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstand tests to verify efficacy of the same. Additional routine/ functional tests with one 100 A and 10kA current impulse (8/20 micro sec.) shall also be performed on the Surge monitor.

ii. Surge monitors shall be routinely tested for water dip test at 1.5m for 30 minutes. No water vapors shall be visible on the monitor glass. Surge monitors shall be routinely tested for water dip test at 1.5m for 30 minutes. No water vapors shall be visible on the monitor glass

5.6 Test on Insulators

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

6. SPARES PARTS AND MAINTENANCE EQUIPMENT:

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

7. TECHNICAL PARAMETERS:

A. 132 KV CLASS SURGE ARRESTER

1	Rated arrester voltage	120 kV
2	Nominal discharge current	10 kA of 8/20 microsecond wav
3	Minimum discharge capability	6kJ/kV (referred to rated arrester voltage corresponding to minimum discharge characteristics.
4	Continuous operating voltage at 50 deg.C	102 kV rms
5	Max. switching surge residual voltage (1kA)	280 kVp
8	Max. residual voltage at i) 5 kA ii) 10 kA nominal discharge current	 310 kVp 330 kVp
9	Long duration discharge class	3
10	High current short duration test value (4/10 micro second wave)	100 kAp
11	Current for pressure relief test	40 kA rms / 50 kA rms (as applicable)
12	Low current long duration test value (2400 micro sec)	As per IEC.
13	Pressure relief class	40kA (as applicable)

B. 11 KV CLASS SURGE ARRESTER

1	Rated arrester voltage	9 kV
2	Nominal discharge current	10 kA of 8/20 microsecond wave
3	Minimum discharge capability	4kJ/kV (referred to rated arrester voltage corresponding to minimum discharge characteristics)
4	Continuous operating voltage at 50 deg.C	7.2 kV rms
5	Max. switching surge residual voltage (1kA)	22.4 kVp
6	Max. residual voltage at i) 5 kA ii) 10 kA nominal discharge current	 26 kVp 26 kVp
7	Long duration discharge class	2
8	Pressure relief class	31.5 kA (as applicable)

8. PRE-COMMISSIONING TESTS:

8.1 An indicative list of tests is given below:

i. Operation check of LA counter.

ii. Insulation resistance measurement

iii. Capacitance and Tan delta measurement of individual stacks.

iv. Third harmonic resistive current measurement (to be conducted after energization.)

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

9. CABLE END TERMINATION AND JOINING

9.1 The cable jointing accessories shall include Outdoor & Indoor the end terminating kits as per price schedule, straight through joints and also any special tools and tackles required for making these joints. For cable jointing & terminating purpose only certified (certification from cable accessories manufacturer or some reputed agency) jointer shall be employed.

9.2 The outdoor end termination

i. Outdoor termination at substation shall be oil type as mentioned below.

ii. It shall be anti-fog, pre-fabricated type. The termination base plate and the cable's metallic sheath shall be electrically insulated from the supporting structure by means of self-supporting stand-off insulators or any other self-supporting means designed to withstand both mechanical and electrical stresses in services. The stress cone shall inhibit possible mechanical stress and deformation of the cable insulation surface during operation and also shall be capable of accommodating minor radial and longitudinal movement without determent to the dielectric stress in the insulation shield.

iii. For OD Termination at substation, the termination shall be within polymeric or porcelain hollow insulator in brown or grey colour as per S.T.P and standard practice of manufacturing in addition upon, arcing horn and shield ring shall have to be supplied wherever required. The termination shall be filled with an insulating compound up to a level where the electric field is substantially reduced and shall be offered from reputed vendor (finalized during detail engineering drawings). Oil filled termination should have silicon oil as di-electric medium. Silicon oil should not be subject to any heating at site prior to filling.

iv. The outdoor terminal should be suitable for very heavily polluted atmospheric conditions with total creep age distance of 31 mm/ kV and protected creep age distance of not more than 50% of the total Creep age distance. The cable end terminals for terminating the cables shall be fully compatible with the cables to be supplied.

9.3 The indoor Termination at GIS SF6 Housing

It shall be dry type without insulating oil. There shall be mechanical devices to maintain the interface pressure if requires. It shall be based on the EPR (Ethylene-Propylene Rubber)- based or silicon-based stress relief cone. Termination shall be dry type without insulating oil. Stress relief cone and mechanical devices shall be designed to fit with controlled interference over the cable insulation and shall follow the cable's diameter variations still guaranteeing under any service condition a sufficient positive pressure to control the electric field concentration. Plug-in type leading conductors shall be supplied though at the time of detailed engineering confirmation shall be given for selection of normal type, blind type or plug-in type. Design and scope of delivery shall be fully complying with IEC-60859, IEC-62271-209 and possibly adjusted the various needs of project. The main insulation components shall be fully examined and tested in the factory. The bidder shall furnish the detailed description on jointing procedure during detailed engineering.

9.4 WORKING PROCEDURE FOR TERMINATION:

i. At cable terminating end sufficient length of spare cable shall be left in the ground and at cable tray also at GIS, for future needs.

ii. The rise of the cable immediately from the ground shall be enclosed in PVC/PE pipe of suitable diameter to protect against direct exposure to the sun.

iii. The cable shall be properly fastened using non-metallic clamps.

iv. Appropriate labels shall be fixed identifying the phase circuit, voltage and date of commissioning etc., on the cable supporting structure.

v. The sealing end shall be mounted on pedestal insulators to isolate them from their supporting steel work.

vi. Protection from contact with the exposed metal work at the termination shall be provided by resin bonded glass fiber shroud.

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

10. ADDITIONAL EQUIPMENT & STRUCTURES FOR CABLE TERMINATION

10.1 The terminating structure being provided should be designed as per the requirement of the cable end sealing, porcelain bushing etc. The mounting structure shall be fixed on the cement concrete foundation, the design and drawings of which shall be submitted to Employer for review and acceptance during the course of detailed engineering.

10.2 After fixing the end termination, the cable shall be fixed to the support, with nonmagnetic material clamps to the required height securely. The mounting structure includes the supports for cable end boxes, link boxes and any other structure required for the intent of the contract. All steel sections used shall be free from all imperfections, mill scales, slag intrusions, laminations, fillings, rust etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Employer.

10.3 Suitable fencing should be provided at the cable terminating yard at cable conductor junction point. The fencing will consist of galvanized steel structure over a brick wall of 2(two) feet meeting electrical requirement (IE). A suitable entry point (gate) has to be provided.

10.4 Outdoor type 120KV lightning arresters for each cable of both the circuits are to be provided at cable-conductor junction point. The technical specification of lightning arresters is given in this volume.

10.5 It is recognized that the Bidder may have standardized on the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Employer. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the specific requisite schedule will not be considered as valid deviation.

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

11. QUALITY ASSURANCE PROGRAM FOR CABLE TERMINATION AND JOINING:

11.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Bidder's Works or at his sub-bidder's premises or at the Employer's site or at any other place of work are in accordance with the specifications, the Bidder shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Bidder and shall be finally accepted by the Employer after discussions before the award of Contract.

11.2 Quality Assurance Documents

The Bidder shall be required to submit the following Quality Assurance Documents within three weeks before laying/erection of the equipment.

i. All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.

ii. Welder and welding operator qualification certificates.

iii. Welder's identification list, listing welder's and welding operator's

qualification procedure and welding identification symbols.

iv. Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.

v. Stress relief time temperature charts/oil impregnation time temperature charts.

vi. Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification.

vii. The quality plan with verification of various customer inspection points (CIP) as mutually agreed and methods used to verify the inspection and testing points in the quality plan were performed satisfactorily.

12. TECHNICAL SPECIFICATION OF OUTDOOR END CABLE TERMINATIONS

12.1 General Properties:

SN	Particulars	Value
1	Rated Voltage kV	132 (145)
2	Diameter over insulation	38.87 - 96.80 mm
3	Diameter over sheath	≤140 mm
4	Cable screen type	Corrugated aluminium sheath/ Lead sheath/Cu wire. etc.
5	Cable Cross section (Cu)	400 mm²
6	Conductor connection	Mechanical (shear head bolts)
7	Material of connection bolt	Aluminium/Copper
8	Material of insulator - outer surface	Silicone Rubber
9	Colour of insulator	Grey
10	Method of stress control	Geometric
11	Stress cone	Pre-moulded silicone rubber
12	Insulating liquid	Silicone Oil/Ester oil/ Polyisobutlyene oil
13	Installation temperature	0 to +40
14	Operation temperature	-5 °C - +55 °C

SN	Particulars	Value
15	Storage temperature	0 to +40

12.2 Electrical Parameter:

SN	Particulars	Unit	Value
1	Relevant Standard		IEC 60840
2	Rated voltage Uo/U (Um)	kV	76/132 (145)
3	Rated frequency	Hz	50
4	Lightening impulse voltage 1.2/50µs	kVp	650
5	Power frequency voltage withstand dry (15/30 min)	kV	190
6	Partial Discharge 1.5Uo (kV)	pC	≤5
7	Rated Short Circuit Current (conductor) 1s	kA	40
8	Creepage distance (min.)	mm	4500
9	Flash-over distance	mm	1340
10	Pollution level (IEC 60137; 1995, VDE 0674 Teil5)		IV
11	Withstand voltage of support insulators (AC/DC)	kV	10/20

CHAPTER 5

TRANSFORMER

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CHAPTER 5 –TRANSFORMER

1. GENERAL

1.1 This specification covers design, engineering, manufacture, testing at manufacturer's works, delivery at site including all materials, accessories, spares, unloading, handling, proper storage at site, erection, testing and commissioning of the equipment specified.

1.2 Transportation

1.2.1 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 shall 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 transformer for all the stages from the manufacturer's work to site.

1.2.2 The contractor shall carry out the route survey along with the transporter and finalize the detail methodology for transportation of transformer and based on route survey; any modification/ extension/ improvement to existing road, bridges, culverts etc. if required, shall be in the scope of the bidder.

1.2.3 The Contractor shall dispatch the transformer filled with oil or in an atmosphere of nitrogen or dry air. In the former case the contractor shall take care of the weight limitation on transport and handling facility at site. In the latter case, necessary arrangement shall be ensured by the contractor to take care of pressure drop of nitrogen or dry air during transit and storage till completion of oil filling during erection. A gas pressure testing valve with necessary pressure gauge and adaptor valve shall be provided.

1.2.4 Transformer shall also be fitted with at least one electronic impact recorder (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted by the contractor during detailed engineering. The recording shall commence in the factory before dispatch and must continue till the unit is installed on its foundation. The data of electronic impact recorder(s) shall be down loaded at site and a soft copy of it shall be handed over to Employer's Engineer. Further, within three weeks the contractor shall communicate the interpretation of the data. In the unlikely event of impact recorder output not available at site, the equipment shall be thoroughly internally inspected by the manufacturer's representative before erection at site to ensure healthiness of the equipment. Contractor shall mount Vehicle tracking system (GPRS/ GPS/ GSM based) to track the exact position of the vehicle on which the equipment is being loaded for transportation in order to ensure traceability and safety during transportation.

2. PERFORMANCE

2.1 The transformers shall be used for bi-directional flow of rated power. The transformer shall have LV winding rated for full power and rated for 11 kV.

2.2 Transformers shall be capable of operating under natural cooled condition up to the full/Specified load. Transformers shall be fitted with coolers, capable of dissipating total losses at continuous maximum rating.

2.3 The transformers shall be capable of being operated, without danger, on any tapping at the rated MVA with voltage variation of ± 10% corresponding to the voltage of the tapping.

2.4 The maximum flux density in any part of the core and yoke at the rated MVA, voltage and frequency shall be such that under 10 per cent continuous over voltage condition it does not exceed 1.9 Tesla at any tap position.

2.5 Dissolve Gas Analysis (DGA) of oil shall be periodically monitored by the Employer and the interpretation of DGA results will be as per IEC - 60599.

2.6 Radio Interference and Noise Level

2.6.1 The transformers shall be designed with particular attention to the suppression of maximum harmonic voltage, especially the third (3^{rd}) and fifth (5^{th}) so as to minimize interference with communication circuit.

2.6.2 The noise level of transformer, when energized at normal voltage and frequency with cooler equipment in operation shall not exceed, when measured under standard conditions, the values specified at relevant clause.

2.7 The transformers shall be capable of being loaded in accordance with IEC-60076-7. There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipment.

2.8 The transformer and all its accessories including CTs etc. shall be designed to withstand without injury, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for a period of 3 secs. The short circuit level of the HV & LV System to which the subject transformers will be connected is, 40 kA (symmetrical, rms,3 phase fault on 132 kV) & 31.5 kA (symmetrical rms 3 phase fault on 11kV).

2.9 Transformer shall be capable of withstanding thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any winding.

2.10 Transformers shall withstand, without injurious heating, combined voltage and frequency fluctuations which produce the following over fluxing conditions:

i. 110% for continuous operation

ii. 125% for 1 – minute

iii. 140% for 5 – seconds

2.11 Dynamic Short Circuit Test requirement

2.11.1 For 132 kV Class Transformer:

Manufacturer must have successfully carried out the complete type test including Dynamic Short Circuit (DSC) test on 45 MVA or higher capacity, 132 kV or higher voltage class transformer as per IEC over last 10 years period as on the originally scheduled date of bid opening in Short-Circuit Testing Liaison (STL) - Accredited Laboratory OR must have successfully completed complete type test including DSC test on 45 MVA or higher

capacity, 132 kV or higher voltage class transformer as per IEC over last 10 (ten) years period as on the originally scheduled date of Bid opening in any internationally accredited Laboratory in the presence of STL representative and certified the same by STL representative as indicated below :

Complete Type test and Dynamic Short Circuit (DSC) test on 45 MVA or higher capacity, 132 kV or higher voltage class transformer as specified in the Technical Data Sheet.

However, IF

The Bidder/Manufacturer has not conducted the complete type tests including the DSC test in Short-Circuit Testing Liaison (STL) - Accredited Laboratory OR has not conducted complete type test including DSC test in the presence of STL representative in an internationally accredited Laboratory as mentioned above within last 10 (ten) years

THEN

The Bidder has to submit an undertaking letter along with the bid to carry out the complete type test on the above-mentioned ratings of transformer including DSC in Short-Circuit Testing Liaison (STL) - Accredited Laboratory OR to carry out the completed type test including DSC in the presence of STL representative and NEA representative in any international accredited laboratory without any cost to the employer.

Further design review of offered 45 MVA, 132 kV class transformers shall be carried out based on design of short circuit tested 132kV or above voltage class transformer.

2.12 Design review

2.12.1 The transformers shall be designed, manufactured and tested in accordance with the best international engineering practices under strict quality control to meet the requirement stipulated in the technical specification. Adequate safety margin with respect to thermal, mechanical, dielectric and electrical stress etc. shall be maintained during design, selection of raw material, manufacturing process etc. so that the transformer provides long life with least maintenance.

2.12.2 Design reviews shall be conducted by Employer or an appointed Consultant at different stages of the procurement process for transformer, however the entire responsibility of design shall be with the manufacturer.

2.12.3 Employer may visit to the manufacturers works to inspect design, manufacturing and test facilities.

2.12.4 The design review will commence after placement of award with successful bidder and shall be finalized before commencement of manufacturing activity. These design reviews shall be carried out in detail to the specific design with reference of the transformer under scope of this specification.

2.12.5 The design review shall be conducted generally following the “Guidelines for conducting design reviews for transformers 10 MVA and 132 kV and above” prepared by CIGRE SC 12 Working Group 12.22.

2.12.6 The manufacturer shall provide all necessary information and calculations during design review to demonstrate that the transformer meets the requirements for short circuit strength and durability. The latest recommendations of IEC and CIGRE SC 12 shall be applied for short circuit withstand evaluation.

2.12.7 The manufacturer will be required to demonstrate the use of adequate safety margin for thermal, mechanical, dielectric and vibration etc. design to take into the account the uncertainties of his design and manufacturing processes.

The scope of such a design review shall at least include the following:

1.	Core and magnetic design
2.	Winding and tapping design
3.	Short-circuit withstand capability
4.	Thermal design including review of localized potentially hot area.
5.	Cooling design
6.	Overload capability
7.	Eddy current losses
8.	Seismic design, as applicable
9.	Insulation co-ordination
10.	Tank and accessories
11.	Bushings and barrier design
12.	Tap changers
13.	Protective devices
14.	Radiators
15.	Oil and oil preservation system
16.	Corrosion protection
17.	Electrical and physical Interfaces with substation
18.	Earthing
19.	Processing and assembly
20.	Testing capabilities
21.	Inspection and test plan
22.	Transport and storage
23.	Sensitivity of design to specified parameters
24.	Acoustic Noise
25.	Spares, inter-changeability and standardization
26.	Maintainability

3. CONSTRUCTION DETAILS

The features and construction details of each power transformer shall be in accordance with the requirement stated hereunder.

3.1 Tank and Tank Accessories

3.1.1 Tank

Tank shall preferably be of welded construction and fabricated from tested quality low carbon steel of adequate thickness.

All seams and those joints not required to be opened at site shall be factory welded, and wherever possible they shall be double welded. After completion of tank and before painting, dye penetration test shall be carried out on welded parts of jacking bosses, lifting lugs and all load bearing members. The requirement of post weld heat treatment of tank/stress relieving shall be based on recommendation of BS-5500 table 4.4.3.1.

Tank stiffeners shall be provided for general rigidity and these shall be designed to prevent retention of water.

The transformer shall have conventional type tank. In case the joint is welded it shall be provided with flanges suitable for repeated welding. The joint shall be provided with a suitable gasket to prevent weld splatter inside the tank. Proper tank shielding shall be done to prevent excessive temperature rise of the joint.

Each tank shall be provided with:

i. Lifting lugs suitable for lifting the equipment complete with oil.

ii. A minimum of four jacking pads in accessible position to enable the transformer complete with oil to be raised or lowered using hydraulic jacks. Each jacking pad shall be designed to support with an adequate factor of safety for at least half of the total mass of the transformer filled with oil allowing in addition for maximum possible misalignment of the jacking force to the center of the working surface.

iii. Suitable haulage holes shall be provided.

The tank shall be designed in such a way that it can be mounted on the rollers.

The base of each tank shall be so designed that it shall be possible to move the complete transformer unit by skidding in any direction without injury when using plates or rails.

3.1.2 Paint system and procedures

The painting details for transformer main tank, pipes, conservator tank, radiator, control cabinet/ marshalling box / oil storage tank etc. shall be as given below. The paint should not fade during drying process. The paint should be able to withstand temperature up to 120 deg. C. The detailed painting procedure shall also be submitted along with the bid which shall be finalized before award of the contract.

	Surface preparation	Primer coat	Intermediate undercoat	Finish coat	Total dry film thickness (DFT)	Colour shade
Main tank, pipes, conservator tank, oil storage tank etc. (external surfaces)	Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30-40mm)	Epoxy high build Micaceous iron oxide (HB MIO) (75mm)	Aliphatic polyurethane (PU), (Minimum 50mm)	Minimum 155mm	RAL 7035
Main tank, pipes (above 80 NB), conservator tank, oil storage tank etc. (Internal surfaces)	Shot Blast cleaning Sa 2 ½*	Hot oil resistant, non-corrosive varnish or paint or epoxy	--	--	Minimum 30mm	Glossy white for paint
Radiator (external surfaces)**	Chemical / Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30-40mm)	Epoxy base Zinc primer (30-40mm)	PU paint, (Minimum 50mm)	Minimum 100mm	Matching shade of tank/ different shade aesthetically matching to tank
Radiator and pipes up to 80 NB (Internal surfaces)	Chemical cleaning, if required	Hot oil proof, low viscosity varnish	--	--	--	--
Control cabinet / marshalling box/RTCC	Seven tank process as per IEC	Zinc chromate primer (two coats)	--	EPOXY paint with PU top coat	Minimum 80mm	RAL 7035 shade for exterior and interior

Note: * Indicates Sa 2 ½ as per Swedish Standard SIS 055900 of ISO 8501 Part-1.

** Radiator hot dip galvanized may also acceptable**.**

3.1.3 Tank Cover

3.1.3.1 The tank cover shall be designed to prevent retention of rain water and shall not distort when lifted. The internal surface of the top cover shall be shaped to ensure efficient collection and direction of free gas to the Buchholz relay.

3.1.3.2 At least one adequately sized inspection openings shall be provided in the transformers for easy access to bushings and earth connections. The inspection covers shall not weigh more than 25 kg. Handles shall be provided on the inspection cover to facilitate lifting.

3.1.3.3 The tank covers shall be fitted with pockets at the position of maximum oil temperature at maximum continuous rating for bulbs of oil and winding temperature indicators. It shall be possible to remove these bulbs without lowering the oil in the tank. The thermometer shall be fitted with a captive screw to prevent the ingress of water.

3.1.3.4 Bushing turrets, covers of inspection openings, thermometer pockets etc. shall be designed to prevent ingress of water into or leakage of oil from the tank.

3.1.3.5 All bolted connections shall be fitted with weather proof, hot oil resistant, resilient gasket in between for complete oil tightness. If gasket is compressible, metallic stops/other suitable means shall be provided to prevent over-compression. All gasketed joints shall be designed, manufactured and assembled to ensure long-term leak and maintenance free operation. Groove provided to accommodate round nitrile rubber cord for rectangular openings shall be milled.

3.1.3.6 Tank hotspot

The maximum temperature on any metal part shall not exceed 130 deg. Celsius.

3.1.3.7 Currents flowing in tank cover and bushing turrets

To allow for the effect of possible induced and capacitive surge current, good electrical connection shall be maintained between the tank and turrets.

3.1.3.8 The transformer shall be provided with pipe flange of suitable diameter with bolted blanking plate, gasket and shall be fitted at the highest point of the transformer tank for maintaining vacuum in the tank.

3.1.4 Axles and Wheels

3.1.4.1 The transformer shall be mounted on rollers, as per manufacturer's standard practice.

3.1.4.2 The roller mounted transformers are to be provided with flanged bi-directional wheels and axles. This set of wheels and axles shall be suitable for fixing to the under carriage of transformer to facilitate its movement on rail track. Suitable locking arrangement along with foundation bolts shall be provided for the wheels to prevent accidental movement of transformer.

3.1.4.3 The rail track gauge shall be 1676 mm/finalized during detail engineering.

3.1.5 Foundation and Anti Earthquake Clamping Device

To prevent transformer movement during earthquake, suitable clamping devices shall be provided for fixing the transformer to the foundation.

3.1.6 Conservator & Oil Preservation System

Main conservator shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture, and shall be fitted with magnetic oil level gauge with low oil level potential free contacts.

3.1.6.1 OLTC shall have conventional type conservator with prismatic oil level gauge.

3.1.6.2 Conservator tank and pipe work

3.1.6.2.1 Conservator tank shall have adequate capacity with highest and lowest visible-levels to meet the requirements of expansion of total cold oil volume in the transformer and cooling equipment from minimum ambient temperature to 100 deg C. The capacity of the conservator tank shall be such that the transformer shall be able to carry the specified overload without overflowing of oil. The Calculation shall be submitted during design engineering.

3.1.6.2.2 The conservator shall be fitted with integral lifting lugs in such a position so that it can be removed for cleaning purposes. Suitable provision shall be kept to replace air cell and cleaning of the conservator wherever applicable.

3.1.6.2.3 Conservator shall be positioned so as not to obstruct any electrical connection to transformer. Pipe work shall neither obstruct the removal of tap changers for maintenance or the opening of inspection or manhole covers.

3.1.6.2.4 Pipe work connections shall be of adequate size for their duty and as short and direct as possible. Only radiused elbows shall be used.

3.1.6.2.5 The feed pipe to the transformer tank shall enter the transformer cover plate at its highest point and shall be straight for a distance not less than five times its internal diameter on the transformer side of the Buchholz relay, and straight for not less than three times that diameter on the conservator side of the relay.

3.1.6.2.6 This pipe shall rise towards the oil conservator, through the Buchholz relay, at an angle of not less than 5 degrees.

3.1.6.3 Oil Preservation Equipment

The requirements of air cell type oil sealing system are given below.

3.1.6.3.1 Contact of the oil with atmosphere is prohibited by using a flexible air cell of nitrile rubber reinforced with nylon cloth.

3.1.6.3.2 The temperature of oil is likely to rise upto 100 deg C during operation. As such air cell used shall be suitable for operating continuously at 100 deg C.

3.1.6.3.3 Air cell of conservator shall be able to withstand the vacuum during installation /maintenance periods. Otherwise, provision shall be kept to isolate the conservator from the main tank when the latter is under vacuum by providing a vacuum sealing valve or other suitable means in the pipe connecting main tank with the conservator. The transformer manual shall give full and clear instructions on the operation, maintenance, testing and replacement of the air cell. It shall also indicate shelf life, life expectancy in operation, the recommended replacement intervals and the supplier.

3.1.6.3.4 The connection of air cell to the top of the conservator is by air proof seal preventing entrance of air into the conservator.

3.1.6.4 Maintenance-free Dehydrating Breather

3.1.6.4.1 Conservator of Main Tank and OLTC each shall be fitted with a maintenance-free dehydrating breather in which only pure silica gel has been filled as dehydrating agent. Connection shall be made to a point in the oil conservator not less than 50 mm above

maximum working oil level by means of a pipe with a minimum diameter of 25 mm. Breather and connecting pipes shall be securely clamped and supported to the transformer or other structure supplied by the contractor in such a manner so as to eliminate undesirable vibration and noise. It shall be so designed that:

3.1.6.4.2 Incoming air is directed toward the desiccant (silica gel) and dried.

The desiccant is regenerated/de-humidified by an installed heating element that shall be sensor-controlled and self-regulating.

Passage of air is through silica gel.

Silica gel is isolated from atmosphere by an oil seal.

Moisture absorption indicated by a change in colour of the tinted crystals can be easily observed from a distance.

Breather is mounted not more than 1200 mm above rail top level.

3.1.6.4.3 The maintenance free dehydrating breather shall have a humidity and temperature sensor and must have 3 LED for status indication and a data logger to log all important events. The maintenance free breather shall be equipped with a self-learning algorithm alpha control for the OLTC conservator and beta control for main tank conservator. Moving parts such as solenoid values or fans are not accepted. Additionally, an anti-condensation heater shall be installed in the control box and test button is required for auto-diagnosis and testing function.

3.1.6.5 Pressure Relief Device

Adequate number of pressure relief devices shall be provided at suitable locations. These shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage to equipment. The device shall operate at a static pressure less than the hydraulic test pressure of the transformer tank. It shall be mounted directly on the tank. One set of electrically insulated contacts shall be provided for alarm/tripping. Discharge of pressure relief device shall be properly taken through pipes and directed away from the transformer/other equipment and this shall be prevented from spraying on the tank. Following routine tests shall be conducted on PRD

a) Air pressure test
b) Liquid pressure test
c) Leakage test
d) Contact test
e) Dielectric test.

3.1.6.6 Buchholz Relay

A double float/reed type Buchholz relay shall be provided. Any gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation and taking gas sample. A copper/stainless steel tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure. Buchholz relay shall be type tested as per international standards. Buchholz relay and its terminal box shall conform to IP 55 degree of protection.

3.1.6.7 Temperature Indicators

3.1.6.7.1 Oil Temperature Indicator (OTI)

All transformers shall be provided with a 150 mm (approx.) dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent ungrounded alarm and trip contacts, maximum reading pointer and resetting device shall be provided in the OTI. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Temperature indicator dials shall have linear gradations to clearly read atleast every 2 deg C. Accuracy of OTI shall be ± 3.0 deg C or better. The setting of alarm and tripping contacts shall be adjustable at site.

In addition to the above, the following equipment shall be provided for remote indication of oil temperature:

a) Signal transmitter

Signal transmitter shall have additional facility to transmit signal for recording oil temperature at Employer's data acquisition system, for which duplex platinum RTD with nominal resistance of 100 ohms at zero degree centigrade shall be supplied. The RTD shall be three wire ungrounded system. The calibration shall be as per SAMA (USA) standard or equivalent. The RTD may be placed in the pocket containing temperature sensing element and image coil for OTI system which will be used for both remote OTI and DAS. Necessary equipment for sending the signal to remote OTI and DAS shall be provided. In lieu, separate RTD for each of the functions shall be provided.

b) Remote oil temperature indicator

It shall be suitable for flush mounting on Employer's/RTCC panel. This shall not be repeater dial of local OTI and will operate by signal transmitter.

Any special cable required for shielding purpose, for connection between cooler control cabinet and remote OTI control circuit, shall be in the scope of Contractor. Only one ROTI with a four-point selector switch shall be provided.

3.1.6.7.2 Winding Temperature Indicator (WTI)

A device for measuring the hot spot temperature of each winding shall be provided (HV and LV). It shall comprise the following:

i. Temperature sensing element.

ii. Image coil.

iii. Auxiliary CTs, if required to match the image coil, shall be furnished and mounted in the cooler control cabinet.

iv. 150 mm (approx) dia. local indicating instrument with maximum reading pointer and two adjustable electrically independent, ungrounded contacts; besides that required for control of cooling equipment if any, one for high winding temperature alarm and one for trip. Temperature indicator dials shall have linear gradations to clearly read at least every 2 deg C.

v. Calibration device.

vi. Accuracy of WTI shall be ± 3.0 deg C or better.

vii. The setting of alarm and tripping contacts shall be adjustable at site and typical values are as given below which will be reviewed during detailed engineering based on manufacturer's recommendation.

Alarm – 110degC

Trip - 120degC

viii. In addition to the above, the following equipment shall be provided for remote indication of winding temperature for each of the winding:

a) Signal transmitter for each winding

Signal transmitter shall have additional facility to transmit signal for recording winding temperature at Employer's data acquisition system, for which duplex platinum RTD with nominal resistance of 100 ohms at zero degree centigrade shall be supplied. The RTD shall be three wire ungrounded system. The calibration shall be as per SAMA (USA) standard or equivalent. The RTD may be placed in the pocket containing temperature sensing element and image coil for WTI system which will be used for both remote WTI and DAS. Necessary equipment for sending the signal to remote WTI and DAS shall be provided. In lieu, separate RTD for each of the functions shall be provided.

b) Remote winding temperature indicator

It shall be suitable for flush mounting on Employer's panel. This shall not be repeater dial of local WTI and will operate by signal transmitter.
Any special cable required for shielding purpose, for connection between cooler control cabinet and remote WTI control circuit, shall be in the scope of Contractor. Only one RWTI with a selector switch shall be provided for all the windings (HV and LV).

3.1.7 Earthing Terminals

3.1.7.1 Two (2) earthing pads (each complete with two (2) nos. holes, M 10 bolts, plain and spring washers) suitable for connection to 75 x 6 mm galvanized steel grounding flat shall be provided each at position close to earth of the two (2) diagonally opposite bottom corners of the tank.

3.1.7.2 Two earthing terminals suitable for connection to 75 x 6 mm galvanized steel flat shall also be provided on cooler, marshalling box and any other equipment mounted separately.

3.2 Core

3.2.1 The core shall be constructed from prime quality, non-ageing, cold rolled, super grain oriented, silicon steel laminations.

3.2.2 The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angles to the plane of laminations which may cause local heating. The temperature of any part of the core or its support structure in contact with oil shall not exceed 120 deg C under normal operating condition and 130 deg C under most extreme operating condition. Adequate temperature margin shall be provided to maintain longer life expectancy for this material.

3.2.3 The insulation of core to bolts and core to clamp plates shall be able to withstand a voltage of 2 KV (rms) for 1 minute.

3.2.4 Core and winding shall be capable of withstanding the shock during transport, installation and service. Adequate provision shall be made to prevent movement of core and winding relative to tank during these conditions.

3.2.5 All steel sections used for supporting the core shall be thoroughly sand blasted after cutting, drilling and welding.

3.2.6 Each core lamination shall be insulated with a material that will not deteriorate due to pressure and hot oil.

3.2.7 The supporting frame work of the core shall be so designed as to avoid presence of pockets which would prevent complete emptying of tank through drain valve or cause trapping of air during oil filling.

3.2.8 Adequate lifting lugs will be provided to enable the core and windings to be lifted.

3.2.9 The core shall be earthed to the core clamping structure at one point only, through a removable external link suitably located and protected to facilitate testing after installation of the transformer.

In case core laminations are divided into sections by insulating barriers or cooling ducts parallel to the plane of the lamination, tinned copper bridging strips shall be inserted to maintain electrical continuity between sections.

A drawing furnishing the details of the internal earthing design shall be included in the manual.

3.3 Windings

3.3.1 The Contractor shall ensure that windings of all transformers are made in dust proof and conditioned atmosphere.

3.3.2 The conductors shall be of electrolytic grade copper free from scales and burrs.

3.3.3 The insulation of transformer windings and connections shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse and be non-catalytic and chemically inactive in transformer oil during service.

3.3.4 Coil assembly and insulating spacers shall be so arranged as to ensure free circulation of oil and to reduce the hot spot of the winding.

3.3.5 The coils would be made up, shaped and braced to provide for expansion and contraction due to temperature changes.

3.3.6 The conductor shall be transposed at sufficient intervals in order to minimize eddy currents and to equalize the distribution of currents and temperature along the winding.

3.4 Unused inhibited Insulating Oil

3.4.1 The insulating oil shall be virgin high grade inhibited, conforming to IEC-60296 & all parameters specified below, while tested at supplier's premises. The contractor shall furnish test certificates from the supplier against the acceptance norms as mentioned below, prior to dispatch of oil from refinery to site. Under no circumstances, poor quality oil shall be filled into the transformer and only thereafter be brought up to the specified parameter by circulation within the transformer.

SN	Property	Test Method	Limits
A1.	Function		
1a.	Viscosity at 100degC	ISO 3104 or ASTM D445 or ASTM D7042	(Max.) 3 mm2/s
1b.	Viscosity at 40degC	ISO 3104 or ASTM D445 or ASTM D7042	(Max.)12 mm2/s
1c.	Viscosity at -30degC	ISO 3104 or ASTM D445 or ASTM D7042	(Max.)1800 mm2/s
2	Appearance	A representative sample of the oil shall be examined in a 100 mm thick layer, at ambient temperature	The oil shall be clear and bright, transparent and free from suspended matter or sediment
3	Pour point	ISO 3016 or ASTM D97	(Max.)- 40degC
4	Water content	IEC 60814 or ASTM D1533	(Max.)
	a) for bulk supply		30 mg/kg
	b) for delivery in drums		40 mg/kg
5	Electric strength (breakdown voltage)	IEC 60156 or ASTM D1298	(Min.) 50 kV (new unfiltered oil) / 70 kV (after treatment)
6	Density at 20 deg C	ISO 3675 or ISO 12185 or ASTM D 4052	0.820 - 0.895 g/ml
7	Dielectric dissipation factor (tan delta) at 90 deg C	IEC 60247 or IEC 61620 Or ASTM D924	(Max) 0.0025
8	Resistivity at 90 deg C	IEC 60247	150 X 10^12 Ohm – cm, (Min.) for records only.
9	Negative impulse testing KVp @ 25 deg C	ASTM D-3300	145 (Min.)
10	Carbon type composition (% of Aromatic, Paraffins and Naphthenic compounds.)	IEC 60590 or ASTM D 2140	Max.Aromatic : 4 to12 % Paraffins : 50% & balance shall be Naphthenic compounds.
B1.	Refining / Stability		
1	Acidity	IEC 62021-1 or ASTM D974	(Max) 0.01 mg KOH/g
2	Interfacial tension at 27degC	ISO 6295 or ASTM D971	(Min) 0.04 N/m
3	Total sulfur content	BS 2000 part 373 or ISO 14596	0.15 % (Max.)
4	Corrosive sulphur	IEC 62535	Non-Corrosive on copper and paper
		ASTM D1275B	Non-Corrosive
5	Presence of oxidation inhibitor	IEC 60666 or ASTM D2668 or D4768	0.08% (Min.) to 0.4% (Max.) Oil should contain no other additives.

SN	Property	Test Method	Limits
			Supplier should declare presence of additives, if any.
6	2-Furfural content	IEC 61198 or ASTM D5837	25 Microgram/litre (Max.)
C1.	Performance		
1	Oxidation stability	IEC 61125 (method c)	
	-Total acidity	Test duration 500 hour	Max 0.3 mg KOH/g
	-Sludge		Max 0.05 %
	- Dielectric dissipation factor (tan delta) at 90 deg C	IEC 60247	Max 0.05
2	Gassing	IEC 60628A or ASTM D2300	No general requirement
3	Oxidation stability (Rotating Bomb test)	IEC: 61125(Method B) / ASTM D2112 (e)	220 Minutes (Min.)
D1.	Health, safety and environment (HSE)		
1	Flash point	ISO 2719	(Min.)135 degC
2	PCA content	BS 2000 Part 346	Max 3%
3	PCB content	IEC 61619 or ASTM D4059	Not detectable (Less than 2 mg/kg)

3.4.2 Prior to filling in main tank at site and shall be tested for

i. Break Down voltage (BDV) :70kV (min.)

ii. Moisture content :5 ppm (max.)

iii. Tan-delta at 90 °C :0.0025 (max)

iv. Interfacial tension : More than 0.04 N/m

3.4.3 Prior to energisation at site oil shall be tested for following properties & acceptance norms as per below generally in line with IEC 60422:

i. Break Down voltage (BDV) : 70 kV (min.)

ii. Moisture content : 10 ppm (max.)

iii. Tan-delta at 90 °C : 0.01 (max.)

iv. Resistivity at 90 °C : 6 X 10 ^12 ohm-cm (min.)

v. Interfacial tension : 0.035 N/m (min.)

vi. *Oxidation Stability (Test method as per IEC 61125 method C,Test duration: 500 hour for inhibited oil)

vii. Acidity : 0.3 (mg KOH /g) (max.)

viii. Sludge : 0.05 % (max.)

ix. Tan delta at 90 °C : 0.05 (max.)

x. * Total PCB content : Not detectable (2 mg/kg total)

* For Sr. No. 6 & 7 separate oil sample shall be taken and test results shall be submitted within 45 days after commissioning for approval of Consultant.

3.5 At manufacturer's works the quality of oil used for first filling, testing and impregnation of active parts shall meet at least parameters as mentioned in serial no. 1 to 5 of clause 3.4.2 above. The oil test results shall form part of equipment test report.

Oil sample shall be drawn before and after heat run test and shall be tested for dissolved gas analysis. Oil sampling to be done 2 hours prior to commencement of temperature rise test. For ONAN/ONAF cooled transformers, sample shall not be taken earlier than 2 hours after shutdown. The acceptance norms with reference to various gas generation rates shall be as per IEC 61181.

3.6 Terminal Arrangements

3.6.1 Bushings

3.6.1.1 The electrical and mechanical characteristics of bushings shall be in accordance with IEC 60137/ DIN 42530.

3.6.1.2 Bushing for various voltage rating shall be as follows

52 kV and above	Hermetically sealed Oil filled condenser type/ RIP bushing with porcelain or composite insulator.
36 kV and below	Solid porcelain or oil communicating type. Dimensions of 11 kV bushing shall conform to IEC

3.6.1.3 Oil Filled condenser type bushing shall be provided with at least the following fittings:

a. Oil level gauge.
b. Tap for capacitance and tan delta test. Test taps relying on pressure contacts against the outer earth layer of the bushing is not acceptable.

3.6.1.4 Where current transformers are specified, the bushings shall be removable without disturbing the current transformers.

3.6.1.5 Bushings of identical rating shall be interchangeable.

3.6.1.6 Porcelain used in bushing manufacture shall be homogenous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

3.6.1.7 Clamps and fittings shall be of hot dip galvanised steel.

3.6.1.8 Bushing turrets shall be provided with vent pipes, to route any gas collection through the Buchholz relay.

3.6.1.9 No arcing horns shall be provided on the bushings.

3.6.1.9.1 Suitable insulating cap (preferably of porcelain) shall be provided on the terminal of Bushing of tertiary winding to avoid accidental external short circuit.

3.6.1.9.2 Installation procedures for the various voltage class bushings shall be clearly brought out in the Instruction manual.

3.6.2 Terminal Marking

The terminal marking and their physical position shall be as per IEC: 60076.

3.6.3 Neutral Earthing Arrangement

The neutral terminals of transformer shall be brought to the ground level by a brass/tinned copper grounding bar, supported from the tank by using porcelain insulators. The end of the brass/tinned copper bar shall be brought to the bottom of the tank, at a convenient point, for making bolted connection to two (2) 75 x 12 mm galvanized steel flats connected to Employer's grounding mat.

3.7 Cooling Equipment and its Control

3.7.1 Cooling Equipment

3.7.1.1 The cooler shall be designed using sufficient number of tank mounted radiators. Design of cooling system shall satisfy the performance requirements.

3.7.1.2 Tank mounted radiators shall have its cooling fans , shut off valves at the top and bottom of suitable size, lifting lugs, top and bottom oil filling valves, air release plug at the top, a drain and sampling valve and thermometer pocket fitted with captive screw cap on the inlet and outlet.

3.7.1.3 Required number of standby fans of approximately 20% capacity shall also be provided with radiators.

3.7.1.4 Cooling fans shall be directly mounted on radiator. Each fan shall be suitably protected by galvanised wire guard. The exhaust air flow from cooling fan shall not be directed towards the main tank in any case.

3.7.1.5 Cooling fans motors shall be suitable for operation from 400 volts, three phase 50 Hz power supply and shall conform to IEC. Each cooling fan motors shall be provided with starter thermal overload and short circuit protection. The motor winding insulation shall be conventional class 'B' type. Motors shall have hose proof enclosure equivalent to IP: 55.

3.7.1.6 The cooler and its accessories shall preferably be hot dip galvanised or corrosion resistant paint (as per clause 3.1.1.8) should be applied to it.

3.7.1.7 Air release device and oil plug shall be provided on oil pipe connections. Drain valves shall be provided in order that each section can be drained independently.

3.7.2 Cooling Equipment Control (ONAN/ONAF COOLING)

3.7.2.1 Automatic operation control of fans shall be provided (with temperature change) from contacts of winding temperature indicator. The Contractor shall recommend the setting of WTI for automatic changeover of cooler control from ONAN to ONAF. The setting shall be such that hunting i.e. frequent start-up operations for small temperature differential do not occur.

3.7.2.2 Suitable manual control facility for cooler fans shall be provided.

3.7.2.3 Selector switches and push buttons shall also be provided in the cooler control cabinet to disconnect the automatic control and start/stop the fans manually.

3.7.2.4 Indicating Devices

Following lamp indications shall be provided in cooler control cabinet:

i. Control Supply failure.

ii. Cooling fan failure.

iii. Common thermal overload trip

One potential free initiating contact for all the above conditions shall be wired independently to the terminal blocks of cooler control cabinet for further wiring to Common Marshalling Box (CMB).

3.7.2.5 Two auxiliary power supplies, 400 volt, three phase four (4) wire shall be provided at common marshalling box. All loads shall be fed by one of the two sources through an electrically interlocked automatic transfer scheme housed in the CMB. Power supply to individual phase unit shall be extended from the CMB. Power supply to spare unit shall be extended from nearest CMB only. Suitably rated power contactors, separate MCBs/MCCBs shall be provided in the Common Marshalling Box for each circuit.

3.7.2.6 Control and power supplies are to be given for Cooler circuits after suitable selection at Common Marshalling Box. Necessary isolating switches and protective devices shall be provided at suitable points as per Employer's approved scheme. The Contractor shall derive AC power for Cooler Control Circuitry from the AC feeder as mentioned above. In case auxiliary power supply requirement for Cooler Control Mechanism is different than station auxiliary AC supply, then all necessary converters shall be provided by the Contractor.

3.7.2.7 For each circuit, suitably rated MCBs/MCCBs as required for further distribution of auxiliary power supply to DM boxes, Online Gases and moisture monitoring system, Online drying system and Fibre optic sensor Box etc. (as applicable), shall be provided by contractor, in individual marshalling boxes /cooler control boxes.

3.7.3 Auxiliary power supply distribution scheme shall be submitted for approval. Supply and laying of Power, Control and special cables from common marshalling box to individual MB/Cooler Control Cubicle (CCC) including spare unit & further distribution from IMB/CCC to all accessories is in the scope of the contractor. Further any special cable (if required) from CMB to Employer’s Control Panels/RTCC panels are also in the scope of the contractor.

3.7.4 The cooler control cabinet / Individual Marshalling box shall have all necessary devices meant for cooler control and local temperature indicators. All the contacts of various protective devices mounted on the transformer and all the secondary terminals of the bushing CTs shall also be wired upto the terminal board in the cooler control cabinet/Individual Marshalling box. All the CT secondary terminals in the cooler control cabinet shall have provision for shorting to avoid CT open circuit while it is not in use. All the necessary terminations for remote connection to Employer's panel shall be wired up to the Common Marshalling box.

3.7.5 Connection arrangement for spare unit shall be in such a way that spare unit of transformer can be connected in place of faulty unit without physically shifting and all the control, protection, indication signals of spare unit shall also be brought in common marshalling box of all the banks. Necessary arrangement in schematic of Common marshalling box is required to facilitate change-over of all the signals of faulty units to spare unit of Transformer, to ensure flow of control, protection and indication signals between Employer’s Control panels / Digital RTCC Panel / SCADA and individual units under operation (i.e. any designated unit for bank or spare unit, if it replace any

designated unit). To facilitate change-over of spare unit signals with faulty unit in CMB, male-female plug-in connector or better arrangement shall be provided to reduce the outage time

3.7.6 Valves

3.7.6.1 All valves shall be of gun metal or of cast steel/cast iron. They shall be of full way type with internal screw and shall open when turned counter clock wise when facing the hand wheel.

3.7.6.2 Suitable means shall be provided for locking the valves in the open and close positions. Provision is not required for locking individual radiator valves.

3.7.6.3 Each valve shall be provided with the indicator to show clearly the position of the valve.

3.7.6.4 All valves' flanges shall have machined faces.

3.7.6.5 All valves in oil line shall be suitable for continuous operation with transformer oil at 115 deg C.

3.7.6.6 The oil sampling point for main tank shall have two identical valves to be put in series .Oil sampling valve shall have provision to fix rubber hose of 10 mm size to facilitate oil sampling.

3.7.6.7 A valve or other suitable means shall be provided to fix (in future) on line dissolved gas monitoring system to facilitate continuous dissolved gas analysis. The location & size of the same shall be finalised during detail engineering stage

3.7.6.8 After testing, inside surface of all cast iron valves coming in contact with oil shall be applied with one coat of oil resisting paint/varnish with two coats of red oxide zinc chromate primer followed by two coats of fully glossy finishing paint conforming to international standards. Outside surface except gasket setting surface of butterfly valves shall be painted with two coats of red oxide zinc chromate conforming to International Standards followed by two coats of fully glossy finishing paint.

3.7.6.9 All hardware used shall be cadmium plated/electro galvanised steel.

3.7.6.10 For estimation purpose of spares one set of valves would mean one valve of each type used in Transformer.

3.8 Tap Changing Equipment

Each transformer shall be provided with On Load Tap changing equipment.

3.8.1 On Load Tap Changing Gear (OLTC)

OLTC shall be motor operated for local as well as remote operation. An external handle shall be provided for local manual operation. This handle shall be suitable for operation by a man standing at ground level

3.8.1.1 Each three-phase transformer shall be provided with voltage control equipment of the tap changing type for varying its effective transformation ratio whilst the transformers are on load and without producing phase displacement.

3.8.1.2 The requirements of on load tap changing equipment are given here below:

i. The current diverting contacts shall be housed in a separate oil chamber not communicating with the oil in main tank of the transformer.

ii. The contacts shall be accessible for inspection without lowering oil level in the main tank and the contact tips shall be replaceable.

iii. The Bidder shall indicate the safeguards in order to avoid harmful arcing at the current diverting contacts in the event of operation of the OLTC gear under overload conditions of the transformer. Necessary tools and tackles shall be furnished for maintenance of OLTC gear.

iv. The diverter switch or arcing switch oil chamber shall have oil filling and drain plug, oil sampling valve, relief vent and level glass. It shall also be fitted with a oil surge relay the outlet of which shall be connected to a separate conservator tank.

v. The diverter switch or arcing switch shall be designed so as to ensure that its operation once commenced shall be completed independently of the control relays or switches, failure of ancillary supplies etc. To meet any contingency which may result in incomplete operation of the diverter switch, adequate means shall be provided to safeguard the transformer and its ancillary equipment.

vi. Tap changer shall be so mounted that bell cover of transformer can be lifted without removing connections between windings and tap changer.

vii. Local OLTC control cabinet shall be mounted on the tank in accessible position. It should be adequately ventilated and provided with anti-condensation metal clad heaters. All contactors relay coils and other parts shall be protected against corrosion, deterioration due to condensation, fungi etc.

viii. Operating mechanism for on load tap changer shall be designed to go through one step of tap change per command. Subsequent tap changes shall be initiated only by a new or repeat command.

ix. On load tap changer shall be equipped with a time delayed INCOMPLETE STEP alarm consisting of a normally open contact which closes, if the tap changer fails to make a complete tap change. The alarm shall not operate for momentary loss of auxiliary power.

x. The selsyn units or approved equivalents shall be installed in the local OLTC control cabinet to provide tap position indication for the transformer. The Bidder shall also provide a set of instruments for tap position indication in the control room. Complete mounting details shall be included in the approved diagram.

xi. Transformer on load tap shall be equipped with a fixed resistor network capable of providing discrete voltage steps for input to the supervisory system.

xii. Limit switches shall be provided to prevent overrunning of the mechanism and shall be directly connected in the circuit of the operating motor. In addition, a mechanical stop shall be provided to prevent over-running of the mechanism under any condition.

xiii. Limit switches may be connected in the control circuit of the operating motor

provided that a mechanical de-clutching mechanism is incorporated.

xiv. Thermal device or other means shall be provided to protect the motor and control circuit. All relays, switches, fuses etc. shall be mounted in the local OLTC control cabinet and shall be clearly marked for the purpose of identification.

xv. A permanently legible lubrication chart if required, shall be fitted within the local OLTC control cabinet.

xvi. Any 'DROP DOWN' tanks associated with the tap changing apparatus shall be fitted with guide rod to control the movements during lifting or lowering.

xvii. A counter of at least five digits shall be fitted to the tap changing equipment to indicate the number of operations completed and shall have no provision for resetting.

xviii. All relays and operating devices shall operate correctly at any voltage between the limits specified.

xix. It shall not be possible to operate the electric drive when the manual operating gear is in use.

xx. It shall not be possible for any two controls to be in operation at the same time.

xxi. The equipment shall be suitable for supervisory control and indication with make before break multi-way switch, having one potential free contact for each tap position. This switch shall be provided in addition to any other switch/switches which may be required for remote tap position indication.

xxii. Operation from the local or remote-control switch shall cause one tap movement only until the control switch is returned to the off position between successive operations.

xxiii. All electrical control switches and the local operating gear shall be clearly labelled in a suitable manner to indicate the direction of tap changing.

xxiv. Transfer of source in the event of failure of one AC supply shall not affect the tap changer.

3.8.1.3 OLTC Control of Three Phase Transformers

Each three-phase transformer shall be suitable for local and remote control. The control feature shall provide the following:

3.8.1.3.1 Local Electrical Control

'Local-remote' selector switch mounted in the local OLTC control cabinet shall switch control of all load tap changers as followings:

When the selector switch is in 'local' position, it shall be possible to operate the 'raise-lower' control switches specified in clause 3.9.3.1(b) below. Remote control of the raise-lower functions shall be prevented.

When the selector switch is in 'remote' position the local OLTC control cabinet mounted 'raise-lower' switch specified in clause below shall be in-operative. Remote control of the raise/lower function shall be possible from the remote-control panel. The 'local-remote'

selector switch shall have at least two spare contacts per position which are closed in that position but open in the other position.

A 'raise-lower' control switch/push button shall be provided in the local OLTC control cabinet. This switch shall be operative only when 'local remote' selector switch is in 'local' position.

An OFF-ON tap changer control switch shall be provided in the local OLTC control cabinet of the transformer. The tap changer shall be in-operative in the OFF position. Also, the OFF-ON switch shall have at least one spare contact per position which is closed in that position but open in the other position.

3.8.1.3.2 Manual Control

The cranking device for manual operation of the OLTC gear shall be removable and suitable for operation by a man standing at ground level. The mechanism shall be complete with the following:

i. Mechanical tap position indicator which shall be clearly visible from near the transformer.

ii. A mechanical operation counters.

iii. Mechanical stops to prevent over-cranking of the mechanism beyond the extreme tap positions.

iv. The manual control considered as back up to the motor operated load tap changer control shall be interlocked with the motor to block motor start-up during manual operation. The manual operating mechanism shall be labelled to show the direction of operation for raising the HV terminal voltage and vice-versa.

3.8.1.3.3 Remote Electrical Group Control

The OLTC control scheme offered shall have provision of remote electrical group control during the parallel operation of transformer. This is in addition to independent control of OLTC:

i. A four-position selector switch having Master, Follower, Independent and Off position shall be provided in the remote OLTC control panel for each transformer. This shall be wired to enable operator to select operation of OLTC in either Master, Follower or Independent mode.

ii. Out of step relays with timer contacts shall also be provided to give alarm and indication in case tap position in all the transformers under group control are not in same position.

iii. Master Position: If the selector switch is in Master position, it shall be possible to control the OLTC units in the follower mode by operating the controls of the master unit. Independent operation of the units under Follower mode shall have to be prevented. However, the units under independent mode will be controlled independently.

i. Follower Position: If the selector switch is in Follower mode, control of OLTC shall be possible only from panel of the Master unit.

ii. Independent Position: In this position of Selector Switch, Control of OLTC of

individual unit shall only be possible.

3.8.1.4 The control circuits shall comply with following conditions:

An interlock to cut off electrical control automatically upon recourse being taken to the manual control in emergency.

i. Reinforcement of the initiating impulse for a tap change, ensuring a positive completion once initiated to the next (higher or lower) tap.

ii. "Step-by-Step" operation ensuring only one tap change from each tap changing impulse and a lock-out of the mechanism if the control switch (or push button) remains in the "operate" position.

iii. An interlock to cut-out electrical control when it tends to operate the gear beyond either of the extreme tap positions.

iv. An electrical interlock to cut-off a counter impulse for reverse step change being initiated during a progressing tap change and until the mechanism comes to rest and resets circuits for a fresh position.

v. Tap change in progress indication shall be provided by means of an indicating lamp at the Employer's control panel. Necessary contacts for this and for remote tap position indicator at Employer's control panel shall be provided by the Bidder.

vi. Protective apparatus, considered essential by the Bidder according to specialties of the gear.

3.8.2 Local OLTC Control Cabinet, Cooler Control Cabinet and Remote Tap Changer Control Panel

3.8.2.1 Each three-phase transformer unit shall be provided with local OLTC control cabinet, cooler control cabinet and RTCC panel.

3.8.2.2 Cabinets and Panels shall be tank mounted, provided with suitable lifting arrangement and have sloping roof.

3.8.2.3 A space heater, and cubicle lighting with ON-OFF switch shall be provided in each panel.

3.8.3 Necessary shorting of terminals shall be done at the cooler control cabinet, local OLTC cabinet and remote OLTC panel. All the CT secondary terminals in the cooler control cabinet shall have provision for short circuiting to avoid CT open circuit while it is not in use.

3.8.4 Cooler Control Cabinet

3.8.4.1 The cooler control cabinet shall have all necessary devices meant for cooler control and local temp indicators. All the contacts of various protective devices mounted on the transformer and all the secondary terminals of the bushing CTs shall also be wired upto the terminal board in the cooler control cabinet. All the necessary terminals for remote connection to Employer's panel shall be wired upto the cooler control cabinet.

3.8.4.2 The cooler control cabinet shall have two (2) sections. One section shall have the control equipment exclusively meant for cooler control. The other section shall house the temperature indicators, aux. CTs and the terminal boards meant for termination of various alarm and trip contacts as well as various bushing CT secondary. Alternatively, the two

sections may be provided as two separate panels depending on the standard practice of the Bidder.

3.8.4.3 The temperature indicators shall be so mounted that the dials are about 1200 mm from ground level. Glazed door of suitable size shall be provided for convenience of reading.

3.8.5 Local OLTC Control Cabinet

The Local OLTC control cabinet shall house all necessary devices meant for OLTC control and indication. It shall be complete with the following:

i. A circuit breaker/contactor with thermal overload devices for controlling the AC Auxiliary supply to the OLTC motor.

ii. Cubicle light with door switch.

iii. Space heaters to prevent condensation of moisture.

iv. Locking arrangement for hinged door of cabinet.

v. Cable terminal glands for power and control cables to the OLTC gear.

3.8.6 Digital RTCC Panel.

3.8.6.1 The digital RTCC panel shall have Automatic Tap Changer control and monitoring relay with Automatic Voltage Regulating features (referred as Digital RTCC relay) to remotely control and monitor OLTC. The relay shall be offered from the manufacturer who has already supplied Digital RTCC relay, which is in operation for at-least 2 years for transformer OLTC application.

3.8.6.2 Digital RTCC relay shall be microprocessor based adopting the latest state of the art design & technology within-built large display for ease of programming and viewing. The unit supplied shall be field programmable so that in the event of change in transformer /location, it could be customized to site conditions without sending back to works. The programming shall be menu driven and easily configurable. If it is designed with draw out type modules, it should take care of shorting all CT inputs automatically while drawing out. The CT/VT ratio shall be field programmable and Relay shall display the actual HV Voltage and current considering suitable multiplying factors. The system shall be self-sufficient and shall not require any additional devices like parallel balancing module etc. All Digital RTCC Relays shall be of same make for smooth integration of these relays for parallel operations of all transformers in the substation.

3.8.6.3 The digital RTCC Panel shall be provided with digital RTCC relay having Raise/Lower push buttons, Manual/ Automatic mode selection features, Master / Follower/ Independent/ off mode selection features and emergency stop Push Button for control of OLTC. Touch screen option in the relay, instead of electrical push button/switch is also acceptable

3.8.6.4 **In Manual Mode:** In this mode, power system voltage based automatic control from digital RTCC relay shall be blocked and commands shall be executed manually by raise/lower push buttons

3.8.6.5 **In Auto Mode:** In Auto mode, digital RTCC relay shall automatically control OLTC taps based on power system voltage and voltage set points. An interlock shall be provided to cut off electrical control automatically upon recourse being taken to the manual control in emergency

3.8.6.6 Master/Follower/Independent/Off mode

Master Position: If the selector switch is in master position, it shall be possible to control the OLTC units of other parallel operating transformers in the follower mode by operation from the master unit. Follower Position: If the selector switch is in Follower position control of OLTC shall be possible only from panel where master mode is selected.

Independent Position: In independent position of selector switch, control of OLTC shall be possible only from the panel where independent mode is selected. Suitable interlock arrangement shall be provided to avoid unwanted/ in consistent operation of OLTC of the transformer.

3.8.6.7 **Raise/Lower control:** The remote OLTC scheme offered shall have provision to raise or lower taps for the complete bank of three 1-phase transformers/3-Phase Transformers. Individual 1-phase OLTC operation shall not be possible from the remote-control panel.

3.8.6.8 Digital RTCC relays shall communicate with SCADA using IEC 61850 protocols to monitor, parameterize & control the OLTC. Any software required for this purpose shall be supplied. The supplied software shall not have restriction in loading on multiple computers for downloading and analyzing the data. Software shall indicate the current overview of all measured parameters of the connected transformer in real time. The digital RTCC Relay shall have multiple selectable set point voltages and it shall be possible to select the set points from SCADA, with a facility to have the possibility of additional set points command from SCADA. Communication between the Digital RTCC relays to execute the commands for parallel operation shall be implemented using required communication protocol. IEC-61850 GOOSE messaging between Digital RTCC relays for OLTC parallel operation is not permitted. Suitable communication hardware shall be provided to communicate upto distance of 1km between digital RTCC relays., Scope shall also include communication cables between digital RTCC relays. Cables as required for parallel operation of OLTCs of all transformers (including existing transformers wherever required) from Digital RTCC relays shall be considered included in the scope of bidder.

3.8.6.9 The Digital RTCC relay shall have programmable Binary Inputs (minimum 7 Nos.) and Binary outputs (minimum 7 Nos.) for Employer‟s future use. It shall be possible to have additional module for Binary Input/output as well as Analogue input module depending upon requirement.

3.8.6.10 The relays shall ensure positive completion of lowering/raising of the OLTC tap, once the command is issued from the relay."Step-by-Step" operation shall be ensured so that only one tap change from each tap changing pulse shall be effected. If the command remains in the "operate" position, lock-out of the mechanism is to be ensured.

3.8.6.11 Following minimum indications/alarms shall be provided in Digital RTCC relay either through relay display panel or through relay LEDs:

i. INCOMPLETE STEP alarm

ii. OLTC motor overload protection alarm

iii. Supply to DM Motor fail alarm

iv. OLTC IN PROGRESS alarm

v. Local/Remote Selector switch positions in DM Box

vi. OLTC upper/lower limits reached alarm

vii. OLTC Tap position indications for transformer units

viii. Independent-combined-remote selector switch positions of CMB

3.8.6.12 In case of parallel operation or 1-PhaseTransformer unit banks OLTC out of step alarm shall be generated in the digital RTCC panel for discrepancy in the tap positions.

3.9 Auxiliary Power Supply of OLTC, Cooler Control and Power Circuit

3.9.1 Two auxiliary power supplies, 400 volt, three phase four (4) wire shall be provided by the Employer at cooler control cabinet for OLTC and cooler control and power circuit.

3.9.2 All loads shall be fed by one of the two feeders through an electrically interlocked automatic transfer switch housed in the cooler control cabinet for on load tap changer control and cooler circuits.

Design features of the transfer switch shall include the following:

i. Provision for the selection of one of the feeder as normal source and other as standby.

ii. Upon failure of the normal source, the loads shall be automatically transferred after an adjustable time delay to standby sources.

iii. Indication to be provided at cooler control cabinet for failure of normal source and for transfer to standby source and also for failure to transfer.

iv. Automatic re-transfer to normal source without any intentional time delay following re-energization of the normal source.

v. Both the transfer and the re-transfers shall be dead transfers and AC feeders shall not be paralleled at any time.

3.9.3 Power Supply for OLTC Circuits

i. AC feeder shall be brought to the local OLTC control cabinet by the Contractor after suitable selection at cooler control cabinet for which description is given in 3.10.2 above, for control power circuit of OLTC.

ii. The Contractor shall derive AC power for OLTC control circuitry from the AC feeder as mentioned above by using appropriately rated dry type transformers. If the control circuit is operated by DC supply, then suitable main and standby converters shall be provided by the Contractor to be operated from AC power source.

3.9.4 Power Supply for Cooler Circuits

3.9.4.1 Control and power supplies are to be given for Cooler circuits after the selection as mentioned above.

3.9.4.2 The Contractor shall derive AC power for Cooler Control Circuitry by using appropriately rated dry type transformer in case of using supply voltage different from the Employer's auxiliary supply. If the control circuit is operated by DC supply then suitable main and standby convertors shall be provided by the Contractor, to be operated from AC power source.

3.9.5 Necessary isolating switches and MCBs/MCCBs shall be provided at suitable points as per Employer's approved scheme**.**

3.10 Construction Features of Cooler Control cabinet/ Marshalling Box/Digital RCC panels

3.10.1 Each transformer unit shall be provided with local OLTC Drive Mechanism Box, cooler control cabinet/individual marshalling box. Digital RTCC panel and common marshalling (for a bank of three 1-phase units) shall be provided.

3.10.2 The cooler control cabinet, Individual Marshalling Box, Common Marshalling Box, shall be made of stainless-steel sheet of at least 1.6mm thick. Digital RTCC panel shall be CRCA sheet of minimum thickness of 2.5mm.

3.10.3 The degree of protection shall be IP: 55 for outdoor and IP: 43 for indoor in accordance with IS: 13947/IEC: 60947

3.10.4 All doors, removable covers and plates shall be gasketed all around with suitably profiled. All gasketed surfaces shall be smooth straight and reinforced if necessary to minimize distortion to make a tight seal. For Control cubicle / Marshalling Boxes etc. which are outdoor type, all the sealing gaskets shall be of EPDM rubber or any better approved quality, whereas for all indoor control cabinets /Digital RTCC panel, the sealing gaskets shall be of neoprene rubber or any better approved quality. The gaskets shall be tested in accordance with approved quality plan, IS: 1149 and IS: 3400.

3.10.5 Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh of brass. All the control cabinets shall be provided with suitable lifting arrangement. Thermostat controlled space heater and cubicle lighting with ON-OFF switch shall be provided in each panel.

The size of Common marshalling box shall not be less than 1600mm (front) X 650mm (depth) X 1800mm (height). All the cabinets except common marshalling box & Digital RTCC shall be tank mounted. All the separately mounted cabinets and panels shall be free standing floor mounted type and have domed or sloping roof for outdoor application

3.11 Transformer Health Monitoring

All the transformers should have the features of predictive health monitoring. The system should be such that online 24X7 health monitoring will happen and the employer will be able to see all the analysis of the health data and the recommended actions on their web based dashboard.

The system should have the below specific features.

1. Measurements

The solution should:

a. Measure moisture in oil

b. Measure top & bottom oil temperature

c. Measure partial discharge activity

d. Measure vibration trends

e. Measure Hydrogen Gas levels in Oil

2. Monitoring Parameters

   The solution should:

   a. Track water content of paper

   b. Track hot spot temperature

   c. Track external moisture ingress

   d. Track impact of moisture on the breakdown voltage of oil

3. Predictive Capabilities

   The solution should:

   a. Predict the remaining insulation life of the transformer

   b. Predict overloading effects on the insulation of the transformer

   c. Help asset engineers to assess transformer risk

   d. Have configurable notifications to alert users to changes in transformer risk

   e. Configurable notifications to alert users when transformer risk parameters exceed levels specified by IEEE and CIGRE standards and make recommendations for action.

   f. Have Fleet-wide view – ability to rank transformers based on multiple parameters including risk and forecast Life Left

4. Condition Based Maintenance

   The solution should:

   a. Assist review of maintenance routines, facilitating condition-based maintenance

   b. Detect small failures and assist in preventing catastrophic failures.

5. Data Storage

   The solution should

   a. Keep track of major maintenance works.

   b. Store monitoring data for a period of up to 7 days in the event of lost communication

6. Sensor Maintenance

   a. The solution shall require a minimum amount of maintenance/calibration during its lifetime

   b. The warranty life of the solution shall be 5 years

   c. Analytic through cloud connectivity subscription for 5 years to be considered while offering

7. Solution Accessibility

   The solution should

   a. Be web accessible i.e., easily access from around the world

   b. Allow inclusion of additional users without charge

8. Installation

The solution should

a. Have communication costs included in the final quote. Communication costs should be met by the vendor

b. Come with fully provisioned telecommunications, requiring no site configuration.

4. FITTINGS

4.1 The following fittings shall be provided with each three-phase transformer covered in this specification.

i. Conservator for main tank with oil filling hole and cap, air cell, isolating valves, drain valve, magnetic oil level gauge with low level alarm contacts and dehydrating silicagel breather.

ii. Pressure relief devices with alarm/trip contacts.

iii. Buchholz relay double float/reed type with isolating valves on both sides, bleeding pipe with pet cock at the end to collect gases and alarm and trip contacts.

iv. Air release plug.

v. Inspection openings and covers.

vi. Bushing with metal parts and gaskets to suit the termination arrangement.

vii. Winding temperature indicators for local and remote mounting. One remote winding temperature indicator with a four-point selector switch shall be provided for the three windings for three phase unit to have selection of any of the three windings.

viii. Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs.

ix. Protected type mercury or alcohol in glass thermometer.

x. Bottom and top filter valves with threaded male adaptors, bottom sampling valve and drain valve.

xi. Rating and diagram plates on transformers and auxiliary apparatus.

xii. Flanged bi-directional wheels/Trolley for movement

xiii. Cooler cabinet.

xiv. Off load / On load tap changing gear.

xv. Cooling equipment

xvi. Bushing current transformers.

xvii. Drain valves/plugs shall be provided in order that each section of pipe work can be drained independently.

xviii. Terminal marking plates.

xix. Valves schedule plates.

xx. Oil temperature indicator for local and remote mounting.

xxi. Oil flow indicator

xxii. Marshalling box/Common Marshalling box

xxiii. Suitable galvanized iron or stainless-steel tray for cabling on main tank for better aesthetics.

xxiv. Terminal clamp & connector

xxv. The fittings listed above are only indicative and other fittings which generally are required for satisfactory operation of the transformer are deemed to be included.

xxvi. One set of hand tools of reputed make packed in a carry bag/box broadly comprising of double ended spanners (open jaws, cranked ring, tubular with Tommy bar each of sizes 9mm to 24mm, one set each), adjustable wrenches (8 &12 inch one set), gasket punches (of different sizes as used in the reactor one set), pliers (flat nose, round nose & side cutting one of each type), hammer with handle (one), files with handle (two), knife with handle (one), adjustable hacksaw (one), and cold chisel (one) shall be supplied per Substation.

5. INSPECTION AND TESTING

The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the equipment. An indication of inspection envisaged by the Employer is given under Clause 5.1. This is however not intended to form a comprehensive programme as it is Contractor's responsibility to draw up and carry out such a programme in the form of detailed quality plan duly approved by Employer for necessary implementation.

5.1 Inspection

5.1.1 Tank and Conservator

i. Certification of chemical analysis and material tests of plates.

ii. Check for flatness.

iii. Electrical interconnection of top and bottom by braided tinned copper flexibles.

iv. Welder's qualification and weld procedure.

v. Testing of electrodes for quality of base materials and coatings.

vi. Inspection of major weld preparation.

vii. Crack detection of major strength weld seams by dye penetration test.

viii. Measurement of film thickness of :

a. Oil insoluble varnish.

b. Zinc chromate paint.

c. Finished coat.

5.1.1.1 Check correct dimensions between wheels, demonstrate turning of wheels through 90 deg C and further dimensional check.

5.1.1.2 Check for physical properties of materials for lifting lugs, jacking pads, etc. All load bearing welds including lifting lug welds shall be subjected to NDT.

5.1.1.3 Leakage test of the conservator.

5.1.1.4 Certification of all test results.

5.1.2 Core

Sample testing of core materials for checking specific loss, bend properties, characteristics and thickness.

Check on the quality of varnish if used on the stampings:

i. Measurement of thickness and hardness of varnish on stampings.

ii. Solvent resistance test to check that varnish does not react in hot oil.

iii. Check overall quality of varnish by sampling to ensure uniform shining colour, no bare spots, no over burnt varnish layer and no bubbles on varnished surface.

iv. Check on the amount of burrs.

v. Bow check on stampings.

vi. Check for the overlapping of stampings. Corners of the sheet are to be part.

vii. Visual and dimensional check during assembly stage.

viii. Check for interlaminar insulation between core sectors before and after pressing.

ix. Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.

x. High voltage test (2 kV for one minute) between core and clamps.

xi. Certification of all test results.

5.1.3 Insulation Material

i. Sample check for physical properties of materials.

ii. Check for dielectric strength.

iii. Visual and dimensional checks.

iv. Check for the reaction of hot oil on insulating materials.

v. Dimension stability test at high temperature for insulating material.

vi. Tracking resistance test on insulating material

1. Certification of all test results.

5.1.4 Winding

i. Sample check on winding conductor for mechanical properties and electrical conductivity.

ii. Visual and dimensional checks on conductor for scratches, dent marks etc.

iii. Sample check on insulating paper for pH value, bursting strength and electric

strength.

iv. Check for the reaction of hot oil on insulating paper.

v. Check for the bonding of the insulating paper with conductor.

vi. Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.

vii. Check for absence of short circuit between parallel strands.

viii. Check for brazed joints wherever applicable.

ix. Measurement of voltage ratio to be carried out when core/yoke is completely restacked and all connections are ready.

x. Conductor enamel test for checking of cracks, leakage and pin holes.

xi. Conductor flexibility test

xii. Heat shrink test for anameled wire.

xiii. Certification of all test results.

5.1.5 Checks Before Drying Process

i. Check condition of insulation on the conductor and between the windings.

ii. Check insulation distance between high voltage connections, cables and earth and other live parts.

iii. Check insulating distances between low voltage connections and earth and other parts.

iv. Insulation of core shall be tested at 2 kV/minute between core to bolts and core to clamp plates.

v. Check for proper cleanliness and absence of dust etc.

vi. Certification of all test results.

5.1.6 Checks During Drying Process

i. Measurement and recording of temperature, vacuum and drying time during vacuum treatment.

ii. Check for completeness of drying by periodic monitoring of IR and Tan delta.

iii. Certification of all test results.

5.1.7 Assembled Transformer

i. Check completed transformer against approved outline drawings, provision for all fittings, finish level etc.

ii. Test to check effective shielding of the tank.

iii. Jacking test with oil on all the assembled transformers.

iv. Dye penetration test shall be carried out after the jacking test.

5.1.8 Bought Out Items

5.1.8.1 The makes of all major bought out items shall be subject to Employer's approval.

5.1.8.2 The Contractor shall also prepare a comprehensive inspection and testing programme for all bought out/sub-contracted items and shall submit the same to the Employer for approval. Such programme shall include the following components:

i. Buchholz Relay.

ii. Axles and wheels.

iii. Winding temperature indicators for local and remote mounting.

iv. Oil temperature indicators.

v. Bushings.

vi. Bushing current transformers.

vii. Cooler cabinet.

viii. ON Load / Off Load Tap change gear.

ix. Oil pumps.

x. Terminal connectors.

xi. Pressure relief device relay

xii. Cables used for interconnecting Turret CT, equipment relays (exposed), with marshalling box.

The above list is not exhaustive and the Contractor shall also include other bought out items in his programme.

5.1.9 Pre-Shipment Checks at Manufacturer's Works

5.1.9.1 Check for interchangeability of components of similar transformers for mounting dimensions.

5.1.9.2 Check for proper packing and preservation of accessories like radiators, bushings, dehydrating breather, rollers, buchholz relay, fans, control cubicle, connecting pipes, conservator etc.

5.1.9.3 Check for proper provision for bracing to arrest the movement of core and winding assembly inside the tank.

5.1.9.4 Gas tightness test to confirm tightness and record of dew point of gas inside the tank.

5.1.9.5 Derivation of leakage rate and ensure the adequate reserve gas capacity.

5.1.9.6 Measure and record the dew point of dry air /Nitrogen at the time of filling and after 24 hours in the transformer tank. Dew point of dry air / nitrogen at the time of transformer dispatch should be better than (-) 30 deg C. Also the dew point of dry air / nitrogen cylinders attached for make up during transportation should of the order of (-) 50 deg C.

5.1.9.7 Functioning of impact recorder(s) at their works before installing on the tank.

5.2 Factory Tests

The manufacturer shall be fully equipped to perform all the required tests as specified. Bidder shall confirm the capabilities of the proposed manufacturing plant in this regard when submitting the bid. Any limitations shall be clearly stated in. The contractor shall

bear all additional costs related to tests which are not possible to carry out at his own works. Procedure for some of tests is given at Annexure-A

The contractor shall submit an Inspection and test plan (ITP) for approval at least including following test.

SN	Item	Test Category
1.	Measurement of winding resistance	Routine
2.	Voltage ratio measurement	Routine
3.	Polarity & Vector group test	Routine
4.	No-load loss and current measurement	Routine
5.	Impedance voltage and load loss measurement	Routine
6.	Measurement of insulation resistance & Polarization Index	Routine
7.	Measurement of insulation power factor and capacitance between winding and earth	Routine
8.	Measurement of insulation power factor and capacitance of bushings	Routine
9.	Lightning impulse test	Routine
10.	Short duration induced AC withstand Test (ACSD) with PD measurement	Routine
11.	Separate source voltage withstand test	Routine
12.	On-load tap changer test (Ten complete cycle before LV test)	Routine
13.	Gas-in-oil analysis	Routine
14.	Core assembly dielectric and earthing continuity test	Routine
15.	Oil leakage test on transformer tank	Routine
16.	Appearance, construction and dimension check	Routine
17.	Magnetic balance test	Routine
18.	Measurement of no load current & Short circuit impedance with 400 V, 50 Hz AC.	Routine
19.	High voltage with stand test on auxiliary equipment and wiring after assembly	Routine
20.	Tank vacuum test	Routine
21.	Tank pressure test	Routine
22.	Frequency response analysis (Soft copy of test report in SFRA format to be submitted to site along with O & M manual)	Routine
23.	Temperature rise test	*Type
24.	Measurement of harmonic level in no load current	*Type
25.	Measurement of acoustic noise level	*Type

SN	Item	Test Category
26.	Measurement of Zero seq. reactance	*Type
27.	Measurement of power taken by fans and oil pumps	*Type

All tests shall be done in line with IEC: 60076 and as per "Annexure-A". Complete test report shall be submitted to Employer after proper scrutiny and signing on each page by the test engineer of the manufacturer.

* Type test shall be carried out at first unit manufactured at manufacturing plant.

5.2.1 Measurement of capacitance and tan delta to determine capacitance between winding and earth. Tan delta value shall not be more than 0.5% at ambient temperature.

5.2.2 Measurement of capacitance and tan delta of OIP bushings. (Tan delta value shall not be more than 0.4% at ambient temperature.

5.2.3 Type Tests on fittings:

All the following fittings shall conform to type tests and the type test reports shall be furnished by the contractor along with the drawings of equipment/ fittings as per the clause no. 9.0 of the Chapter2 – GTR. The list of fittings and the type test requirement is:

i. Bushing (Type Test as per IEC: 60137, including snap back/seismic test)

ii. Buchholz relay (Type Test as per IEC and IP-55 Test on terminal box)

iii. OLTC (Temperature Rise of contact, short circuit current test, Mechanical test and Dielectric Test as per IEC: 60214 and IP-55 test on driving mechanism box).

iv. Cooling fan and motor assembly – Free air delivery, Temperature rise, sound level, running at reduced voltage, IP-55 degree of protection for terminal box.

v. Air Cell (Flexible air separator) – Oil side coating, Air side under Coating, Air side outer coating and coated fabric as per BS: 903.

vi. Cooler Control cabinet (IP-55 test)

vii. Pressure Relief device Test

The pressure Relief Device of each size shall be subjected to increase in oil pressure. It shall operate before reaching the test pressure specified in transformer tank pressure test above. The operating pressure shall be recorded. The device shall seal off after excess pressure has been released.

The terminal box / boxes of PRD should conform to degree of protection as per IP-55.

i. Magnetic Oil Level gauge & Terminal Box for IP-55 degree of protection.

ii. OTI & WTI – Switch setting & operation, switch differential, switch rating.

5.2.4 Pre-Shipment Checks at Manufacturer's Works

5.2.5 Check for interchangeability of components of similar transformers for mounting dimensions.

5.2.6 Check for proper packing and preservation of accessories like radiators, bushings, dehydrating breather, rollers, Buchholz relay, fans, control cubicle, connecting pipes, conservator etc.

5.2.7 Check for proper provision for bracing to arrest the movement of core and winding assembly inside the tank.

5.2.8 Gas tightness test to confirm tightness and record of dew point of gas inside the tank.

5.2.9 Derivation of leakage rate and ensure the adequate reserve gas capacity.

5.2.10 Measure and record the dew point of dry air /Nitrogen at the time of filling and after 24 hours in the transformer tank. Dew point of dry air / nitrogen at the time of transformer dispatch should be better than (-) 30 deg C. Also the dew point of dry air / nitrogen cylinders attached for make up during transportation should of the order of (-) 50 deg C.

5.3 Inspection and Testing at Site

The Contractor/Manufacturer shall carry out a detailed inspection and testing programme for field activities covering areas right from the receipt of material stage up to commissioning stage. An indicative programme of inspection as envisaged by the Employer is given below. Pre commissioning Procedures and Formats for equipments shall be contractor's responsibility to draw up and carry out such a programme.

5.3.1 Receipt and Storage Checks

5.3.1.1 Check and record condition of each package, visible parts of the transformer etc. for any damage.

5.3.1.2 Check and record the gas pressure in the transformer tank as well as in the gas cylinder. Measure and record the dew point of dry air /nitrogen in the transformer tank.

5.3.1.3 Visual check for wedging of core and coils before filling up with oil and also check conditions of core and winding in general.

5.3.2 Installation Checks

Inspection and performance testing of accessories like tap changers etc.

i. Check the direction of rotation of fans.

ii. Check the bearing lubrication.

5.3.2.1 Check whole assembly for tightness, general appearance etc.

5.3.2.2 Oil leakage test

5.3.2.3 Capacitance and tan delta measurement of bushing before fixing/connecting to the winding, contractor shall furnish these values for site reference.

5.3.2.4 Leakage test on bushing before erection.

5.3.2.5 Measure and record the dew point of nitrogen/dry air in the main tank before assembly. Manufacturer shall submit dew point acceptable limits along with temperature correction factor and shall form part of instruction manual. In case dew point values are not within permissible limit suitable drying out process shall be applied for dry out of active part in consultation with the Manufacturer.

5.3.2.6 Oil filling.

5.3.2.6.1 Oil impregnation or drying under vacuum at site shall be done with the transformer and oil at a temperature not exceeding 70 deg C.

5.3.2.6.2 The duration of the vacuum treatment shall be demonstrated as adequate by means of water measurement with a cold trap or other suitable method. The vacuum shall be measured on the top of the transformer tank and should be less than 1mbar.

5.3.2.6.3 Vacuum shall not be broken until the transformer is oil filled up to the Buchholz relay. Whenever the active insulation or any paper insulated HV connections, especially those from the windings to the bushings are exposed, these shall be re-impregnated under vacuum along with the complete transformer. For this purpose the transformer shall first be drained to expose all insulation material.

5.3.2.6.4 The minimum safe level of oil filling (if different from the Buchholz level) to which the transformer shall be oil filled under vacuum, shall be indicated in the manual.

5.3.2.6.5 Procedures for site drying, oil purification, oil filling etc shall be submitted for approval and complete instructions shall form part of the manual.

5.3.3 Commissioning Checks

5.3.3.1 Check the colour of silica gel in silica gel breather.

5.3.3.2 Check the oil level in the breather housing, conservator tanks, cooling system, condenser bushing etc.

5.3.3.3 Check the bushing for conformity of connection to the lines etc.,

5.3.3.4 Check for correct operation of all protection devices and alarms:

i. Buchholz relay.

ii. Excessive winding temperature.

iii. Excessive oil temperature.

iv. Low oil flow.

v. Low oil level indication.

vi. Fan and pump failure protection.

5.3.3.5 Check for the adequate protection on the electric circuit supplying the accessories.

5.3.3.6 Check resistance of all windings on all steps of the tap changer. Insulation resistance measurement for the following:

i. Control wiring.

ii. Main windings.

5.3.3.7 Check for cleanliness of the transformer and the surroundings.

5.3.3.8 Continuously observe the transformer operation at no load for 24 hours. Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise and noise level etc.

5.3.3.9 Phase out and vector group test.

Ratio test on all taps.

Magnetizing current test.

Capacitance and Tan delta measurement of winding and bushing.

DGA of oil just before commissioning and after 24 hours energization at site.

Frequency response analysis (FRA) at site by the equipment to be provided by the bidder.

Contractor shall prepare a comprehensive commissioning report including all commissioning test results and forward to Employer for future record.

6. TECHNICAL PARAMETERS

6.1 Technical Particulars / Parameters of Transformers

(132/11 kV, 3-Phase Power Transformer)

S. No.	Description	Unit	TECHNICAL PARAMETERS	
1.	Rated Capacity			
	HV	MVA	31.5	45
	LV	MVA	31.5	45 Correct rating as per cooling below
2.	Voltage ratio (HV/LV) Line to line	kV	132/11	
3.	Single / Three Phase Design		3 (THREE)	
4.	Applicable Standard		IEC 60076	
5.	Frequency	Hz	50	
6.	Cooling		ONAN/ONAF	
7.	Rating at different cooling	%	70 / 100	
8.	Type of Transformer		Constant Ohmic impedance type (Refer note 1)	
9.	HV-LV Impedance at 75 Deg C			
i)	Max. Voltage tap	%	10.3%(+/- 7.5% tol) tap 5	
ii)	Principal tap	%	12.50%(+/- 15% tol) tap 1	
iii)	Min. Voltage tap	%	15.40%(+/- 15% tol) tap 17	
iv)	Tolerance on Impedance	%	As per IEC	
10.	Service		OUTOOR	
11.	Duty		CONTINUOUS	
12.	Overload Capacity		IEC 60076-7	
13.	Temperature rise over 50deg C Ambient Temp			
i)	Top oil measured by thermometer	^{o}C	50	
ii)	Average winding measured by resistance method	^{o}C	55	
14.	Windings			
i)	System Fault level			
	HV	kA	40 kA for 1 sec	

	LV	kA	31.5 kA for 1 Sec
	Neutral	kA	-
ii)	Lightning Impulse withstand Voltage		
	HV	kV_p	650
	LV	kV_p	75
	Neutral (HV/LV)	kV_p	95/75
iii)	Switching Impulse withstand Voltage		
	HV	kV_p	460
iv)	One Minute Power Frequency withstand Voltage		
	HV	kV_{rms}	275
	LV	kV_{rms}	28
	Neutral (HV/LV)	kV_{rms}	38/28
v)	Neutral Grounding		Solidly grounded
vi)	Insulation		
	HV		GRADED
	LV		UNIFORM
vii)	Tan delta of winding	%	<0.5%
15.	Vector Group (3 –ph) (Unless specified differently elsewhere)		YNyn0
16.	Tap Changer		OLTC (Vacuum Type)
i)	Tap Range & No. of steps		–10% to +10% of HV variation in the step of 1.25%, 17 steps
ii)	Location of Tap changer		On the HV side of the series winding
iii)	Design		Constant flux voltage variation type as per cl. 6.2 of IEC 60076 part-I
iv)	Tap control		Full capacity -on load tap changer suitable for group/independent, remote /local electrical and local manual operation and bi-directional power flow.
17.	Bushings		
i)	Rated voltage		
	HV	kV	145
	LV	kV	12
	Neutral HV/LV	kV	36/12
ii)	Rated current (Min.)		
	HV	A	800
	LV		3000
	Neutral	A	3000
iii)	Lightning Impulse withstand Voltage		
	HV	kVp	650
	LV	kVp	75

	Neutral (HV/LV)	kVp	95/75
iv)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	305
	LV	kVrms	28
	Neutral (HV/LV)	kVrms	38/28
v)	Minimum total creepage distances		
	HV	mm	3625
	LV	mm	300
	Neutral (HV/LV)	mm	3625/3
vi)	Tan delta of bushing		
	HV	%	<0.4
vii)	Max Partial discharge level at U_m		
	HV	pC	10
18.	Max Partial discharge level at 1.5Um/√3	pC	100
19.	Max Noise level at rated voltageand at principal tap on full load and all cooling active	dB	Less than 75 dB for ONAN Less than 80 dB at Full Load

Notes:

i. For parallel operation of transformers, the impedance, OLTC connection & range and the winding configuration (if necessary) is to be matched.

ii. No external or internal Transformers / Reactors are to be used to achieve the specified HV/LV impedances.

iii. Tan delta of Winding & Bushing shall be measured at ambient temperature. No temperature correction factor shall be applied.

iv. The criteria for Transformer losses shall be "Copper Loss (Load Loss) > Iron Loss (No Load Loss) > Cooler Loss (Auxiliary Loss)".

7. BUSHING CURRENT TRANSFORMER

7.1 Current transformers shall comply with IEC-60185.

7.2 It shall be possible to remove the turret mounted current transformers from the tank without removing the tank cover. Necessary precautions shall be taken to minimize eddy currents and local heat generated in the turret.

7.3 Current transformer secondary leads shall be brought out to a weather proof terminal box near each bushing. These terminals shall be wired out to cooler control cabinet/ marshalling box using separate cables for each core.

7.4 Bushing Current transformer parameters indicated in this specification are tentative and liable to change within reasonable limits. The Contractor shall obtain Employer's approval before proceeding with the design of bushing current transformers.

7.5 Technical Parameters for Bushing CT

7.5.1 Technical Parameters of Current Transformers (for 45 MVA, 132/11kV 3-Ph Transformers)

Description	Current Transformer Parameters (Transformer)			
	HV Side	HV Neutral Side	LV Side	LV Neutral Side
(a)Ratio				
CORE 1	250/1	250/1	3000/1	3000/1
CORE 2	250/1	-	3000/1	-
(a) Minimum knee point voltage or burden and accuracy class				
CORE 1	PS	PS	PS	PS
CORE 2	0.2 Class, 15VA ISF ≤ 5	250 V	0.2 Class, 15VA ISF ≤ 5	3000 V
(b) Maximum CT Secondary Resistance				
CORE 1	1.5 Ohm	1.5 Ohm	1.5 Ohm	1.5 Ohm
CORE 2		-	-	-
(c) Application				
CORE 1	Protection	Protection	Protection	Protection
CORE 2	Metering		Metering	-
(d) Maximum magnetization current (at knee point voltage)				
CORE 1	100 mA	100 mA	100 mA	100 mA
CORE 2		-	-	-

NOTE:

i. For TPS class CT's, Dimensioning parameter "K" and Secondary VA shall be considered 1.5 and 20 respectively. Class (for the relevant protection and duties) as per IEC 60185.

ii. Rated continuous thermal current rating shall be 200% of rated primary current.

iii. Parameters of WTI CT for each winding shall be provided by the contractor.

iv. For estimation of spares, one set of CTs shall mean one CT of each type used in transformer.

v. The CT used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.

8. OIL STORAGE TANK

8.1 General

This specification is for oil storage tank. Oil Storage tank shall be supplied if specified in Bid Price schedule.

8.2 Standard

The oil storage tank shall be designed and fabricated as per relevant standards.

8.3 Specifications

Transformer oil storage tanks shall be towable on pneumatic tyres and rested on manual screw jacks of adequate quantity & size. The tank shall be cylindrical in shape and mounted horizontally and made of mild steel plate of adequate thickness. Size of the storage tank shall be as follows:

Diameter	• 1.5 meter (For 10 cubic meter capacity) • 2.0 meter (For 20 cubic meter capacity)
Minimum Capacity	As mentioned in BPS

The tank shall be designed for storage of oil at a temperature of 100°C.

8.3.1 The Bidder may further note that maximum height of any part of the complete assembly of the storage tank shall not exceed 4.0 meters above road top.

8.3.2 The tank shall have adequate number of jacking pad so that it can be kept on jack while completely filled with oil. The tank shall be provided with suitable saddles so that tank can be rested on ground after removing the pneumatic tyres.

8.3.3 The tank shall also fitted with manhole, outside & inside access ladder, silicagel breather assembly, inlet & outlet valve, oil sampling valve with suitable adopter, oil drainage valve, air vent etc. Pulling hook on both ends of the tank shall be provided so that the tank can be pulled from either end while completely filled with oil. Bidder shall indicate the engine capacity in horse power to pull one tank completely fitted with oil. Oil level indicator shall be provided with calibration in terms of litre so that at any time operator can have an idea of oil in the tank. Suitable arrangement shall also be provided to prevent overflow in the tank. Solenoid valve (Electro-mechanically operated) with centrifugal pump shall be provided at bottom inlet so that pump shall be utilized both ways during oil fill up and draining. Suitable arrangement shall also be provided to prevent overflow and drain from the tank.

8.3.4 The following accessories shall form part of supply along with each Oil storage tank.

i. Four numbers of suitable nominal bore rubber hoses for transformer oil application up to temperature of 100°C, full vacuum and pressure up to 2.5 Kg/ cm2 with couplers and unions each not less than 10 meter long shall be provided.

ii. Two numbers of suitable nominal bore vacuum hoses, suitable for full vacuum without collapsing and kinking, with couplers and unions each not less than 10 meter long shall also be provided.

iii. One number of digital vacuum gauge with sensor capable of reading up to 0.001 torr, operating on 230V 50Hz AC supply shall be supplied. Couplers and unions for sensor should block oil flow in the sensor. Sensor shall be provided with at least 8-meter cable so as to suitably place the Vacuum gauge at ground level.

8.3.5 The painting of oil storage tank and its control panel shall be as per clause no 3.1.1.8.

8.3.6 The tank shall contain a self-mounted centrifugal oil pump with inlet and outlet valves, with couplers -suitable for flexible rubber hoses and necessary switchgear for its control. There shall be no rigid connection to the pump. The pump shall be electric motor driven, and shall have a discharge of not less than 3.0 (For 10 cubic meter capacity) / 6.0 kl/hr (For 20 cubic meter capacity) with a discharge head of 8.0m. The pump motor and the control cabinet shall be enclosed in a cubical with IP-55 enclosure.

9. OIL SAMPLING BOTTLE

9.1 Oil sampling bottles shall be suitable for collecting oil samples from transformers, for Dissolved Gas Analysis. Bottles shall be robust enough, so that no damage occurs during frequent transportation of samples from site to laboratory.

9.2 Oil sampling bottles shall be made of stainless steel having a capacity of one litre.

9.3 Oil Sampling bottles shall be capable of being sealed gas-tight and shall be fitted with cocks on both ends.

9.4 The design of bottle & seal shall be such that loss of hydrogen shall not exceed 5% per week.

9.5 An impermeable oil-proof, transparent plastic or rubber tube of about 5 mm diameter, and of sufficient length shall also be provided with each bottle along with suitable connectors to fit the tube on to the oil sampling valve of the equipment and the oil collecting bottles respectively.

10. NAME PLATE DETAILS

The name plates shall be white with black engraved letters. On side of transformer, on front as well as rear sides, larger and bold name plates shall be provided to identify the Transformer details including thermal loading graph. Name plates with full and clear inscriptions shall also be provided on side of equipment for identification of the various equipment and ease of operation and maintenance.

ANNEXURE -A

All tests shall be carried out as per IEC: 60076 on transformer.

1. MAGNETIC CIRCUIT TEST

After assembly each core shall be tested for 1 minute at 2000 Volts between all bolts, side plates and structural steel work.

2. TANK TESTS

2.1 Oil Leakage Test

All tanks and oil filled compartments shall be tested for oil tightness by being completely filled with air or oil of a viscosity not greater than that of insulating oil conforming to IEC-60296 at the ambient temperature and applying a pressure equal to the normal pressure plus 35 KN/Sq.m (5 psi) measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours for oil and one hour for air during which time no leak shall occur.

2.2 Vacuum Test

All transformer tank of each size shall be subjected to the specified vacuum. The tank designed for full vacuum shall be tested at an internal pressure of 3.33 KN/Sq.m absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been released shall not exceed the values specified below:

Horizontal Length of flat plate (in mm)	**Permanent deflection in mm**
Up to and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

2.3 Pressure Test

All transformer tank of each size, its radiator, conservator vessel and other fittings together or separately shall be subjected to an air pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN/m2 whichever is lower measured at the base of the tank and maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figure specified above for vacuum test.

2.4 Measurement of capacitance and tan delta

to determine capacitance between winding and earth. Tan delta value shall not be more than 0.5% corrected at 20 deg C. Temperature correction factor table shall be given by the Contractor and shall form the part of test results.

2.5 Temp. Rise Test (as per IEC 60076)

Gas chromatographic analysis on oil shall also be conducted before and after this test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC 60567. For the evaluation of the gas analysis in temperature rise test the procedure shall be as IEC: 60567 and results will be interpreted as per IEC -61181. The DGA results shall generally conform to IEC/IEEE guidelines.

The temperature rise test shall be conducted at a tap for the worst combination of loading on the three windings of the transformer. The Contractor before carrying out such test shall submit detailed calculations showing alternatives possible, on various taps of the transformer and shall recommend the combination that results in highest temperature rise for the test.

2.6 Type Tests on fittings:

All the following fittings shall conform to type tests and the type test reports shall be furnished by the contractor along with the drawings of equipment/ fittings. The list of fittings and the type test requirement is:

i. Bushing (Type Test as per IEC: 60137)

ii. Buchholz relay (Type Test and IP-55 Test on terminal box)

iii. Marshalling box (IP-55 test)

iv. Pressure Relief device Test

The pressure Relief Device of each size shall be subjected to increase in oil pressure. It shall operate before reaching the test pressure specified in transformer tank pressure test. The operating pressure shall be recorded. The device shall seal off after excess pressure has been released. The terminal box / boxes of PRD should conform to degree of protection as per IP-55.

i. Magnetic Oil Level gauge & Terminal Box for IP-55 degree of protection.

ii. Air Cell (Flexible air separator) –Oil side coating, Air side under Coating, Air side outer coating and coated fabric as per BS: 903.

iii. OTI & WTI – Switch setting & operation, switch differential, switch rating.

2.7 Inspection and Testing at Site

The Contractor/Manufacturer shall supervise testing & commissioning at site. Testing & commissioning shall be carried out by the Employer (MOEP-2). Contractor shall submit a detailed procedure for Testing & Commissioning at site including receipt, storage & installation checks as mentioned below.

2.7.1 Receipt and Storage Checks

i. Check and record condition of each package, visible parts of the transformer etc. for any damage.

ii. Check and record the gas pressure in the transformer tank as well as in the

gas cylinder.

iii. Visual check for wedging of core and coils before filling up with oil and also check conditions of core and winding in general.

iv. Check and record reading of impact recorder at receipt and verify the allowable limits as per manufacturer's recommendations.

- Installation Checks
- Check whole assembly for tightness, general appearance etc.
- Oil leakage test
- Capacitance and tan delta measurement of bushing before fixing/connecting to the winding, contractor shall furnish these values for site reference.
- Leakage check on bushing before erection.
- Measure and record the dew point of nitrogen/dry air in the main tank before assembly. Manufacturer shall submit dew point acceptable limits along with temperature correction factor and shall form part of instruction manual. In case dew point values are not within permissible limit suitable drying out process shall be applied for dry out of active part in consultation with the Manufacturer.

2.7.2 Oil filling

i. Oil impregnation or drying under vacuum at site shall be done with the transformer and oil at a temperature not exceeding 70°C.

ii. The duration of the vacuum treatment shall be demonstrated as adequate by means of water measurement with a cold trap or other suitable method but shall generally not be less than 72 hours. The vacuum shall be measured on the top of the transformer tank and should be less than 1mbar.

iii. Vacuum shall not be broken until the transformer is oil filled up to the Buchholz relay. Whenever the active insulation or any paper insulated HV connections, especially those from the windings to the bushings are exposed, these shall be re-impregnated under vacuum along with the complete transformer. For this purpose, the transformer shall first be drained to expose all insulation material.

iv. The minimum safe level of oil filling (if different from the Buchholz level) to which the transformer shall be oil filled under vacuum, shall be indicated in the manual.

v. Procedures for site drying, oil purification, oil filling etc shall be submitted for approval and complete instructions shall form part of the manual.

2.7.3 Commissioning Checks

i. Check the colour of silicagel in silicagel breather.

ii. Check the oil level in the breather housing, conservator tanks, cooling system, condenser bushing etc.

iii. Check the bushing for conformity of connection to the lines etc.

iv. Check for correct operation of all protection devices and alarms:

- Buchholz relay.
- Excessive winding temperature.
- Excessive oil temperature.
- Low oil level indication.

v. Check for the adequate protection on the electric circuit supplying the accessories.

vi. Check resistance of all windings on all steps of the tap changer. Insulation resistance measurement for the following:

- Control wiring.
- Main windings.

vii. Check for cleanliness of the transformer and the surroundings.

viii. Continuously observe the transformer operation at no load for 24 hours.

ix. Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise and noise level etc.

x. Phase out and vector group test.

xi. Ratio test on all taps.

xii. Magnetizing current test.

xiii. Capacitance and Tan delta measurement of winding and bushing.

xiv. DGA of oil just before commissioning and after 24 hours energization at site.

CHAPTER 6

11 KV INDOOR SWITCHGEAR

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CHAPTER 6: 11 KV INDOOR SWITCHGEAR

1. TECHNICAL REQUIREMENT OF EQUIPMENT

1.1 The manufacturer, whose Indoor switch gear panels are offered should have designed, manufactured, type tested as per relevant IEC, supplied and commissioned the Panels of similar voltage rating.

1.2 The panel proposed shall have capacity of 4000 A bus bar with double tier arrangement.

1.3 In addition to the requirements above, the Vacuum circuit breaker, CT, PT and relays should have been designed, manufactured and type tested as per relevant IEC and should have been in satisfactory operation.

2. GENERAL REQUIREMENTS

2.1 The equipment offered by the Bidder shall be complete in all respects. Any material and component not specifically stated in this specification but which are necessary for trouble free operation of the equipment and accessories specified in this specification shall be deemed to be included unless specifically excluded. All such equipment / accessories shall be supplied without any extra cost. Also, all similar components shall be interchangeable and shall be of same type and rating for easy maintenance and low spare inventory.

2.2 Equipment shall be installed in a neat workman-like-manner so that it is leveled, plumbed, squared and properly aligned and oriented. Tolerances shall be as established on Contractor's drawings or as stipulated by Employer. No equipment shall be permanently bolted down / tag welded to foundation until the alignment has been checked and found acceptable by the employer. Contractor shall furnish all supervision labor, tools, equipment rigging materials, bolts, wedges, anchors, concrete inserts etc. in proper time, re red to completely install, test and commission the equipment.

2.3 Manufacturers and Employer's instructions and recommendations shall be correctly followed in handling, erection, testing and commissioning of all equipment.

2.4 Contractor shall move all equipment into the respective rooms through the regular door or openings specifically provided for this purpose. No parts of structure shall be utilized to lift or erect any equipment without prior permission of employer.

2.5 Switchgear shall be installed on finished surfaces, concrete or steel sills. Contractor shall be required to install and align any channel sills which form part of foundations. Minor modifications to foundations shall be carried out by the Contractor at no extra cost. Power bus enclosure, ground and control splices of conventional nature shall be cleaned and bolted together with torque wrench of proper size or by other approved means. Tape or compound shall be applied where called for in drawings. Contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments and relays are supplied loose along with switchgear, they shall be mounted only after the associated switchgear panels have been erected and aligned. The blocking materials, employed for safe transit of instrument and relays shall be removed after ensuring that panels have been completely installed and no further movement of the same would be necessary. Any damage shall be immediately reported to employer.

3. CODES AND STANDARDS

3.1 All work shall be carried out as per the relevant standards, specification and codes of practices, referred to herein & in Chapter 2 GTR, shall be the latest editions including all applicable official amendments and revisions as on the date of opening of bid.

3.2 Equipment conforming to any other internationally accepted standards will also be considered if they ensure performance and constructional features equivalent or superior to the standards listed above.

4. EQUIPMENT SPECIFICATION

4.1 Switchgear Panel

4.1.1 The switchgear boards shall have a single front, single/double tier (single tier for power transformers & bus-tie and double-tier for feeders), fully compartmentalized, metal enclosed construction complying with clause No. 3.102 of IEC 62271-200, comprising of a row of free-standing floor mounted panels. Each circuit shall have a separate vertical panel with distinct compartments for circuit breaker truck, cable termination, main bus-bars and auxiliary control devices. The adjacent panels shall be completely separated by steel sheets except in bus-bar compartments where insulated barriers shall be provided to segregate adjacent panels. The Service Class Continuity of Switchgears shall be LSC 2B-PM (as per IS/IEC 622771-200). However, manufacturer's standard switchgear designs without inter panel barriers in bus-bar compartment may also be considered.

4.1.2 The circuit breakers shall be mounted on withdrawable trucks which shall roll out horizontally from service position to isolated position. For complete withdrawal from the panel, the truck shall rollout on the floor or shall roll out on telescopic rails. In case the later arrangement is offered, suitable trolley shall be provided by the Bidder for withdrawal and insertion of the truck from and into the panel. Testing of the breaker shall be possible in Isolated position by keeping the control plug connected.

4.1.3 The trucks shall have distinct SERVICE and ISOLATED positions. It shall be possible to close the breaker compartment door in isolated position also, so that the switchgear retains its specified degree of protection. While switchboard designs with doors for breaker compartments would be preferred, standard designs of reputed switchgear manufacturers where the truck front serves as the compartment cover may also be considered provided the breaker compartment is completely sealed from all other compartments and retains the IP-4X degree of protection in the Isolated position. In case the later arrangement is offered, the Bidder shall ensure that proper sealing is achieved and shall include blanking covers one for each size of panel per switchboard in his offer.

4.1.4 The switchgear assembly shall be dust, moisture, rodent and vermin proof, with the truck in any position SERVICE, ISOLATED or removed, and all doors and covers closed. All doors, removable covers and glass windows shall have gaskets all round with synthetic rubber or neoprene gaskets. However, Panels which are type tested for IP-4X as per IEC/IS, without any gasket arrangement are also acceptable.

4.1.5 All louvers, if provided, shall have very fine brass or GI mesh screen. Tight fitting gourmet / gaskets are to be provided at all openings in relay compartment. Numerical Relays shall be fully flush mounted on the switchgear panels at a suitable height.

4.1.6 11 kV indoor Switchgear shall have an Internal Arc Classification of IAC FLR 31.5 KA, 1 sec. The switchgear construction shall be such that the operating personnel are not endangered by breaker operation and internal explosions, and the front of the panels shall be specially designed to withstand these. Pressure relief device shall be provided in each high voltage compartment of a panel, so that in case of a fault in a compartment, the gases produced are safely vented out, thereby minimizing the possibility of its spreading to other compartments and panels. The pressure relief device shall not however reduce the degree of protection of panels under normal working conditions. Contractor shall submit the type test report for satisfactory operation of pressure relief device in line with IEC 62271-200 Annexure – A.

4.1.7 Enclosure shall be constructed with rolled steel sections. The doors and covers shall be constructed from cold rolled steel sheets of 2.0 mm or higher thickness but for front door the thickness of cold rolled steel sheet of 2.5 mm or higher. Gland plates shall be 2.5 mm thick made out of hot rolled or cold rolled steel sheets and for nonmagnetic material it shall be 3.0 mm. Thickness of explosion vent shall be as per manufacturer's standard design.

4.1.8 The switchgear shall be cooled by pressurized air flow (for double tier 4000 A bus bar).

4.1.9 Total height of the switchgear panels shall be finalized during detail engineering in line with building design. The height of switches, pushbuttons and other hand operated devices shall not exceed 1800 mm and shall not be generally less than 700 mm.

4.1.10 Necessary guide channels shall be provided in the breaker compartments for proper alignment of plug and socket contacts when truck is being moved to SERVICE position. A crank or lever arrangement shall preferably be provided for smooth and positive movement of truck between Service and Isolated positions. Suitable locking arrangement should be provided for the racking mechanism.

4.1.11 Safety shutters complying with IEC 62271-200 shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the truck is moved to ISOLATED position. The shutters shall move automatically, through a linkage with the movement of the truck. Preferably it shall however, be possible to open the shutters of busbar side and cable side individually against spring pressure for testing purpose after defeating the interlock with truck movement deliberately. In case, insulating shutters are provided, these shall meet the requirements of IEC 62271-200 and necessary test report shall be submitted as per IEC 62271-200 Clause 5.103.3.3. A clearly visible warning label "Isolate elsewhere before earthing" shall be provided on the shutters of incoming and tie connections which could be energized from another end.

4.1.12 Switchgear construction shall have a bushing or other sealing arrangement between the circuit breaker compartment and the busbar/ cable compartments, so that there is no air communication around the isolating contacts in the shutter area with the truck in service position.

4.1.13 The breaker and the auxiliary compartments provided on the front side shall have strong hinged doors. Busbar and cabling compartments provided on the rear side shall have separate bolted covers with self-retaining bolts for easy maintenance and safety. Breaker compartment doors shall have locked facility. Suitable interlock shall be provided, which will ensure that breaker is OFF before opening the back doors. For Incomer/ Bus-coupler/ Bus-Section panels, suitable interlock shall be provided to prevent opening of any

compartment doors which has any of the MV (11 kV) equipment, in case the incoming supply is ON.

4.1.14 In the Service position, the truck shall be so secured that it is not displaced by short circuit forces. Busbars, jumpers and other components of the switchgear shall also be properly supported to withstand all possible short circuit forces corresponding to the short circuit rating specified.

4.1.15 Suitable base frames made out of steel channels shall be supplied along with necessary anchor bolts and other hardware, for mounting of the switchgear panels. These shall be dispatched in advance so that they may be installed and leveled when the flooring is being done, welding of base frame to the insert plates shall be in Bidder's scope. The bidder may offer panels with built in base frame ready for dispatch and suitable for installation on indoor cable trenches.

4.1.16 The switchboard shall have the facility of extension on both sides. Any adopter panels and dummy panels as required to meet the various busbar arrangements, cable / bus duct termination and layouts shall be included in Bidder's scope of work.

4.1.17 Thermostatically controlled space heater for each chamber (CB, Bus bar, cable, PT/CT chamber etc. as applicable) along with common MCB shall be provided.

4.2 Circuit Breakers (VCB Type)

4.2.1 The circuit breakers shall be of Vacuum type. They shall comprise of three separate, identical single pole interrupting units, operated through a common shaft by a sturdy operating mechanism.

4.2.2 Outgoing breakers shall be suitable for switching transformers at any load.

4.2.3 Circuit breaker shall be re-strike free, stored energy operated and trip free type. Motor wound closing spring charging shall only be acceptable. An anti-pumping relay shall be provided for each breaker, even if it has built-in mechanical anti- pumping features. An arrangement of two breakers in parallel to meet a specified current rating shall not be acceptable.

4.2.4 During closing, main poles shall not rebound objectionably and mechanism shall not require adjustments. Necessary dampers shall be provided to withstand the impact at the end of opening stroke.

4.2.5 Plug and socket isolating Contacts for main power circuit shall be silver plated, of self-aligning type, of robust design and capable of withstanding the specified short circuit currents. They shall preferably be shrouded with an insulating material. Plug and socket contacts for auxiliary circuits shall also be silver plated, sturdy and of self-aligning type having a high degree of reliability. Thickness of silver plating shall not be less than 10 microns.

4.2.6 All working part of the mechanism shall be of corrosion resisting material. Bearings which require greasing shall be equipped with pressure type grease fittings. Bearing pins, bolts, nuts and other parts shall be adequately secured and locked to prevent loosening or change in adjustment due to repeated operation of the breaker and the mechanism.

4.2.7 The operating mechanism shall be such that failure of any auxiliary spring shall not prevent tripping and shall not lead to closing or tripping of circuit breaker. Failure of any

auxiliary spring shall also not cause damage to the circuit breaker or endanger the operator.

4.2.8 Mechanical indicators shall be provided on the breaker trucks / front to indicate OPEN / CLOSED conditions of the circuit breaker, and CHARGED / DISCHARGED conditions of the closing spring. An operation counter shall also be provided. These shall be visible without opening the breaker compartment door.

4.2.9 The rated control supply voltage shall be as mentioned elsewhere under technical parameters. The closing coil and spring charging motor shall operate satisfactorily at all values of control supply voltage between 85-110% of the rated voltage. The shunt trip coil shall operate satisfactorily under all operating conditions of the circuit breaker upto its rated short circuit breaking current at all values of control supply voltage between 70-110% of the rated voltage. The trip coil shall be so designed that it does not get energized when its healthiness is monitored by indicating lamps (Red) and trip coil supervision relay.

4.2.10 The time taken for charging of closing spring shall not exceed 30 seconds. The spring charging shall take place automatically preferably after a closing operation. Breaker operation shall be independent of the spring charging motor which shall only charge the closing spring. Opening spring shall get charged automatically during closing operation. As long as power supply is available to the charging motor, a continuous sequence of closing and opening operations shall be possible. One open-close- open operation of the circuit breaker shall be possible after failure of power supply to the motor. Spring charging motors shall be capable of starting and charging the closing spring twice in quick succession without exceeding acceptable winding temperature when the control supply voltage is anywhere between 85-110% of rated voltage. The initial temperature shall be as prevalent in the switchgear panel during full load operation with 50 deg. C ambient air temperature. The motor shall be provided with Over load protection.

4.2.11 Motor windings shall be provided with class E insulation or better. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in a hot, humid and tropical climate.

4.2.12 Circuit breaker shall be provided with inter pole barriers of insulating materials. The use of inflammable materials like Hylam shall not be acceptable.

4.2.13 Circuit breaker pole shall be with epoxy encasing / epoxy encapsulation to safe guard against mechanical impact and climatic condition such as moisture, humidity and dust.

4.2.14 The circuit breaker shall be mounted on an inbuilt carriage to facilitate isolation and withdrawal of the breaker. Where the carriage is fixed in the compartment and does not allow to complete withdrawal of the breaker outside it‘s compartment, then a purposely built trolley shall be provided equipped with a lowering /raising gear to lower the Circuit breaker to the floor and to raise the circuit breaker to it‘s compartment by one person. This requirement shall be demonstrated during FAT. Trolley of the VCB should be horizontally isolated and there should be a minimum ground clearance of 0.55 meter between thimble point of cable termination and GL. There should be a minimum clearance of 300 mm between any 11kV live bus and GL.

4.3 Control and Interlocks

4.3.1 The circuit breaker will normally be controlled remotely from SAS/SCADA system through closing and shunt trip coils. However, it shall also be designed to locally control from Indoor Switchgear panel. Suitable mimic on Panel shall be provided.

4.3.2 Facilities shall be provided for mechanical tripping of the breaker and for manual charging of the stored energy mechanism for a complete duty cycle, in an emergency. These facilities shall be accessible only after opening the compartment door.

4.3.3 Each compartment of panel shall have two separate limit switches, one for the Service position and the other for isolated position. Each of these limit switches shall have at least four (4) contacts which shall close in the respective positions.

4.3.4 Auxiliary Contacts of breaker may be mounted in the fixed portion or in the withdrawable truck as per the standard practice of the manufacturer, and shall be directly operated by the breaker operating mechanism.

4.3.5 Auxiliary contacts mounted in the fixed portion shall not be operable by the operating mechanism, once the truck is withdrawn from the service position, but remain in the position corresponding to breaker open position. Auxiliary contacts mounted on the truck portion, and dedicated for Employer's use shall be wired out in series with a contact denoting breaker service position. With truck withdrawn, the auxiliary contacts shall be operable by hand for testing. There shall be at least Six (6) NO and Six (6) NC breaker auxiliary contacts made available for Employer's future use.

4.3.6 The contacts of all limit switches and all breaker auxiliary contacts located on truck portion and fixed portion shall be rated to make, carry and break 1.0A, 240V DC (Inductive) / 10A, 240V AC. Contacts of control plug and socket shall be capable of carrying the above current continuously.

4.3.7 Movement of truck between SERVICE and ISOLATED positions shall be mechanically prevented when the breaker is closed. An attempt to withdraw a closed breaker shall not trip it.

4.3.8 Closing of the breaker shall be possible only when truck is either in ISOLATED or in SERVICE position and shall not be possible when truck is in between. Further, closing shall be possible only when the auxiliary circuits to breaker truck have been connected up, and closing spring is fully charged.

4.3.9 It shall be possible to easily insert breaker of one typical rating into any one of the panels meant for same rating but at the same time shall be prevented from inserting it into panels meant for a different type or rating.

4.3.10 Indications shall be provided in display unit of the relay flush mounted on the panel front as brought out in the specification elsewhere. It shall be possible to easily make out whether the truck in SERVICE OR ISOLATED POSITION even when the compartment door is closed.

4.4 Busbars and Insulators

4.4.1 All busbar and jumper connections shall be of high conductivity Copper of adequate size and bus bar size calculation / supporting type test report shall be submitted for approval. They shall be adequately supported on insulators to withstand electrical and mechanical stresses due to specified short circuit currents.

4.4.2 Busbar cross-section shall be uniform throughout the length of switchgear. Busbars and other high voltage connection shall be sufficiently corona free at maximum working voltage.

4.4.3 Contact surfaces at all joints shall be silver plated or properly cleaned and non- oxide grease applied to ensure an efficient and trouble-free connection. All bolted joints shall have necessary plain and spring washers. All connection hardware shall have high corrosion resistance. Bimetallic connectors or any other technically proven method shall be used for aluminum to copper connections.

4.4.4 Busbar insulators shall be of arc and track resistant, high strength, non- hygroscopic, non-combustible type and shall be suitable to withstand stresses due to over-voltages, and short circuit current. Busbar shall be supported on the insulators such that the conductor expansion and contraction are allowed without straining the insulators. In case of organic insulator partial discharge shall be limited to 100 pico coulomb at rated Voltage X 1.1/ $\sqrt{3}$. Use of insulators and barriers of in-flammable material such as Hylam shall not be accepted.

4.4.5 All busbars shall be color coded for phase identification.

4.4.6 The temperature of the busbar and all other equipment, when carrying the rated current continuously shall be limited as per the stipulations of relevant International Standards, duly considering the specified ambient temperature (50 deg. C). The temperature rise of the horizontal and vertical busbars when carrying the rated current shall be in line with IEC at 50 deg. C ambient.

4.5 Earthing and Earthing Devices

4.5.1 A copper / galvanized steel earthing bus shall be provided at the bottom and shall extend throughout the length of each switch board. It shall be bolted/ welded to the framework of each panel and each breaker earthing contact bar.

4.5.2 The earth bus shall have sufficient cross section to carry the momentary short-circuit and short time fault currents to earth as indicated under switchgear parameters without exceeding the allowable temperature rise.

4.5.3 Suitable arrangement shall be provided at each end of the earth bus for bolting to Employer's earthing conductors. All joint splices to the earth bus shall be made through at least two bolts and taps by proper lug and bolt connection.

4.5.4 All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical continuity of the whole switchgear enclosure frame work and the truck shall be maintained even after painting.

4.5.5 The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions i.e., SERVICE and ISOLATED as well as throughout the intermediate travel. The truck shall also get and remain earthed when the control plug is connected irrespective of its position.

4.5.6 All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq. mm. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering shall not be acceptable.

Looping of earth connections which would result in loss of earth connection to other devices, when a device is removed is not acceptable. However, looping of earth connections between equipment to provide alternative paths of earth bus is acceptable.

4.5.7 VT and CT secondary neutral point earthing shall be at one place only on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit may be removed without disturbing the earthing of other circuits.

4.5.8 Separate earthing trucks shall be provided by the Contractor for maintenance work. These trucks shall be suitable for earthing the switchgear busbars as well as outgoing / incoming cables. The trucks shall have a voltage transformer/ Voltage Presence Indicator (VPI) and an interlock to prevent earthing of any live connection. The earthing trucks shall in addition have a visual/ audible annunciation to warn the operator against earthing of live connections.

4.5.9 As an alternative to separate earthing trucks the Bidder may also offer built-in earthing facilities for the busbars and outgoing / incoming feeders, in case such facilities are available in their standard proven switchgear design. The inbuilt earthing switches shall have provision for short circuiting and earthing a circuit intended to be earthed. These switches shall be quick make type, independent of the action of the operator and shall be operable from the front of the switchgear panel. These switches shall have suitable facility for locking in the earthed condition.

4.5.10 The earthing device (truck / switch) shall have the short circuit withstand capability equal to that of associated switchgear panel. 4 NO + 4 NC of auxiliary contacts of the earthing device shall be provided for interlocking purpose.

4.5.11 All hinged doors shall be earthed through flexible earthing braid.

4.5.12 Interlocks shall be provided to prevent:

i. Closing of the earthing switch if the associated circuit breaker truck is in Service position.

ii. Insertion of the breaker truck to Service position if earthing switch is in closed position.

4.6 Painting

All sheet steel work shall be pre-treated, in tanks, in accordance with IS: 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "Class-C" as specified in IS: 6005. The phosphate surfaces shall be rinsed and passivated. After passivation, Electrostatic Powder Coating shall be used. Powder should meet requirements of IS 13871 (Powder coating specification). Finishing paint shade for complete panels shall be RAL7032 for all boards, unless required otherwise by the Employer. The paint thickness shall not be less than 50 microns. Finished parts shall be suitably packed and wrapped with protective covering to protect the finished surfaces from scratches, grease, dirt and oil spots during testing, transportation, handling and erection.

4.7 Instrument Transformers

4.7.1 All current and voltage transformers shall be completely encapsulated cast resin insulated type, suitable for continuous operation at the ambient temperature prevailing inside the

switchgear enclosure, when the switchboard is operating at its rated load and the outside ambient temperature is 50 deg. C. The class of insulation shall be E or better.

4.7.2 All instrument transformers shall withstand the power frequency and impulse test voltage specified for the switchgear assembly. The current transformer shall further have the dynamic and short time ratings at least equal to those specified for the associated switchgear and shall safely withstand the thermal and mechanical stress produced by maximum fault currents specified when mounted inside the switchgear for circuit breaker modules.

4.7.3 The parameters of instrument transformers specified in this specification are tentative and shall be finalized by the Employer in due course duly considering the actual burden of various relays and other devices finally selected. In case the Bidder finds that the specified ratings are not adequate for the relays and other devices offered by him, he shall offer instrument transformer of adequate ratings.

4.7.4 All instrument transformers shall have clear indelible polarity markings. All secondary terminals shall be wired to separate terminals on an accessible terminal block.

4.7.5 Current transformers shall be located in the cable termination compartment. All CT/VT shall be single phase type. VT mounting shall be fixed/ withdrawable type.

4.7.6 All voltage transformers shall have suitable HRC current limiting fuses on both primary and secondary sides. Primary fuses shall be mounted suitably on the fixed / withdrawable portion.

4.8 Numerical Protection Relays (IEDs)

4.8.1 Indoor switchgear panels shall have communicable numerical protection relays (IEDs) complying with IEC-61850 on all feeders which shall be networked on Ethernet to communicate with substation SAS/SCADA system on IEC-61850 protocol. These IEDs shall also be used for control & monitoring the switchgear from SAS. In addition to status of devices (CBs/Isolators) and equipment alarms, Metering data shall also be made available to SAS/SCADA station from protection IEDs. Further, multifunction meters with Modbus protocol are also envisaged, which will be connected in daisy-chain-link to communicate to station SAS. Modbus to IEC 61850 converter shall be provided for integration with SAS.

4.8.2 The Bidder's scope shall include the followings:

i. Communicable Numerical Protection Relays (with IEC 61850) in each of the incomer, feeders & Bus-section

ii. IED's / Numerical Relays shall have Graphical Display to facilitate settings, relay operations and to view measurement, event and alarm etc.

iii. Relays shall have built in Local/Remote Switch.

iv. Cat6e Ethernet cable for connection of Numerical Relays (IEDs) to Ethernet switches. Optical cable shall be used between Ethernet switch (for indoor switch gear IEDs) and ring/ redundant network of Substation LAN switch.

v. Required number of Ethernet switches mounted in Indoor Switchgear panels for communication with IEDs on IEC 61850 protocol.

vi. The SAS/SCADA system has been envisaged as part of main substation.

Bidder shall facilitate in successful Integration of Numerical Relays to the SAS/SCADA system through Ethernet switches/fiber optics.

4.8.3 All numerical relays shall be of types, proven for the application satisfying requirements specified elsewhere and shall be subject to Employer's approval.

4.8.4 Numerical Relays shall have appropriate setting ranges, accuracy, resetting ratio, transient overreach and other characteristics to provide required sensitivity to the satisfaction of the Employer.

4.8.5 All numerical relays shall be rated for control supply voltage as mentioned elsewhere under system parameters and shall be capable of satisfactory continuous operation between 80-120% of the rated voltage. Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Contacts for breaker close and trip commands shall be so rated as to be used directly used in the closing and tripping circuits of breaker without the need of any interposing / master trip relays. Threshold voltage for binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages and typically shall be more than 70% of the rated control supply voltage.

4.8.6 All IEDs shall have freely programmable optically isolated binary inputs (BI) and potential free binary output (BO) contacts as per approved scheme. These I/O points shall be used for wiring of status of devices (CBs/Isolators) and equipment alarms etc. Heavy duty binary output contacts of IEDs shall be suitable for CB closing / tripping directly and no separate master trip relay shall be used.

4.8.7 Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker operation.

4.8.8 Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping. Event records & alarms shall be stored in Non-volatile memory and failure of control supply shall not result in deletion of any of these data.

4.8.9 All Numerical relays shall have features for electrical measurements including voltage, current, power (active & reactive), frequency, power-factor and energy parameters.

4.8.10 All numerical relays shall have provision of both current (CT) and voltage (VT) inputs as required for protection & measurement purposes using protection cores.

4.8.11 All numerical relays shall have key pad / keys to allow relay setting from relay front. Relay to be self or hand reset type which shall be software selectable. Manual resetting shall be possible from remote.

4.8.12 Relays shall have suitable output contact for circuit breaker failure protection (LBB) logic.

4.8.13 Relays shall have self-diagnostic feature with continuous self-check for power failure, program routines, memory and main CPU failures and a separate output contact for indication of any failure.

4.8.14 Contractor shall submit applicable Type Test reports for Numerical relays as per IEC including report for IEC 61850 protocol from accredited lab.

4.9 Control & Protection System

All numerical relays shall communicate to station SCADA / SAS on IEC-61850 communication protocol. It is envisaged that these protection IEDs shall be used for CB control & monitoring of bay equipment.

4.9.1 Numerical Transformer Protection Relay

i. The relay shall have instantaneous as well as time delayed three over current (50/51) and one earth fault (50N/51N) protections.

ii. The over current element should have the minimum setting adjustable between 20-200% of CT secondary rated current and high set setting 500-2000%.

iii. The relay shall have selectable directional & non-directional feature

iv. The earth fault element of relay shall be suitable for detection of earth fault currents in the range of 5% to 80% of the CT rated current (IDMT) and high set 100-1000%.

v. For transformers of rating 5MVA and above, definite time delayed Stand by earth fault protection shall be provided having a pick-up setting range of 10% to 40% with a timer delay of 0.3 sec to 3 sec.

vi. The relay shall allow higher setting during transformer charging (inrush) and lower setting during normal operating condition.

vii. Transformer troubles like Buchholz, winding temperature, Oil temperature & Pressure Relief Device trips (as applicable) shall be wired to separate binary inputs of the relay and shall be configured to issue trip command to the breaker.

viii. Trip circuit supervision shall be provided to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions.

4.9.2 Numerical Line Protection Relay

i. The relay shall have instantaneous as well as time delayed three over current (50/51) and one earth fault (50N/51N) protections.

ii. The over current element should have the minimum setting adjustable between 20-200% of CT secondary rated current.

iii. The relay shall have selectable directional & non-directional feature

iv. The earth fault element of relay shall be suitable for detection of earth fault currents in the range of 5% to 80% of the CT rated current.

v. Trip circuit supervision shall be provided to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions.

4.9.3 Numerical Bus Coupler/Bus-Section Protection Relay

i. The relay shall have instantaneous as well as time delayed three over current (50/51) and one earth fault (50N/51N) protections.

ii. The over current element should have the minimum setting adjustable between 20-200% of CT secondary rated current.

iii. The earth fault element of relay shall be suitable for detection of earth fault

currents in the range of 5% to 80% of the CT rated current.

iv. Bus no volt signal shall be configured in the relay for use in control logics and other Protections and Control functions in the Relays.

v. Trip circuit supervision shall be provided to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions.

4.9.4 Other Control and Protections features

i. Control of breakers shall be carried out from the station HMI of SAS/SCADA system through the LAN and the numerical relays.

ii. The HMI shall have a graphical dynamic Plant Key Single Line Diagram to view the complete system status. This shall include the status of the switchgears, measurement values, operation counters, graphical alarm representation, etc. Spontaneous changes of a state, typically opening of a circuit breaker from a protection, shall have a specific colour code. All the Breakers with the status shall be clearly displayed along with values of currents, voltages, and frequency, active and reactive powers etc.

iii. Separate Master trip (86) relay with self-reset type for Line protection and Electrical reset type for Transformer shall be provided. Electrical reset shall be possible through IED & Substation SAS.

iv. Schematics requiring auxiliary relays / timers for protection function shall be a part of numerical relay. The number of auxiliary relay and timer functions shall be as required for the application. Timer functions shall be configurable for on & off delays as per requirement.

v. The numerical relay shall be capable of measuring and storing values of a wide range of quantities, all events, faults and disturbance recordings with a time stamping using the internal real time clock. Battery backup for real time clock in the event of power supply failure shall be provided.

vi. At least 250 time tagged events / records shall be stored with time stamping. Details of at least 5 previous faults including the type of protection operated, operating time, all currents & voltages and time of fault.

vii. Diagnostics Automatic testing, power on diagnostics with continuous monitoring to ensure high degree of reliability shall be shall be provided. The results of the self-reset functions shall be stored in battery back memory. Test features such as examination of input quantities, status of digital inputs and relay outputs shall be shall be available on the user interface

viii. The alarm/status of each individual protection function and trip operation shall be communicated to the SAS/SCADA system.

ix. Sequence of events shall have 1ms resolution at device level.

x. Measurement accuracy shall be 1% for rated RMS Current and voltage (20-120% of Rated primary).

xi. It shall be possible to carryout open / close operation of breakers from a laptop by interfacing from the relay front port during initial commissioning.

5. ETHERNET SWITCH

5.1 Ethernet switches shall be 'substation hardened ', and shall comply with IEC61850 for communications with IEDs. The Ethernet switches shall be of managed type with two (2) No. of Fiber optic cable ports and at least Sixteen (16) Copper ports to achieve the LAN configuration. More no. of switches or higher ports switch can also be supplied to meet all IEDs requirements for the LAN. The Ethernet switches shall have features to support the redundant rings. These switches shall be mounted in the switchgear Panels. The FO ports shall be Single-mode 1000Mbps ports. Copper ports shall be 10/100Mbps ports.

5.2 Necessary software for configuration and real-time network monitoring shall be provided along with the Ethernet switches.

6. POWER CABLE TERMINATION

6.1 Cable termination compartment shall receive the stranded copper conductor, XLPE insulated, shielded, armored, PVC jacketed, single core / three core, unearthed / earthed grade power cable(s).

6.2 Adequate clearance shall be kept between the cable lug bottom ends and gland plates for stress cone formation for XLPE cables. Inter-phase clearance in the cable termination compartment shall be adequate to meet electrical and mechanical requirement besides facilitating easy connections and disconnection of cables. Dimensional drawing of cable connection compartment showing the location of lug, glands, CTs, gland plates etc. and the electrical clearances available shall be submitted for Employer's approval during detail engineering.

6.3 Cable termination compartment shall have provision for termination of power cables of sizes indicated in the bidding documents with removable undrilled gland plates. For all single core cables gland plates shall be of non-magnetic material. Cable entry shall generally be from the bottom; however, this shall be finalized during detail engineering.

7. CONFIGURATION OF INDOOR VCB IN EACH COMPARTMENT OF PANEL

SN.	Equipment	IP1	IP2	IP3	IP4
		I/C	O/G	LT TR	B/S
1	VCB as per spec	1	1	1	1
2	CB Spring charge indicator (Mechanical)	1	1	1	1
3	Mechanical ON/OFF indicator for CB	1	1	1	1
4	Operation counter for CB	1	1	1	1
5	CT (1-Phase)	3	3	3	3
6	VT (1-Phase)	3	-	-	3
7	Multi-Function Meter	1	1	1	1

SN.	Equipment	IP1	IP2	IP3	IP4
		I/C	O/G	LT TR	B/S
8	Control switch for breaker(T-N-C)	1	1	1	1
9	Green Indicating lamp for CB Open	1	1	1	1
10	Red indicating lamp for CB Close	1	1	1	1
11	DC healthy lamp (white)	1	1	1	1
12	Trip circuit healthy lamp	1	1	1	1
13	Mimic to represent SLD	1	1	1	1
14	Voltmeter with selector switch	1	-	-	1
15	Numerical protection relay (IED)	1	1	1	1
16	Master Trip Relay (86)	1	1	1	1
17	Semaphore Indicator for Line Isolator & Line Earth Switch	-	2	-	-
18	LAN Switches and LAN/FO Cables	AS per requirement			

Notes:

i. IP1: Panel for Transformer Incomer feeder (I/C)

ii. IP2: Panel for outgoing Line Feeder (O/G)

iii. IP3: Panel for LT Transformer feeder (LT TR)

iv. IP4: Panel for Bus Sectionaliser (B/S)

v. Location of VT (I/C or B/S Module) shall be decided during detail design.

vi. Numerical protection relay (IED) for all type of VCB module shall preferably be interchangeable to optimize mandatory spares.

8. TESTS

8.1 Type Tests

The contractor shall submit the reports for the following type tests on the equipment to be supplied under the contract:

8.1.1 Switchgear Panel (with Circuit Breaker installed)

i. Short circuit duty test

ii. Short time and peak withstand current test

iii. Power frequency withstand test

iv. Lightning impulse withstand test

v. Temperature rise test

vi. Internal Arc Test as per IEC 62271-200 (for 1 second)

vii. Measurement of resistance of main circuit

viii. Test to verify pressure relief operation of the panel (During internal arc test)

ix. Cable charging test

x. Short circuit withstand test of earthing device (truck / switch).

8.1.2 Circuit Breaker

Mechanical Endurance Test

8.1.3 Current Transformer

i. Short time current test

ii. Temperature rise test

iii. Lighting Impulse voltage withstand test

8.1.4 Potential Transformer

i. Temperature rise test

ii. Lighting Impulse voltage withstand test

8.1.5 Switchgear Panel

IP 4X test

8.2 Routine Tests

All acceptance and routine tests as per the specification and relevant standards IEC 62271-200 & IEC 62271-100 shall be carried out. Charges for these shall be deemed to be included in the equipment price.

The manufacturer shall furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

8.3 Commissioning Checks / Tests

After installation of panels, power and Control wiring and connections, Contractor shall perform commissioning checks as listed below to verify proper operation of switchgear / Panels and correctness of all equipment in all respects. In addition, the Contractor shall carry out all other checks and tests recommended by the manufacturers.

8.3.1 General

i. Check name plate details according to specification.

ii. Check for physical damage

iii. Check tightness of all bolts, clamps and connecting terminals

iv. Check earth connections.

v. Check cleanliness of insulators and bushings

vi. Check heaters are provided

vii. H.V. test on complete switchboard with CT & breaker in position.

viii. Check all moving parts are properly lubricated.

ix. Check for alignment of busbars with the insulators to ensure alignment and

fitness of insulators.

x. Check for interchangeability of breakers.

xi. Check continuity and IR value of space heater.

xii. Check earth continuity for the complete switchgear board.

8.3.2 Circuit Breaker

i. Check alignment of trucks for free movement.

ii. Check correct operation of shutters.

iii. Check control wiring for correctness of connections, continuity and IR values.

iv. Manual operation of breakers completely assembled.

v. Power closing / opening operation, manually and electrically

vi. Closing and tripping time.

vii. Trip free and anti-pumping operation.

viii. IR values, resistance and minimum pick up voltage of coils.

ix. Simultaneous closing of all the three phases.

x. Check electrical and mechanical interlocks provided.

xi. Checks on spring charging motor, correct operation of limit switches and time of charging

xii. All functional checks.

8.3.3 Current Transformers

i. Megger between windings and winding terminals to body.

ii. Polarity tests.

iii. Ratio identification checking of all ratios on all cores by primary injection of current.

iv. Magnetization characteristics & secondary winding resistance.

v. Spare CT cores, if any to be shorted and earthed.

8.3.4 Voltage Transformers

i. Insulation resistance test.

ii. Ratio test on all cores.

iii. Polarity test.

iv. Line connections as per connection diagram.

8.3.5 Cubicle Wiring

i. Check all switch developments.

ii. It should be made sure that the wiring is as per relevant drawings. All interconnections between panels shall similarly be checked.

iii. All the wires shall be meggered to earth.

iv. Functional checking of all control circuit e.g. closing, tripping interlock, supervision and alarm circuit including proper functioning of component / equipment.

v. Check terminations and connections.

vi. Wire ducting.

vii. Gap sealing and cable bunching.

8.3.6 Relays

i. Check internal wiring.

ii. IR of all terminal body.

iii. IR of AC to DC terminals

iv. Check operating characteristics by secondary injection.

v. Check operation of electrical/ mechanical targets.

vi. Relay settings.

9. SYSTEM PARAMETERS:

1	Nominal System voltage	11 kV
2	Highest System voltage	12 kV
3	Rated Frequency	50 Hz
4	Number of phases/ poles	Three
5	System neutral earthing	As per Vector Group Transformers
6	One minute power frequency withstand voltage	28
7	1.2/50 microsecond Impulse withstand voltage	75 kV (peak)
8	Short time rating for bus bars, CB, CT and switchgear Assembly.	31.5 kA (rms) for One (1) sec.
9	Dynamic withstand rating	62.5 kA (peak)
10	IAC Rating	31.5kA, 1 Sec
11	Control supply voltage	
12	- Trip and closing coils	220 V DC Supply
	- Spring charging motor	220 V DC Supply
13	Maximum ambient air temperature	50 deg. C

a) CIRCUIT BREAKERS		
1	Rated Voltage	12 kV

2	CB rated Current	
a)	Incomer & Sectionalized Breaker	3000 A
b)	Outgoing feeder Breaker	1250 A
3	Short circuit breaker Current	
a)	A.C. component	31.5 kA
b)	D.C. component	As per IS: 13118 or IEC-62271
4	Short Circuit making current	62.5 kA(peak)
5	Out of phase breaking Current capacity	As per IEC
6	Rated line/cable charging Interrupting current at 90° Leading power factor angle	As per IEC
7	Maximum allowable switching Over voltage under any switching Condition	As per IEC
8	Rated small inductive current Switching capability with over Voltage less than 2.3 pu	As per IEC
9	First pole to clear factor	1.5
10	Operating Duty	O-0.3 Sec-CO-3 Min-CO
11	Total break time	Not more than 4 cycles
12	Total make time	Not more than 5 cycles
13	Reclosing	3 phase auto reclosing
14	Max. difference in the instants of closing/opening contacts between poles at rated control Voltage and rated operating and quenching media pressures	As per IEC
15	Auxiliary contacts	2NO + 2NC for Employer's future use besides scheme requirement
16	Operating Mechanism	Motor wound spring charged stored energy type as per IEC- 62271

b) Current Transformer		
1	Rated primary voltage	11 kV
2	Rated primary current (Incoming /Outgoing)	3000-1500A/600-300A
	Rated Secondary Current	1A
3	Type of CT	Cast Resin, Bar Primary
4	Voltage class and Frequency	6.6 kV, 50Hz
5	Max temp rise	As per IEC:61869
6	Class of Insulation	Class E or better

b) Current Transformer		
7	One minute power frequency withstand voltage between secondary terminal & earth	3kV

c)Voltage Transformer		
1	Type	Cast Resin
1	Rated primary voltage	11 kV
2	Highest system voltage	12 kV
	Rated Voltage factor	1.1 continuous for 3 seconds
3	PT Ratio	11000√3 /110/√3/110/√3 V
4	Accuracy Class (Protection, Metering)	3P, 0.2
	Burden	50 VA
	One minute power frequency withstand voltage on primary winding	3 kV
	Limit of temp.rise of winding (°C)	55°C above
5	Voltage factor	1.2 cont. &1.9 for 8 hours

The ratings indicated for instrument transformers are tentative only and may be changed to meet the functional requirements.

10. INPUT SIGNAL TO SAS SYSTEM

The following digital input of 11kV Indoor switchgear bays shall be provided through IEDs in the SAS system:

i. Status of CB, Isolator, Earth switch
ii. CB trouble
iii. CB operation/closing lockout
iv. Trip circuit faulty
v. Bus VT FUSE Fail
vi. Back-up overcurrent & earth fault protection Operated
vii. DC source fail

11. MULTIFUNCTION METER

The Multifunction meter shall have feature to measure kV, I, MW, MVAr, PF, MWhr, MVArhr, Hz with accuracy class of 0.2. Further, multifunction meter shall have bi-directional feature to register/record MWhr values.

11.1 REQUIREMENT FOR 11 kV CURRENT TRANSFORMERS (INCOMER LINE and BUS COUPLER)

	Metering	O/C & E/F	Tr. Differential
Current ratio	3000-1500/1	3000-1500/1	3000-1500/1
Accuracy class	0.2	5P20	PS
Knee point voltage (at minimum ratio)	-	-	3000/1500
Secondary Resistance			10/20 ohm
Excitation Current			20 mA/10 mA
Rated burden	7.5VA	-	

11.2 REQUIREMENT FOR 11KV CURRENT TRANSFORMERS (LINE FEEDER)

	Metering	O/C & E/F Protn.	Spare
Current ratio	600-300/1	600-300/1	600-300/1
Accuracy class	0.2	5P20	5P20
Knee point voltage (at minimum ratio)	-	-	-
Rated burden	7.5VA	-	

11.3 REQUIREMENT FOR 11 KV CURRENT TRANSFORMERS (LT TRANSFORMER FEEDER)

	Metering	O/C & E/F Protn.
Current ratio	40-20/1	40-20/1
Accuracy class	0.2	5P20
Knee point voltage (at minimum ratio)	-	-
Rated burden	7.5VA	-

CHAPTER 7

LT SWITCHGEAR

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CHAPTER 7: LT SWITCHGEAR

1. CONSTRUCTIONAL DETAILS OF SWITCHBOARDS AND DISTRIBUTION BOARDS

1.1 All boards shall be of metal enclosed, indoor floor mounted, compartmentalized double front construction and freestanding type.

1.2 All board frames, shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary. Gland plate shall be cold rolled sheet steel having thickness not less than 3 mm in all cases. However, in case of termination of single core power cables, gland plate shall be of non-magnetic material of at least 4mm thickness.

1.2.1 All panel edges and cover/door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.

1.2.2 The complete structures shall be rigid, self-supporting, and free from flaws, twists and bends. All cut-outs shall be true in shape and devoid of sharp edges.

1.2.3 All boards shall be of dust and vermin proof construction and shall be provided with a degree of protection of IP: 52, for category I enclosure as per IEC 60947 (Part-1). However, the busbar chambers having a degree of protection of IP: 42, in accordance with IEC 60947 (Part-1), are also acceptable where continuous busbar rating exceeds 1000 Amp. Provision shall be made in all draw out Air Circuit Breaker compartments for providing IP: 52 degrees of protection, when Circuit breaker trolley, has been removed. Panels with lighting transformers shall have IP 31 degree of protection in accordance with IEC 60947 (Part-1). Door frame of panels, meters, relays, Breaker cut-outs shall be provided with neoprene rubber gaskets generally conforming to IEC/International Standards.

1.2.4 Provision of louvers on boards would not be preferred. However, louvers backed with metal screen are acceptable on the busbar chambers where continuous busbar rating exceeds 1000 Amps. Panels with lighting transformers in lighting distribution boards shall have louvers.

1.2.5 All boards shall be of uniform height not exceeding 2450 mm.

1.2.6 Boards shall be easily extendible on both sides, by the addition of the vertical sections after removing the end covers of bus bar chambers.

1.2.7 Boards shall be supplied with base frames made of structural steel sections, along with all necessary mounting hardware required for welding the base frames to the insert plates.

1.2.8 All boards shall be of double front construction and shall have ÷

i. A completely enclosed busbar compartment for running horizontal busbars and vertical busbars. Busbar chambers shall be completely enclosed with metallic portions. Bolted covers shall be provided for access to horizontal and vertical busbars for repair and maintenance, which shall be feasible without disturbing feeder compartment. Vertical bus bar chambers shall be

accessible from front as well as back side of the panel and shall be of at least 350 mm width. One set of vertical busbars shall be used in between two adjacent sections for switchgear connections. In case of ACB feeders, the panel shall have single front without any vertical busbar chamber, however vertical busbars associated with ACBs shall be located in rear side and shall be additionally covered with metallic perforated/ transparent acrylic or polyvinyl bolted sheets to avoid direct access after opening rear door of chamber.

ii. Completely enclosed switchgear compartment(s) one for each circuit for housing circuit breaker or MCCB or motor starter.

iii. A distinct compartment or alley for power and control cables on each side of panel. Cable alley compartment shall have a through metallic partition for segregating cables on both sides. Cable alley door shall preferably be hinged. Cable alley shall have no exposed live parts. Any live terminals shall be fully shrouded/insulated from safety aspects. However, it shall be of at least 350mm width.

iv. A compartment for relays and other control devices associated with a circuit breaker.

1.2.9 Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. Each shipping section shall have full metal sheets at both ends for transport and storage.

1.2.10 All equipment associated with a single circuit except MCB circuits shall be housed in a separate compartment of the vertical section. The Compartment shall be sheet steel enclosed on all sides with the withdrawal units in position or removed. The front of the compartment shall be provided with the hinged single leaf door, with locking facilities.

In case of circuits controlled by MCBs, group of MCB feeders can be offered in common compartment. In such case number of MCB feeder to be used in a common compartment shall not exceed 4 (four) and front of MCB compartment, shall have a viewing port of toughen glass sheet for viewing and sheet steel door of module shall be lockable with star knob/panel key.

1.2.11 After isolation of power and control circuit connections it shall be possible to safely carryout maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose over the cable terminations located in cable alley.

1.2.12 The minimum clearance in air between phases and between phase and earth for the entire run of horizontal and vertical busbars, shall be 25 mm. For all other components, the clearance between "two live parts", " A live part and an earthed part" and isolating distance shall be at least ten (10) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers. However, for horizontal run of busbar minimum clearance of 25 mm should be maintained even if they are sleeved.

1.2.13 The temperature rises of horizontal & vertical busbars when carrying rated current along its full run shall in no case exceed 55°C, with silver plated joints and 40°C with all other type of joints over an outside ambient temperature of 50°C.

1.2.14 All busbar chambers shall be provided with removable bolted covers. The covers shall be provided with danger labels.

1.2.15 All identical circuit breakers and module chassis of same test size shall be fully interchangeable without having to carryout modifications.

1.2.16 All Circuit breaker boards shall be of Single Front type, with fully draw out circuit breakers, which can be drawn out without having to unscrew any connections. The circuit breakers shall be mounted on rollers and guides for smooth movement between SERVICE, TEST and ISOLATED positions and for withdrawal from the Switchboard. Testing of the breaker shall be possible in the TEST position.

1.2.17 Wherever two breaker compartments are provided in the same vertical section, insulating barriers and shrouds shall be provided in the rear cable compartment to avoid accidental touch with the live parts of one circuit when working on the other circuit.

1.2.18 All disconnecting contacts for power circuits shall be of robust design and fully self aligning. Fixed and moving contacts of the power drawout contact system shall be silver plated. Both fixed and moving contacts shall be replaceable.

1.2.19 All AC & DC boards shall be of double Front type.

1.2.20 All module shall be fixed type except air circuit breaker module, which shall be draw out type.

1.2.21 The connections from busbars to the main switch shall be fully insulated/shrouded, and securely bolted. The partition between the feeder compartment and cable alley may be non-metallic and shall be of such construction as to allow cable cores with lugs to be easily inserted in the feeder compartment for termination.

1.2.22 All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to EMPLOYER approval. Bidder shall submit dimensional drawings showing complete internal details of Busbars and module components, for each type and rating for approval.

1.2.23 The tentative power and control cable entries shall be from bottom. However, Employer reserves the right to alter the cable entries, if required, during detailed engineering, without any additional commercial implication.

1.2.24 Adopter panels and dummy panels required to meet the various busbar arrangements and layouts required shall be included in Bidder's scope of work.

2. DERATING OF EQUIPMENT

2.1.1 The current ratings of all equipment as specified in the Single Line Diagram For AC & DC System are the minimum standards current ratings at a reference ambient temperature as per relevant Indian Standards.

3. POWER BUS BARS AND INSULATORS

3.1 All AC Distribution Boards shall be provided with three phase buses and a neutral bus bar and the DC Distribution Boards shall be provided with two busbars.

3.2 All busbars and jumper connections shall be of high conductivity aluminum/copper of adequate size.

3.3 The Cross-Section of the busbars shall be uniform throughout the length of Switchgear and shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents.

3.4 All busbars shall be adequately supported by adequate numbers of high strength type Polyester Fibre Glass Moulded Insulators to withstand short circuit withstand capability of panel. Separate supports shall be provided for each phase and neutral busbar. If a common support is provided anti-tracking barriers shall be provided between the supports.

3.5 All busbars' joints shall be provided with high tensile steel bolts. Belleville/spring washers and nuts, so as to ensure good contacts at the joints. Non-silver-plated Busbars joints shall be thoroughly cleaned at the joint locations and a suitable contact grease shall be applied just before making a joint.

3.6 All busbars shall be colour coded as per IEC: 60446.

3.7 The Bidder shall furnish calculations, establishing the adequacy of busbar sizes for specified current ratings, On the basis of short circuit current and temperature rise consideration at specified ambient temp.

4. EARTH BUS

4.1 A galvanized steel earthing shall be provided at the bottom of each panel and shall extend throughout the length of each switchboard. It shall be welded/bolted to the frame work of each panel and breaker earthing contact bar vertical bus shall be provided in each vertical section which shall in turn be bolted/welded to main horizontal ground bus.

4.2 The earth bus shall have sufficient cross-section to carry the momentary short circuit and short time fault currents to earth without exceeding the allowable temperature rise.

4.3 Suitable arrangements shall be provided at each end of the horizontal earth bus for bolting to Employer's earthing conductors. The horizontal earth bus shall project out the switchboard ends and shall have predrilled holes for this connection. A joint spaced and taps to earth bus shall be made through at least two bolts.

4.4 All non-current metal work of the Switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosures frame work and the truck shall be maintained even after painting.

4.5 The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions. SERVICES & ISOLATED, as well as throughout the intermediate travel.

4.6 Air Circuit Breaker (ACB) module frame shall get engaged to the vertical earth bus, before the disconnecting contacts on these modules are engaged to the vertical busbar.

4.7 All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 mm2. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering is not acceptable. Looping of earth Connection which would result in loss of earth connection to the devices when a device is removed is not acceptable. However, looping of earth connections between equipment to provide alternative paths or earth bus is acceptable.

4.8 VT and CT secondary neutral point earthing shall be at one place only, on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit shall be removed without disturbing the earthing of other circuit.

4.9 All hinged doors shall be earthed through flexible earthing braid.

4.10 Caution nameplate `Caution-Live Terminals shall be provided at all points where the terminals are like to remain live and isolation is possible only at remote end.

5. AIR CIRCUIT BREAKERS

5.1 Circuit breakers shall be three-pole air break horizontal draw-out type and shall have inherent fault making and breaking capacities as specified in "Technical Parameters". The circuit breakers which meet specified parameter only after provision of releases or any other devices shall not be acceptable.

5.2 Circuit breakers shall be mounted along with-it operating mechanism on a wheeled carriage. Suitable guides shall be provided to minimise misalignment of the breaker.

5.3 There shall be `Service', `Test' and `Fully withdrawn positions for the breakers. In `Test' position the circuit breaker shall be capable of being tested for operation without energising the power circuits i.e., the power Contacts shall be disconnected while the Control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the `SERVICE', `TEST' OR FULLY WITHDRAWN' position. It shall be possible to close the door in TEST position.

5.4 All circuit breakers shall be provided with 4 NO and 4 NC potentially free auxiliary contacts. These contacts shall be in addition to those required for internal mechanism of the breaker. Separate limit switches each having required number of contacts shall be provided in both `SERVICE' & `TEST' position of the breaker. All contacts shall be rated for making continuously carrying and breaking 10 Amps at 230 V AC and 1 Amp (Inductive) at 220 DC.

5.5 Suitable mechanical indications shall be provided on all circuit breakers to show `OPEN'. `CLOSE', `SERVICE', `TEST' and `SPRING CHARGED' positions.

5.6 Main poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half cycle of rated frequency.

5.7 All circuit breakers shall be provided with the interlocks as explained in further clauses.

5.8 Movement of a circuit breaker between SERVICE AND TEST positions shall not be possible unless it is in PEN position. Attempted with drawl of a closed-circuit breaker shall trip the circuit breaker.

5.9 Closing of a circuit breaker shall not be possible unless it is in SERVICE, TEST POSITION or in FULLY WITHDRAWN POSITION.

5.10 Circuit breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage to cover the stationary isolated contacts when the breaker is withdrawn. It shall however, be possible to open the shutters intentionally, against spring pressure for testing purpose.

5.11 A breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.

5.12 Circuit breakers shall be provided with electrical anti-pumping and trip free feature, even if mechanical antidumping feature is provided.

5.13 Mechanical tripping shall be possible by means of front mounted RED `Trip' push-button. In case of electrically operated breakers these push buttons shall be shrouded to prevent accidental operation.

5.14 Breaker controlled motors shall operate satisfactorily under the following conditions:

i. Direct on-line starting of Induction Motors rated 110 kW to 220 kW with a locked rotor current of seven times the rated current, and starting time of up to 30 seconds.

ii. Breaking on-load, full load and locked rotor currents of Induction Motors for rated 100 kW to 220 kW.

5.15 Means shall be provided to slowly close the circuit breaker in withdrawn position. If required for inspection and setting of Contacts, in service position slow closing shall not be possible.

5.16 Power operated mechanism shall be provided with a universal motor suitable for operation 220 DC Control supply with voltage variation from 90% to 110% rated voltage. Motor insulation shall be class `E' or better.

5.17 The motor shall be such that it requires not more than 30 seconds for fully charging the closing spring.

5.18 Once the closing springs are discharged, after the one closing operation of circuit breaker, it shall automatically initiate, recharging of the spring.

5.19 The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply at least one open-close-open operation shall be possible.

5.20 Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically get mechanically decoupled.

5.21 All circuit breakers shall be provided with closing and trip coils. The closing coils shall operate correctly at all values of Voltage between 85% to 110% at rated control voltage. The trip coil shall operate satisfactorily under all values of supply voltage between 70% to 110% of rated control voltage.

5.22 Provision for mechanical closing of the breaker only in `TEST' and `WITHDRAWN' positions shall be made.

6. PROTECTION CO-ORDINATION

It shall be the responsibility of the Contractor to fully co-ordinate the overload and short circuit tripping of the circuit breakers with the upstream and downstream circuit breakers/fuses/motor starters, to provide satisfactory discrimination.

7. MOULDED CASE CIRCUIT BREAKER (MCCB) AND MCB

7.1 MCCB shall in general conform to IEC: 60947 Part-2. All MCCB offered shall have Ics = 100% Icu rating.

7.2 MCCB shall be flush mounted on the AC/DC distribution boards and shall have extended handle.

7.3 MCCBs shall be provided with thermo-magnetic type release for over current and short circuit protection. The setting of the thermal release shall be adjustable between 80% to 100% of the rated current. The MCCB shall have breaking capacity not less than 20kA.

7.4 MCCBs used for ACDB incomers and Bus coupler shall be equipped with stored energy mechanism for electrical closing and tripping. All other MCCBs shall be manually operated. The operating handle should give a clear trip indication.

7.5 Miniature circuit breaker (MCB) shall conform to IEC: 60898.

8. RELAYS

8.1 All relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent dust tight covers removable from the front. All protective relays shall have a drawout construction for easy replacement from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay. The auxiliary relays and timers may be furnished in non-drawout cases.

8.2 All AC relays shall be suitable for operation, at 50 Hz with 110 volts VT secondary and 1 amp CT secondary.

8.3 All protective relays and timers shall have at least two potentially free output contacts. Relays shall have contacts as required for protection schemes. Contacts of relays and timers shall be silver faced and shall have a spring action. Adequate number of terminals shall be available on the relay cases for applicable relaying schemes.

8.4 All protective relays auxiliary relays and timers shall be provided with hand reset operation indicators (Flags) for analysing the cause of operation.

8.5 All relays shall withstand a test voltage of 2 KV (rms) for one minute.

8.6 Motor starters shall be provided with three element, ambient temperature compensated, time lagged, hand reset type overload relays with adjustable settings. The setting ranges shall be properly selected to suit the motor ratings. These relays shall have a separate black coloured hand reset push button mounted on compartment door and shall have at least one changeover contact.

8.7 All fuse-protected contactor-controlled motors shall have single phasing protection, either as a distinct feature in the overload relays (by differential movement of bimetallic strips), or as a separate device. The single phasing protection shall operate even with 80% of the set current flowing in two of the phases.

9. CONTACTORS

9.1 Motor starter contactors shall be of air-break, electromagnetic type rated for uninterrupted duty as per IEC: 60947 Part 4.

9.2 Contactors shall be double break, non-gravity type and their main contacts shall be silver faced.

9.3 Direct on-line starter contactors shall be of utilisation category AC2. These contactors shall be as per IEC:60947 Part 4.

9.4 Each contactor shall be provided with two (2) normally open (NO) and two (2) normally close (NC) auxiliary contacts.

9.5 Operating coils of contactors shall be of 230V AC Unless otherwise specified elsewhere. The Contactors shall operate satisfactorily between 85% to 110% of the rated voltage. The Contactor shall drop out at 70% of the rated voltage.

10. INSTRUMENT TRANSFORMERS

10.1 All current and voltage transformers shall be completely encapsulated cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated condition and the outside ambient temperature is 50°C.

10.2 All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the associated switchgear.

10.3 All instrument transformer shall have clear indelible polarity markings. All secondary terminals shall be wired to a separate terminal on an accessible terminal block where star-point formation and earthing shall be done.

10.4 Current transformers may be multi or single core type. All voltage transformers shall be single phase type. The Bus VTs shall be housed in a separate compartment.

10.5 All VTs shall have readily accessible MCBs on both primary and secondary sides.

11. INDICATING INSTRUMENTS

11.1 All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90-degree scales, and shall have an accuracy class of 2.5 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.

11.2 All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment without removing or dismantling the instruments.

11.3 All instruments shall have white dials with black numerals and lettering. Black knife edge pointer with parallax free dials will be preferred.

11.4 Ammeters provided on Motor feeders shall have a compressed scale at the upper current region to cover the starting current.

11.5 Watt-hour meters shall be of 3 phase three element type, Maximum demand indicators need not be provided.

12. CONTROL & SELECTOR SWITCHES

12.1 Control & Selector switches shall be of rotary type with escutcheon plates clearly marked to show the function and positions. The switches shall be of sturdy construction suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred.

12.2 Circuit breaker selector switches for breaker Controlled motor shall have three stay put positions marked `Switchgear', `Normal' and `Trial' respectively. They shall have two contacts of each of the three positions and shall have black shade handles.

12.3 Ammeter and voltmeter selector switches shall have four stay put position with adequate number of contacts for three phase 4 wire system. These shall have oval handles Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondaries.

12.4 Contacts of the switches shall be spring assisted and shall be of suitable material to give a long trouble-free service.

12.5 The contact ratings shall be at least the following:

i.	Make and carry continuously	10 Amp.
ii.	Breaking current at 220 DC	1 Amp (Inductive)
iii.	Breaking current at 230 V AC	5 Amp (at 0.3 pf lagging)

13. AIR BREAK SWITCHES

13.1 Air breaker switch shall be of the heavy duty, single throw group operated, load break, fault make type complying with IEC: 60947 Part-3.

13.2 The Bidder shall ensure that all switches are adequately rated so as to be fully protected by the associated fuses during all abnormal operating conditions such as overload, locked motor, short circuit etc.

13.3 Switch operating handles shall be provided with padlocking facilities to lock them in `OFF' position.

13.4 Interlocks shall be provided such that it is possible to open the cubicle door only when the switch is in `OFF' position and to close the switch only when the door is closed. However suitable means shall be provided to intentionally defeat the interlocks explained above.

13.5 Switches and fuses for AC/DC control supply and heater supply wherever required shall be mounted inside and cubicles.

14. PUSH BUTTONS

14.1 Push-buttons shall be of spring return, push to actuate type. Their contacts shall be rated to make, continuously carry and break 10 A at 230 V and 0.5 A (inductive) at 220 DC.

14.2 All push-buttons shall have one normally open and one normally closed contact, unless specified otherwise. The contact faces shall be of silver or silver alloy.

14.3 All push-buttons shall be provided with integral escutcheon plates marked with its function.

14.4 The colour of the button shall be as follows:

i. GREEN : For motor START, Breaker CLOSE

ii. RED : For motor TRIP, Breaker OPEN

iii. BLACK : For overload reset.

14.5 All push-buttons on panels shall be located in such a way that Red-push-buttons shall always be to the left of green push-buttons.

14.6 INDICATING LAMPS

14.7 Indicating lamps shall be of the panel mounting cluster LED type. The lamps shall have escutcheon plates marked with its function, wherever necessary.

14.8 Lamps shall have translucent lamp-covers of the following colours, as warranted by the application:

i. RED :For motor ON, Breaker CLOSED

ii. GREEN :For motor OFF, Breaker OPEN

iii. WHITE :For motor Auto-Trip

iv. BLUE :For all healthy conditions (e.g. control supply, and also for 'SPRING CHARGED"

v. AMBER : For all alarm conditions (e.g. overload) Also for `SERVICE' and `TEST' positions indicators.

14.9 Lamps shall be easily replaceable from the front of the cubicle.

14.10 Indication lamps should be located just above the associated push buttons/control switches. Red lamps shall invariable be located to the right of green lamps. In case a white lamp is also provided, it shall be placed between the red and green lamps along with the centre line of control switch/push button pair. Blue and Amber lamps should normally be located above the red and green lamps.

14.11 When associated with push-buttons, red lamps shall be directly above the green push button, and green lamps shall be directly above the red push-button. All indicating lamps shall be suitable for continuous operation at 90 to 110% of their rated voltage.

15. FUSES

15.1 All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted. Fuses for AC Circuits shall be of class 2 type, 20 kA (RMS) breaking current at 400 AC, and for DC circuits Class 1 type 4 kA breaking current.

15.2 Fuses shall have visible operation indicators.

15.3 Fuses shall be mounted on fuses carriers, which are mounted on fuse bases, wherever it is not possible to mount fuses on carriers fuses shall be directly mounted on plug in type of bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchgear.

15.4 Fuse rating shall be chosen by the Bidder depending upon the circuit requirements and these shall be subject to approval of EMPLOYER.

16. TERMINAL BLOCKS

16.1 Terminal blocks shall be of 750 volts grade and have continuous rating to carry the maximum expected current on the terminals. It shall be complete with insulating barriers, clip-on-type/stud type terminals for Control Cables and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring on diagrams. It shall be similar to `ELEMEX' standard type terminals, cage clamp type of Phoenix or WAGO or equivalent

16.2 Terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall be provided with short circuiting and earthing facilities. It shall be similar to `Elem.' `CATD' - Type.

16.3 In all circuit breaker panels at least 10% spare terminals for external connections shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks. Space for adding another 10% spare terminals shall also be available.

16.4 All terminal blocks shall be suitable for terminating on each side, two (2) Nos. of 2.5 mm square size standard copper conductors.

16.5 All terminals shall be numbered for identification and grouped according to the function. Engraved white-on-black labels shall be provided on the terminal blocks.

16.6 Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.

16.7 Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks. The minimum clearance between the first row of terminal block and the associated cable gland plate shall be 250 mm.

17. NAME PLATES AND LABELS

17.1 All switchgears, AC/DC distribution boards, shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.

17.2 All name plates shall be of non-rusting metal or 3-ply lamicoid with white engraved lettering on black back ground. Inscriptions and lettering sizes shall be subject to EMPLOYER approval.

17.3 Suitable plastic sticker labels shall be provided for easy identification of all equipment, located inside the panel/module. These labels shall be positioned so as to be clearly visible and shall give the device number as mentioned in the module wiring drawings.

18. SPACE HEATER

18.1 Space heater shall be provided in all the boards for preventing harmful moisture condensation.

18.2 The space heaters shall be suitable for continuous operation on 230V AC, 50 Hz, single phase supply, and shall be automatically controlled by thermostats. Necessary isolating switches and fuses shall also be provided.

19. CONTROL AND SECONDARY WIRING

19.1 All switchboards shall be supplied completely wired internally up to the terminal blocks ready to receive Employer's control cables.

19.2 All inter cubicle and inter panel wiring and connections between panels of same switchboard including all bus wiring for AC and DC supplies shall be provided by the bidder.

19.3 All internal wiring shall be carried out with 1100 V grade, single core, 1.5 square mm or larger stranded copper wires having colour coded, PVC insulation. CT circuits shall be wired with 2.5 square mm copper wires. Voltage grade and insulation shall be same as above.

19.4 Extra-flexible wires shall be used for wiring to device mounted on moving parts such as hinged doors.

19.5 All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminals blocks.

20. POWER CABLES TERMINATION

20.1 Cable termination compartment and arrangement for power cables shall be suitable for stranded aluminium conductor, armoured XLPE/PVC insulated and sheathed, single core/three core, 1100 V grade cables.

20.2 All necessary cable terminating accessories such as Gland plates, supporting clamps and brackets, power cable lugs, hardware etc. shall be provided by the successful bidder, to suit the final cable sizes which would be advised later.

20.3 The gland plate shall be of removable type and shall cover the entire cable alley. Bidder shall also ensure that sufficient space is provided for all cable glands. For all single core cables, gland plates shall be of non-magnetic Material.

21. TYPE TESTS

Type tests reports on Panels (Switchgear and Control gear assemblies) as per IEC: 60439 Part-1 shall be submitted for the following tests in line with clause 9.0 of Chapter 2 GTR before the fabrication of switchgear is started:

i. Verification of temperature rise limits

ii. Verification of the dielectric properties

iii. Verification of short circuit strength

iv. Verification of the continuity of the protective circuit

v. Verification of clearances and creepage distances

vi. Verification of mechanical operation

vii. Verification of degree of protection

21.1 Contractor shall submit type test reports for the following Switchgear and Control gears before the fabrication of switchgear is started:

i. Circuit breakers/MCCB as per IEC: 60947 Part 2.

ii. Protective Relays as per IEC: 60255.

iii. Lighting transformers as per IEC:60076

For above equipment, test conducted once are acceptable (i.e. the requirement of test conducted within last five years shall not be applicable)

22. ERECTION, TESTING AND COMMISSIONING

22.1 The Contractor shall unload, erect, install, test and put into commercial use all electrical equipment included in this specification.

22.2 Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented. Tolerance shall be as established in Contractor's drawings or as stipulated by Employer. No equipment shall be permanently bolted down to foundations until the alignment has been checked and found acceptable by the Employer.

22.3 Contractor shall furnish all supervision, labour tools equipment rigging materials, bolts, wedges, anchors, concrete inserts etc. in proper time required to completely install, test and commission the equipment.

22.4 Manufacturer's and Employer's instructions and recommendations shall be correctly followed in handling, setting, testing and commissioning of all equipment.

22.5 Contractor shall move all equipment into the respective room through the regular door or openings specifically provided for this purpose. No part of the structure shall be utilised to lift or erect any equipment without prior permission of Employer.

22.6 All boards shall be installed in accordance with relevant code of practices and at Employer's instructions. All boards shall be installed on finished surfaces, concrete or steel stills. Contractor shall be required to install and align any channel sills which form part of foundations. In joining shipping sections of switchboards together adjacent housing of panel sections or flanged throat sections shall be bolted together after alignment has been completed. Power bus, enclosures ground and control splices of conventional nature shall be cleaned and bolted together being drawn up with torque spanner of proper size or by other approved means.

22.7 All boards shall be made completely vermin proof.

22.8 Contractor shall take utmost care in holding instruments, relaying and other delicate mechanism wherever the instruments and relays are supplied separately they shall be mentioned only after the associated panels have been erected and aligned. The packing materials employed for safe transit of instrument and relays shall be removed after ensuring that panel have been completely installed and to further movement of the same should be necessary. Any damage shall be immediately reported to Employer.

22.9 Equipment furnished with finished coats of paint shall be touched by up Contractor if their surface is specified or marred while handling.

22.10 After installation of panels, power and control wiring and connections, Contractor shall perform operational tests on all switchboards, to verify proper operation of switchboards/panels and correctness of all equipment in each and every respect. The cable opening and cables entries for cables terminating to the panels shall be sealed with fire sealing materials.

23. COMMISSIONING CHECK TESTS

The Contractor shall carry out the following commissioning checks, in addition to the other checks and tests recommended by the manufacturers.

23.1 General

i. Check name plate details according to the specification.

ii. Check for physical damage.

iii. Check tightness of all bolts, clamps, joints connecting terminals.

iv. Check earth connection.

v. Check cleanliness of insulators and bushings.

vi. Check all moving parts for proper lubrication.

vii. Check settings of all the relays.

23.2 Circuit Breakers

i. Check alignment of breaker truck for free movement.

ii. Check correct operation of shutters.

iii. Check control wiring for correctness of connections, continuity and IR values.

iv. Manual operation of breaker completely assembled.

v. Power closing/opening operation, manually and electrically.

vi. Breaker closing and tripping time.

vii. Trip free and anti-pumping operation.

viii. IR values, minimum pick up voltage and resistance of coils.

ix. Contact resistance

x. Simultaneous closing of all the three phases.

xi. Check electrical & mechanical interlocks provided.

xii. Check on spring charging motor, correct operation of limit switches, and time of charging.

xiii. All functional checks.

23.3 Current Transformers

i. Megger between winding and winding terminals to body.

ii. Polarity test

iii. Ratio identification checking of all ratios on all cores by primary injection of current.

iv. Spare CT cores, if available, to be shorted and earthed.

23.4 Voltage Transformer

i. Insulation resistance test

ii. Ratio test on all cores.

iii. Polarity test.

iv. Line connections as per connection diagram.

23.5 Cubicle Wiring

i. Check all switch developments.

ii. Each wire shall be traced by continuity tests and it should be made sure that the wiring is as per relevant drawing. All interconnections between panels/equipment shall be similarly checked.

iii. All the wires shall be meggered to earth.

iv. Functional checking of all control circuit e.g. closing, tripping control, interlock, supervision and alarm circuit.

23.6 Relays

i. Check connections and wiring.

ii. Megger all terminals to body.

iii. Megger AC to DC terminals.

iv. Check operating characteristics by secondary injection.

v. Check minimum pick up voltage of DC coils.

vi. Check operation of electrical/mechanical targets

vii. Relays settings.

viii. Check CT and VT connections with particular reference to their polarities for directional relays, wherever required.

23.7 Meters

i. Check calibration by comparing it with a sub-standard.

ii. Megger all insulated portions.

iii. Check CT and VT connections with particular reference to their polarities for power type meters.

23.8 SPECIAL TOOLS AND TACKLES

i. The Bidder shall include in his proposal any special tools and tackles required for erection, testing commissioning and maintenance of the equipment offered.

ii. The list of these special tools and tackles shall be given in the bid proposal sheets along with their respective prices.

iii. The total price of the special tools and tackles shall be included in proposal sheets.

23.9 EQUIPMENT TO BE FURNISHED

23.9.1 The Bidder shall quote for various AC/DC distribution boards in accordance with this specification.

23.9.2 Standard scheme of interconnection of switchboards and distribution boards along with tentative feeder disposition for each board is indicated in Standard SLD of AC & DC system enclosed along with bid documents. The bidder shall quote board prices on the basis of standard SLD and their estimation of feeders for entire present and future bays requirement. Any other feeder required as per system requirement for efficient and reliable operation shall be deemed to be included in bidder's scope.

23.9.3 The Bill of Materials for each type of module shall be as under. These are minimum indicative requirement of the system. The necessary auxiliary relays, push buttons and indicating lamps shall be provided as per scheme requirement. Any other item/component required with in a module for efficient and reliable operation shall be deemed to be included in bidder's scope.

23.9.4 Module Type AE (Electrically controlled circuit breaker for incoming and Bus Coupler Circuit).

i. One (1) Triple pole air circuit breaker complete with all accessories and power operated mechanism as specified.

ii. Two (2) Neutral link.

iii. Three (3) Current Transformer for metering.

iv. One (1) Ammeter with selector switch.

v. Three (3) Current Transformer for relaying.

vi. One (1) Triple pole instantaneous over-current relay having the setting range of 200-800% or 500-2000% of CT secondary and adjustable definite minimum time.

vii. One (1) Instantaneous earth fault relay having an adjustable setting range of 10-40% or 20 - 80% of CT secondary current and adjustable definite minimum time. The earth fault relay shall be provided with a stabilizing resistor.

viii. One (1) set Current and Voltage transducers.

ix. One (1) set High speed tripping relays.

23.9.5 Module Type - M1 (Circuit Breaker Controlled Motor Feeder)

i. One (1) Triple pole Air Circuit Breaker complete with accessories, and power operated mechanism as specified.

ii. One (1) three position 6 pole selector switch 'SWITCHGEAR/NORMAL /TRIAL'.

iii. Three (3) Current Transformer for metering.

iv. One (1) Ammeter with Ammeter Selector Switch

v. Three (3) Current Transformer for relaying.

vi. One (1) Triple pole instantaneous over-current relay for providing positive sequence current protection in all the three phases. The relay setting range shall be continuously adjustable between 200-800% or 400-1600% of CT secondary rated current as required.

vii. One (1) Double pole inverse definite minimum time over current relays connected in R & B phases for over current protection of motor rated 110 kW - 200 kW. The relay shall have an adjustable setting range of 50% - 200% of CT Secondary current and time setting range of 0-30 Second. The relay shall be CDGM-22 of EE or equivalent.

viii. One (1) Single pole adjustable definite time delay relay for motor overload alarm connected in Y-phase only. The relay shall have resetting ratio of not less than 90%. The relay shall have continuously adjustable time delay range of 2.5 to 25 Sec.

ix. One (1) Instantaneous earth fault relay having an adjustable setting range of 10-40% or 20-80% of CT secondary current. The earth fault relay shall be provided with a stabilising resistor.

x. One (1) set Current and Voltage transducers.

xi. One (1) set High speed tripping relay.

23.9.6 Module Type E

One (1) Four pole MCCB

23.9.7 Module G-1 (VT Module with under Voltage Relay)

i. Three (3) $\underline{400}/\sqrt{3}$ $\underline{110}/\sqrt{3}$ volts single phase voltage transformer star/star

ii. Connect with star point solidly earthed mounted on common draw out chassis. Accuracy Class 0.5 for protection and Accuracy class 0.3 metering with 50VA Burden.

iii. Six (6) HRC Fuses mounted on the above chassis.

iv. One (1) Four position voltmeter selector switch.

v. One (1) Voltmeter (0-500V)

vi. One (1) Double pole instantaneous under voltage relays with continuous variable setting range of 40-80% of 110 Volts.

vii. One (1) Time delay pick up relay having a time setting range of 0.5 to 3 secs. with 3 `NO'. Self-reset contacts, suitable for 220 DC.

viii. One (1) Auxiliary relay 220 DC with 2 NO. Self-reset contacts.

ix. Three (3) Indicating lamps with series resistor and color lenses (Red, Blue & Yellow).

23.9.8 Module Type G-2

x. Three (3) HRC Fuse

xi. One (1) Voltmeter (0-500V)

xii. One (1) Voltmeter selector switch four position (R-Y, Y-B, B-R OFF).

xiii. Three (3) Indication lamps (Red, Blue & Yellow)

23.9.9 Module Type H & H (BC) (Isolating Switch Controlled Incoming Circuit)

i. One (1) Four pole MCCB

ii. One (1) Red Indicating lamp to indicate isolating switch closed position.

23.9.10 Module Type S: (DC Metering and Protection Module)

i. One (1) Voltmeter 300-0-300 V DC for 220 DC DB/Voltmeter 0-75 V DC for 50 V DCDB

ii. One (1) Three (3) position voltmeter selector switch

iii. One (1) Instantaneous under voltage relay with 95% of 220 DC. The resetting ratio of relay of relay should not be more than 1.25. The relay shall be provided with a series resistor and a push button across if for resetting (pick up) the relay at about 105% of the drop out voltage.

iv. One (1) Instantaneous over voltage relay with setting range of 110% of 220 DC. The resetting ratio of relay should not be less than 0.8. The relay shall have a push button in series of resetting the relay at about 95% of the operating voltage.

v. One (1) Earth leakage relay only for 220 DC system having adjustable pick up range between 3 to 7 milliamps the relay shall be suitable for 220 DC/230V AC Auxiliary supply.

23.9.11 Module Type X

One (1) Double pole 250 V MCB/ MCCB suitable for 20kA for 1 sec. Fault level

23.9.12 Module Type-DC (Incomer from Battery & Chargers)

i. One (1) Double pole 250V DC MCCB for incomer from Battery.

ii. One (1) DC ammeter with shunt and range of 90-0-400 Amps. For 220 DC DB and 90-0-200 Amp for 50V DC DB.

iii. Two (2) Double pole 250V DC MCCB/MCB

iv. One (1) Double pole single throw 250V DC air break switch connecting battery & charger sections to DC DB.

v. One (1) set Voltage and Current Transducers

23.9.13 Module Type H1

One (1) Double pole DC Switch with pad locking facility in off position.

23.9.14 Module Type EL

i. One (1) Four pole MCCB

ii. One (1) Contactor

iii. Electronic Timer suitable for continuous operation, push button and selector switch be as per scheme requirement

23.10 PARAMETERS

23.11 Power Supply

23.11.1 AC System: 3 phases, 4 wire, solidly earthed

i. Voltage 400 Volts, ± 10%

ii.	Frequency	50 Hz ± 2.5%
iii.	Combined variation	± 105% Absolute Sum in Voltage & frequency
iv.	Fault Level	20 kA (rms)

23.11.2 **DC System**: 2 Wire, unearthed

i.	System voltage	220 ± 10
ii.	Fault Level	4 kA

23.11.3 Control Supply Voltage

i.	Trip and closing coils	220 DC Unearthed
ii.	Spring charging	220 DC Unearthed

23.11.4 Cubicle Data

23.11.4.1 Busbar Rating

1.	Continuous for Vertical panels	As specified in Standard SLD For AC & DC system.
2.	Short time (1 sec. kA (rms)	20 kA
3.	Momentary (kA) PEAK	45 kA
4.	Ambient Temperature	50°C
5.	One Minute Power Frequency Withstand	
	Power Circuit	2500 Volts (rms)
	Control Circuit	2500 Volts (rms)

23.11.4.2 Cubicle Colour Finish

i.	Interior	Smoke Grey shade No.692
ii.	Exterior	Smoke Grey Shade No.692

23.11.5 Circuit Breaker

1.	Type	Air Break
2.	No. of poles	3
3.	Voltage & Frequency	400 Volts, ± 10%, 50 HZ + 2.5%
4.	Rated Operating Duty	As per IEC
5.	Rated service short-circuits Breaking capacity (Ics)	20 kA (RMS)
6.	Short Circuit making current	45 kA (Peak)

7.	Short time withstand current for 1 sec duration.	20 kA (RMS) for 1 sec.
8.	Operating Mechanism current for 1 sec. duration.	20 kA (RMS) for 1 sec.
9.	No. of auxiliary contacts	4 NO & 4 NC contacts for Employer's use on fixed portion of the cubicle
10	Short Circuit breaking current	
	AC Component	20 kA (RMS
	DC Component	As per IEC: 60947 (Part 2)

23.11.6 MOULDED CASE CIRCUIT BREAKER

		AC System	DC System
i.	No. of poles	4	2
ii.	Voltage & Frequency	400 Volts, ± 10% 50 HZ ± 2.5%	250V
iii.	Rated Operating Duty	As per IEC	
iv.	Rated service short - circuit	20 kA (RMS)	4 kA
v.	Breaking capacity (Ics)		
vi.	Short Circuit making current	45 kA (Peak)	
vii.	No. of auxiliary Contacts (only for incomer and bus-coupler MCCBs)		
		1 NO &1 NC	1NO &1 NC
viii.	Rated Ultimate Short Circuit breaking capacity		
	AC Component	20 kA (RMS)	As per IEC
	DC Component	As per IEC 60947	As per IEC 60947

23.11.7 Meters

i.	Accuracy class	2.5
ii.	One minute power frequency withstand test voltage in KV	2.0

23.11.8 Current Transformers

SN	Particular	Type
1	type	Cast rasin , bar primary
2	Voltage class and frequency	650V, 50 Hz
3	Class of Insulation	Class E or Better

4	Accuracy class metering CT	Class 1, VA adequate for application but not less than 7.5 VA
5	Accuracy Class Protection CT	5P15, VA adequate for application but not less than 7.5 VA
6	Short time current rating (for CTs associated with CBs) Current Duration Dynamic rating One minute power frequency withstand test voltage	 20 kA RMS 1 second 45 kA Peak 2.5 kV RMS

23.11.9 Voltage Transformer

SN	Particular	Type
1	type	Cast rasin , bar primary
2	Rated Voltage Primary Secondary	 400/√3 V 110/√3 V
3	Method of connection Primary Secondary	 Star Star
4	Class of Insulation	Class E or Better
5	Rated voltage factor	1.1 continuous, 1.5 for 3 seconds
4	Accuracy class	0.5, not less than 20VA
6	One minute power frequency withstand test voltage	2.5 kV RMS

23.11.10 Relay

One minute power Frequency withstand test 2 kV (rms)

23.11.11 Transducers (1 phase)

i. Operating Voltage 220 DC

ii. I/P 1

iii. O/P 4-20 mA

iv. Type Analogue

23.12 AUTOMATIC CONTROL OF OUTDOOR LIGHTING

EL-type module of 400V Main lighting distribution board and Emergency lighting distribution board and shall be controlled by timer and contactor module to facilitate its operation automatically.

23.13 ANALOGUE INPUTS

LT System shall have provision of following analogue inputs for Employer's substation automation purpose. These analogue inputs shall be generated by distinct transducers to be provided in respective modules. These inputs shall be wired up to respective terminal blocks.

ANALOGUE INPUTS:

i. Voltage R-Y, Y-B, B-R of Main Switch Board section-I
ii. Voltage R-Y, Y-B, B-R of Main Switch Board section-II
iii. Current from LT transformer-I
iv. Current from LT transformer-II
v. Voltage of 220 DCDB-I
vi. Voltage of 220 DCDB-II
vii. Current from 220 Battery set-I
viii. Current from 220 Battery set-II
ix. Voltage of 48V DCDB-I
x. Voltage of 48V DCDB-II
xi. Current from 48V Battery set-I
xii. Current from 48 V Battery set-II

23.14 DIGITAL (Potential Free) INPUTS:

System shall have provision of following digital inputs for Employer's substation automation purpose. These digital inputs shall be made available in the form of potential free contacts to be provided in respective modules. These potential free contacts shall be wired up to respective terminal blocks.

i. Main (MSB) Incomer-I breaker On/Off
ii. Main (MSB) Incomer-II breaker On /Off
iii. Main (MSB) 400V Bus-I/II U/V
iv. Main (MSB) bus coupler breaker on/off
v. LT transformer-I WTI Alarm & trip
vi. LT transformer-II WTI Alarm & trip
vii. LT transformer-I OTI Alarm & trip
viii. LT transformer-II OTI Alarm & trip
ix. 220 V DC-I earth fault
x. 220 DC-II earth fault

CHAPTER 8

BATTERY AND BATTERY CHARGER

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CHAPTER 8: BATTERY AND BATTERY CHARGER

1. GENERAL TECHNICAL REQUIREMENTS

1.1 All materials/components used in battery chargers and batteries shall be free from flaws and defects and shall conform to the relevant Indian/IEC standards and good engineering practice.

1.2 DC System shall consist of two (2) float-cum-boost chargers with capacity 150A and two (2) battery sets 800Ah for 220V system. The standard scheme drawing is enclosed with this specification. For equipment requiring 48 V DC, employer will provide the source and rest of other arrangement should be done by the contractor.

1.3 Bidder shall select number of cells, float and Boost voltage to achieve following system requirement:

System Voltage	Maximum Voltage during Float operation	Maximum Voltage during Boost operation	Minimum voltage available when no charger working and battery fully discharged up to 1.85 V per cell.	Minimum Nos of cell
220 Volt	242 Volt	302 Volts	198 Volt	107

Bidder shall furnish calculation in support of battery sizing, selection of number of cells, float and Boost voltages during detailed engineering for Employer's acceptance.

Battery sizing calculations shall be done as per IEEE- 485 on the basis of following duty cycle:

	Load	**Duration**	**Type of Loads**
220 V DC System	Continuous Load	3 hours	Relays, IEDs, Station HMIs, spring charging, Isolator interlocking load, Miscellaneous permanently connected loads etc.
	Emergency Load	1 hour	Substation emergency lighting loads.
	Momentary Load	1 minute	Breaker closing, Tripping loads (taking simultaneous occurrence as per system)

2. BATTERY

2.1 Type

The DC Batteries shall be VRLA (Valve Regulated Lead-Acid) type and shall be Normal Discharge type. These shall be suitable for a long life under continuous float operations and occasional discharges. Air-conditioning shall be provided in Battery room the requirement of which has been specified elsewhere in the Technical Specification. The 220 V DC system is unearthed system.

2.2 Constructional Requirements

The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted.

Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/electrical connections.

2.3 Containers

The container material shall have chemical and electro-chemical compatibility and shall be acid resistant. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. The container shall be fire retardant and shall have an Oxygen Index of at least 28 %. The porosity of the container shall be such as not to allow any gases to escape except from the regulation valve. The tensile strength of the material of the container shall be such as to handle the internal cell pressure of the cells in the worst working condition. Cell shall not show any deformity or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigours of transport, storage and handling. The containers shall be enclosed in a steel tray.

2.4 Cell Covers

The cell covers shall be made of suitable material compatible with the container material and permanently fixed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant. Fixing of Pressure Regulation Valve & terminal posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electro-static spark are prevented.

2.5 Separators

The separators used in manufacturing of battery cells, shall be of glass mat or synthetic material having high acid absorption capability, resistant to sulphuric acid and good insulating properties. The design of separators shall ensure that there is no misalignment during normal operation and handling.

2.6 Pressure Regulation Valve

Each cell shall be provided with a pressure regulation valve. The valve shall be self-re-sealable and flame retardant. The valve unit shall be such that it cannot be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

2.7 Terminal Posts

Both the +ve and –ve terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both +ve and –ve posts shall be clearly and unambiguously identifiable.

2.8 Connectors, Nuts & Bolts, Heat Shrinkable Sleeves

Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably lead coated to withstand corrosion due to sulphuric acid at a very high rate of charge or discharge.

Nuts and bolts for connecting the cells shall be made of copper, brass or stainless steel. Copper or brass nuts and bolts shall be effectively lead coated to prevent corrosion. Stainless steel bolts and nuts can be used without lead coating.

All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

2.9 Flame Arrestors

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

2.10 Battery Bank Stand

All batteries shall be mounted in a suitable metallic stand/frame. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand.

2.11 Capacity Requirements

When the battery is discharged at 10-hour rate, it shall deliver 80% of C (rated capacity, corrected at 27º Celsius) before any of the cells in the battery bank reaches 1.85V/cell.

The battery shall be capable of being recharged from the fully exhausted condition (1.75V/cell) within 10 hrs up to 90% state of charge. All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life.

The capacity (corrected at 27ºCelcius) shall also not be less than C and not more than 120% of C before any cell in the battery bank reaches 1.75V/cell. The battery voltage shall not be less than the following values, when a fully charged, battery is put to discharge at C/10 rate:

i. After Six minutes of discharge : 1.98V/cell

ii. After Six hours of discharge : 1.92V/cell

iii. After 8 hours of discharge : 1.85V/cell

iv. After 10 hours of discharge : 1.75V/cell

Loss in capacity during storage at an average ambient temperature of 35º Celcius for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within 0.05V of the average voltage throughout the storage period. Ampere hour efficiency shall be better than 90% and watt hour efficiency shall be better than 80%.

2.12 Expected Battery Life

The battery shall be capable of giving 1200 or more charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27º Celsius. DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-hour) removed from a cell or battery on discharge to its rated capacity. The battery sets shall have a minimum expected life of 20 years at float operation.

2.13 Routine Maintenance of Battery system

For routine maintenance of battery system, the contractor shall supply 1 set of following tools:

a. Torque wrench.

b. Cell test voltmeter (-3-0-+3) volts with least count of 0.01 Volt.

2.14 Type Test of Battery

2.14.1 Contractor shall submit type test reports of following tests as per IEC 60896-21 & IEC 60896-22, 2004. The type test reports shall be submitted in accordance with the requirements stipulated in Technical Specification, Chapter 2: GTR except that the requirement of tests having been conducted within last five years as mentioned therein shall not be applicable.

SN	Description of test
1.	Gas emission
2.	High current tolerance
3.	Short circuit current and d.c. internal resistance
4.	Protection against internal ignition from external spark sources
5.	Protection against ground short propensity
6.	Content & durability of required markings
7.	Material identification
8.	Valve operation
9.	Flammability rating of materials
10.	Intercell connector performance
11.	Discharge Capacity
12.	Charge retention during storage
13.	Float service with daily discharges for reliable mains power
14.	Recharge behaviour
15.	Service life at an operating temperature of 40^0 C for brief duration exposure time.
16.	Impact of a stress temperature of 60^0 C for brief duration exposure time with 3 h rate discharge test.
17.	Abusive over-discharge
18.	Thermal runaway sensitivity
19.	Low temperature sensitivity
20.	Dimensional sensitivity at elevated internal pressure and temperature
21.	Stability against mechanical abuse of units during installation

Tests shall be conducted in accordance with IEC 60896-21 & IEC 60896-22, 2004.

2.14.2 List of Factory & Site Tests for Battery

SN	Test	Factory Tests	Site Tests
1.	Physical Verification		√
2.	C/10 Capacity test on the cell	√	
3.	8 Hrs. Charge and 15 minutes discharge test at full rated load		√

2.15 Installation and commissioning

2.15.1 Manufacturer of Battery shall supervise the installation and commissioning and perform commissioning tests as recommended in O&M manual / or relevant standards. All necessary instruments, material, tools and tackles required for installation, testing at site and commissioning are to be arranged by Battery manufacturer/ Contractor

i. Contractor shall be submitted following documents for approval:

ii. Data sheet as per Annexure-I

iii. GA of cell and layout drawing

iv. Discharge Data for 10 Hour, 8 Hour, 3 Hour, 2 Hour, 1 Hour, 15 Minutes and One Minute indicating capacity factors for end cell voltage of 1.75 V & 1.85 V.

v. Temperature correction factors

vi. Installation and commissioning Instructions

vii. O & M Manual

3. BATTERY CHARGER

The DC system for 220V DC is unearthed. The Battery Chargers having capacity 150 Ampere as well as their automatic regulators shall be of static type and shall be compatible with offered VRLA batteries. All battery chargers shall be capable of continuous operation at the respective rated load in float charging mode, i.e. Float charging the associated Lead-Acid Batteries at 2.13 to 2.27 Volts per cell while supplying the DC load. The chargers shall also be capable of Boost charging the associated DC Battery at 2.28 to 2.32 volts per cell at the desired rate.

Charger shall regulate the float/boost voltage in case of prescribed temperature rise of battery as per manufacturer's recommendation to avoid thermal runaway. Necessary temperature sensors shall be provided in mid location of battery banks and shall be wired up to the respective charger for feedback control. The manufacturer shall demonstrate this feature during testing of each charger.

3.1 All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. When on automatic control mode during Float charging, the Charger output voltage shall remain within ±1% of the set value, for AC input voltage variation of ±10%, frequency variation of ±2.5%, a combined voltage and frequency variation of ±10%, and a DC load variation from zero to full load.

3.2 All battery chargers shall have a constant voltage characteristic throughout the range (from zero to full load) at the floating value of the voltage so as to keep the battery fully charged but without harmful overcharge.

3.3 All chargers shall have load limiters having drooping characteristic, which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the Load limiter setting of the Charger. The Load-limiter characteristics shall be such that any sustained overload or short circuit in DC System shall not damage the Charger, nor shall it cause blowing of any of the Charger fuses. The Charger shall not trip on overload or external short circuit.

3.4 Uniform and step less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire float charging output range specified. Step less adjustments of the Load-limiter setting shall also be possible from 80% to 100% of the rated output current for charging mode.

3.5 During Boost Charging, the Battery Charger shall operate on constant current mode (when automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode.

3.6 The Charger output voltage shall automatically go on rising, when it is operating on Boost mode, as the Battery charges up. For limiting the output voltage of the Charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage anywhere in the output range specified for Boost Charging mode.

3.7 The Charger manufacturer may offer an arrangement in which the voltage setting device for Float charging mode is also used as output voltage limit setting device for Boost charging mode and the Load-limiter of Float charging mode is used as current setting device in boost charging mode.

3.8 Suitable filter circuits shall be provided in all the chargers to limit the ripple content (Peak to Peak) in the output voltage to 1%, irrespective of the DC load level, when they are not connected to a Battery.

3.9 MCCB

All Battery Chargers shall have 2 Nos. MCCBs on the input side to receive cables from two sources. Mechanical interlock should be provided such that only one shall be closed at a time. It shall be of P2 duty and suitable for continuous duty. MCCB's should have auxiliary contacts for annunciation.

3.10 Rectifier Transformer

The rectifier transformer shall be continuously rated, dry air cooled (A.N) and of class F insulation type. The rating of the rectifier transformer shall have 10% overload capacity.

3.11 Rectifier Assembly

The rectifier assembly shall be fully/half-controlled bridge type and shall be designed to meet the duty as required by the respective Charger. The rectifier shall be provided with heat sink having their own heat dissipation arrangements with natural air cooling. Necessary surge protection devices and rectifier type fast acting HRC fuses shall be provided in each arm of the rectifier connections.

3.12 Instruments

One AC voltmeter and one AC ammeter along with selector switches shall be provided for all chargers. One DC voltmeter and DC ammeter (with shunt) shall be provided for all Chargers. The instruments shall be flush type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustment. The instruments shall be of 1.5 accuracy class. In addition to the above a centre zero voltmeter with selector switch shall also be provided for 220 V chargers for testing purpose.

3.13 Air Break Switches

One DC output switch shall be provided in all chargers. They shall be air break type suitable for 500 volts AC/ 250 DC. The contacts of the switches shall open and close with a snap action. The operating handle of the switch shall be fully insulated from circuit. `ON' and `OFF' position on the switch shall be clearly indicated. Rating of switches shall be suitable for their continuous load. Alternatively, MCCB's of suitable ratings shall also acceptable in place of Air Break Switch.

3.14 Fuses

All fuses shall be HRC Link type. Fuses shall be mounted on fuse carriers which are in turn mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type base. In such case one insulated fuse pulling handle shall be supplied for each charger. Fuse rating shall be chosen by the Bidder depending on the circuit requirement. All fuses in the chargers shall be monitored. Fuse failure annunciation shall be provided on the failure of any fuse.

3.15 Blocking Diode

Blocking diode shall be provided in the positive pole of the output circuit of each charger to prevent current flow from the DC Battery into the Charger.

3.16 Annunciation System

i. Audio-visual indications through bright LEDs shall be provided in all Chargers for the following abnormalities:

ii. AC power failure

iii. Rectifier/chargers fuse blown.

iv. Over voltage across the battery when boost charging.

v. Abnormal voltage (High/Low)

vi. DC fail.

vii. Any other annunciation if required.

Potential free NO Contacts of above abnormal conditions shall also be provided for common remote indication "CHARGER TROUBLE" in Employer's Control Board. Indication for charger in float mode and boost mode through indication lamps shall be provided for chargers. A potential free contact for float/boost mode shall be provided for external interlocks.

3.17 Name Plates and Marking

The name plates shall be white with black engraved letters. On top of each Charger, on front as well as rear sides, larger and bold name plates shall be provided to identify the Charger. Name plates with full and clear inscriptions shall also be provided on and inside of the panels for identification of the various equipment and ease of operation and maintenance.

3.18 Charger Construction

The Chargers shall be indoor, floor-mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Chargers shall be fabricated from 2.0mm cold rolled sheet steel and shall have folded type of construction. Removable gland plates for all cables and lugs for power cables shall be supplied by the Contractor. The lugs for power cables shall be made of electrolytic copper with tin coat. Power cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and drilling of gland plates. The Charger shall be tropicalised and vermin proof. Ventilation louvers, if provided shall be backed with screens. All doors and covers shall be fitted with synthetic rubber gaskets. The chargers shall have hinged double leaf doors provided on front and on backside for adequate access to the Charger's internals. All the charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be at least IP-42 as per IEC:-60947 Part 1.

3.18.1 All indicating instruments, control switches and indicating lamps shall be mounted on the front side of the Charger.

3.18.2 Each Charger shall be furnished completely wired upto power cable lugs and terminal blocks and ready for external connections. The control wiring shall be carried out with PVC insulated, 1.5 sq.mm. Stranded copper wires. Control terminals shall be suitable for connecting two wires, with 2.5 sq.mm stranded copper conductors. All terminals shall be numbered for ease of connections and identification. Each wire shall bear a ferrule or tag on each end for identification. At least 20% spare terminals shall be provided for control circuits.

3.18.3 The insulation of all circuits, except the low voltage electronic circuits shall withstand test voltage of 2 KV AC for one minute. An air clearance of at least ten (10) mm shall be maintained throughout for such circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

3.19 Painting

All sheet steel work shall be pre-treated, in tanks, in accordance with IEC/International Standards. Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be in accordance with IEC/International Standards. Welding shall not be done after phosphating. The phosphating surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint of shade-692 (smoke grey) shall be applied, unless required otherwise by the Employer. The inside of the chargers shall be glossy white. Each coat of finishing synthetic enamel paint shall be properly staved. The paint thickness shall not be less than fifty (50) microns.

4. UPS SYSTEM

4.1 DC/AC inverters shall employ fully static elements such as single or three phase inverters or diodes with pulse width modulation. By suitable bias control signal, the direct current shall be chopped into a series of rectangular pulses passes through a filter (leakage inductance and capacitance) to obtain a sinusoidal voltage with low content of higher harmonics. By varying the pulse width of chopped DC blocks, the Ac output voltage shall kept constant in a wide range despite varying the DC input voltage on the AC load (Pulse-width modulation principle) other control principle shall also acceptable if providing the same result; they shall be subject to approval of the Employer. The static inverters shall be natural air cooled type. The normal power source to the inverters shall be DC from the DC auxiliary supply system.

4.2 Beside the normal DC power source, every inverters shall be equipped with a stand-by feeder connected to the AC mains with a matching and decoupling transformer and a static operation shall be:

4.2.1 Stand –by Operation

The load is fed by the AC stand –by feeder. The inverters is neither connected to the DC nor to the AV side.

4.2.2 Test Operation

The load is fed by the AC stand –by feeder. The inverters is connected to the DC system. It shall be possible to manually initiating automatic load transfer from the stand –by feeder to the inverter and vice versa without AC voltage interruption.

4.2.3 Normal Operation

The load is fed by the inverter. Upon loss of the inverter output, the AC load shall be automatically transferred by the SBS without AC voltage interruption to the stand –by feeder.

In the event of automatic transfer of the load to the bypass circuit and subsequent restoration of the inverter output quantities within the permissible tolerance, automatic retransfer to inverter shall be carried out. Manual transfer shall also be possible.

The two UPS system (2*100%) shall be equipped with all necessary facilities to work in parallel in 50% load-sharing mode.

4.3 Dependent on the mode of operation the inverter frequency shall be controlled either by the AC mains of by an oscillator (frequency generator) which shall be part of the inverter. The inverter frequency control shall be automatically match frequency and time phase of the inverter output voltage to the standby voltage within the permissible limits at any instant prior to load transfer. A lock-out circuit shall be included to prevent automatic transfer to the stand-by AC power supply if source voltage is not available.

4.4 The inverter AC output circuit shall be short circuit proof i.e. the commutation circuit shall be designed that the thyrister stack fuses are not blowing at short circuit conditions. After the transient inrush, the short circuit current shall be limited to maximum of 4 times the rated AC current. The inverter shall continue to automatically provide reduced voltage during short-circuit or overload condition and to arise it automatically upon its removal.

4.5 An input filter shall be provided to avoid noise feedback from the inverter in to the DC input. This filter shall also prevent voltage surges from the battery disturbing the inverter.

4.6 When de-energised, the inverter as well as the stand by source shall withstand without trip the transient inrush current.

4.7 The UPS system shall comprise digital, microprocessor controlled units providing the following feature:

i. Control of the power circuits;

ii. Control of the thyristors;

iii. Monitoring and self-diagnostic function;

iv. Display of AC/DC voltage and current ,frequency;

v. Indication of operation mode and alarms;

vi. Treatment of measuring values, status and alarm units;

vii. Interface to CCS.

4.8 Cubicles shall be floor mounted, self-supporting type with hinged front rear doors, protection class IP 41.

4.9 The switchboards shall be equipped with all necessary circuit breakers, contractor, load break switch, MCB, measuring instruments (V/A/Hz), transducers voltage monitoring devices and interface units.

5. TESTS

5.1 Battery chargers shall conform to all type tests as per relevant International Standard. Performance test on the Chargers as per Specification shall also be carried out on each Charger as per specification. Rectifier transformer shall conform to all type tests specified in IEC: 60146 and short circuit test as per IEC:60076. Following type tests shall be carried out for compliance of specification requirements:

i. Voltage regulation test

ii. Load limiter characteristics test

iii. Efficiency tests

iv. High voltage tests

v. Temperature rise test

vi. Short circuit test at no load and full load at rated voltage for sustained short-circuit.

vii. Degree of protection test

viii. Measurement of ripple by oscilloscope.

ix. Temperature compensation feature demonstration

5.1.1 The Contractor may be required to demonstrate to the EMPLOYER that the Chargers conform to the specification particularly regarding continuous rating, ripple free output, voltage regulation and load limiting characteristic, before dispatch as well as after installation at site. At site the following tests shall be carried out :

i. Insulation resistance test

ii. Checking of proper annunciation system operation.

5.1.2 If a Charger fails to meet the specified requirements, the Contractor shall replace the same with appropriate Charger without affecting the commissioning schedule of the Sub-station, and without any extra cost to the EMPLOYER.

5.1.3 The Contractor shall present for inspection, the type and routine test certificates for the following components whenever required by the EMPLOYER.

i. Switches.

ii. Relays/ MCCBs

iii. Instruments.

iv. DC fuses.

v. SCR.

vi. Diodes.

vii. Condensers.

viii. Potentiometers.

ix. Semiconductor

x. Annunciator.

xi. Control wiring

xii. Push buttons and contactors.

Makes of above equipment shall be subject to Employer's approval.

CHAPTER 9

LIGHTING SYSTEM

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CHAPTER 9: LIGHTING SYSTEM

1. LIGHTING SYSTEM

1.1 LIGHTING SYSTEM FOR SUBSTATION

The scope of work comprises of design, engineering, testing, supply, installation, testing and commissioning of various lighting fixtures complete with lamps, supports and accessories, ceiling fans complete with electronic regulators, exhaust fans for toilets and pantry & accessories, lighting panels, lighting poles complete with distribution boxes, galvanized rigid steel /rigid PVC conduits, lighting wires, G.I. Earth wire, receptacles, tag block & telephone socket, switchboards, switches, junction boxes, pull out boxes complete with accessories, for control room cum administrative building, switchyard panel room, Auxiliary building/Transit Camp, Fire Fighting pump house, Switchyard and street lighting.

The entire control room building, firefighting pump house and Transit camp lighting shall be done by LED based low power consumption luminaries to achieve desired lux level specified. The bidder shall quote on lump sum basis on the basis of design criteria specified for each control room building, Transit Camp and firefighting pump house.

1.2 SYSTEM DESCRIPTION

The lighting system shall comprise of the following:

1.2.1 AC Normal Lighting

AC lights will be connected to AC lighting panels. All the lights connected to the AC lighting system in different areas will be connected to the main lighting distribution boards.

1.2.2 AC Emergency Lighting

This system will be available in control room building, firefighting pump house, & switchyard. AC lighting load will be connected to this system which will be normally 'ON'. The lighting panels of this system will be connected to the Emergency lighting board which is fed from diesel generator during the emergency. 25% of lighting fixtures shall be connected on AC emergency lighting.

1.2.3 D.C. Emergency lighting

A few DC emergency lighting fixtures operated on the DC system will be provided in the strategic locations including staircase, corridors, electrical rooms, Battery charger room, LT switchgear room in control room building, and Firefighting pump house so that the operating personnel can safely find their way even during emergency of a total AC failure. These lights will be normally 'OFF' and will be switched 'ON' automatically when under voltage occurs in the AC main lighting distribution board. GLS lamp down lighters in false ceiling area and Bulkhead fixtures in non-false ceiling area to be used.

1.2.4 Exit Lightings

All Exit lightings in the buildings shall be fed by DC lighting panels. All necessary wiring and its termination shall be in the contractor's scope.

1.3 The lighting layout for and around Control Room Cum Administrative Office Building & Firefighting Pump House indicating the type & BoQ for items shall be prepared and submitted by the contractor for employer's approval during detailed engineering.

The lux levels to be maintained in the switchyard shall be as per following:

S N	Area	Average Lux Level
1.	Control Room Building, Firefighting pump house, Transit Camp	**Area Average Lux level at floor level** i) Control Room & Conference room - 350 Lux ii) Battery room, Passage, Pantry, Toilets, Corridors etc. - 100 Lux iii) All other rooms -200 Lux
2.	Switchyard	-50 lux on main equipment (i.e., Transformer, Reactor ISO, CB, CT, CVT, SA) at first level (Equipment connections level.) -20 lux on balance area of switchyard and street / Road at ground level. -10 lux (Area between fence and peripheral roads around the switchyard). The lighting between the fence and the peripheral road around switchyard shall be done by providing the lighting fixtures on lighting pole of suitable height, if required.

The minimum lux level to average lux level ratio should not be less than 0.6 (i.e Emin/Eav>0.6). The maintenance factor for indoor illumination design shall be considered as 0.8. The surface reflectance for ceiling/wall/floor shall be 50/30/10

For achieving the specified lux levels in the switchyard, the contractor can provide luminaries of 1x400 W/1x250 W and 2x400 W/ 2x250 W flood light as per requirement.

The contractor shall submit detailed calculation for reaching the above Lux level. Contractor shall conform the Lux levels at different locations of the switch yard and street lighting by measurement.

In addition to the normal lighting provided in the switchyard area to maintain the desired lux levels, high beam fixtures (Type SF4- 8 nos) on swivel support shall be provided in strategic locations near equipment for new substations which shall be kept normally OFF and these shall be switched ON in case of maintenance work.

1.3.1 Ceiling fans (1400 mm sweep, AC 230 Volts) shall be provided in, firefighting pump house and non-AC rooms in the control room building and all the rooms in transit camp building & residential quarters as per the requirements. Wall mounted fans shall be provided in the conference room, control room, shift manager and substation in-charge rooms in control room building. Exhaust fans shall be provided in toilets and pantry.

1.3.2 One no. of aluminum ladder of each size shall be supplied by the contractor for maintenance purpose.

1.3.3 The following specific areas are included in the scope of lighting:

i. Switchyard Area.

ii. Switchyard Control Room cum Administrative Office Building

iii. Firefighting pump house

iv. Street lighting (peripheral) inside switchyard fencing (Street lighting shall be

done using street lighting poles)

v. DG area lighting

vi. LT Transformer area

vii. Transit Camp

viii. Residential quarters

ix. GIS building (including panel rooms)

1.3.4 For Outdoor Illumination

The switchyard and street lighting design including lux level calculations, surface illuminance diagram at varying equipment surface levels, detailed drawings showing the lighting layout and Electrical distribution diagram and BOQ for items shall be prepared by the Contractor and submitted for approval. The above layout drawings will include disposition and location of lighting fixtures, receptacles, etc.

1.3.5 For Indoor Illumination

The conduit layout drawing for substation buildings, Electrical distribution diagram for substation buildings, & for substation yard etc. shall be prepared by the Contractor. All wiring including telephone wiring (tinned two pair copper) shall be in concealed conduit. Concealed MS junction boxes for sockets and light points shall be provided in all the rooms of Control Room cum Administrative Office Building and Fire Fighting pump house. In case where false ceiling surface conducting is permissible, all down run conduits will be concealed in wall below the false ceiling.

1.3.6 Each cable run shall be tagged with number that appear in the cable schedules. Cables shall be tagged at their entrance and/or exit from any piece of equipment, junction or pull box, floor opening etc.

1.3.7 The tag shall be made up of aluminum with the number punched on it and securely attached to the cable by not less than two turns of G.I. wire. Cable tags shall be rectangular in shape for power cables and circular shape for control cables.

1.3.8 Location of cables laid directly under ground shall be indicated clearly by cable marker made of galvanised iron plate embedded in concrete block.

1.3.9 The location of underground cable joints if any, shall be clearly indicated with cable marker with an additional inscription "cable joint".

1.3.10 The marker, which is a concrete block, shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change of direction. It shall also be located on both sides of the road or drain crossing.

2. DESCRIPTION OF ITEMS

2.1 DESCRIPTION OF ITEMS FOR SUBSTATION LIGHTING

The Contractor shall supply and install the following equipment and accessories in accordance with the specification.

2.2 LIGHTING PANELS

2.2.1 OUTDOOR

400V AC lighting panel with 400V, 63A, 3 phase 4 wire bus and one no. 63A, TPN, MCB with neutral unit as incomer and 20A, SP MCB as outgoing feeders, the details are as follows.

Type Of Panel	Description	Detail Of Outgoing Feeders
ACP 2	Outdoor	6 nos- 20 A single pole MCB and 3 No. 32 A Triple pole MCB with Neutral and suitable timer and contactor for automatic switching.
ACP 3	Outdoor Street lighting Panel	3 nos.-32A Triple pole MCB with Neutral with suitable timer and contactor for automatic switching

Note: The number of outgoing feeders indicated above are the minimum.

2.2.2 INDOOR

400 V indoor AC lighting panel ,63 A 3 phase 4 wire bus and one number 63 amp FP MCB with 300ma 63 A FP RCCB. Flush mounted with per phase isolation and LED indication lamps. The DB will be flush mounted and double door type.

Type Of Panel	Description	Detail Of Outgoing Feeders
ACP 1	Indoor	18 nos outgoing ,16 Amps SP MCB

220 V DC indoor type change over board and 220V DC 32A two wire bus and one 32A contractor backed up by 32A double pole MCB as incomer. The panel shall have local push button controls. Following are the various types of panels required with control timer.

Type Of Panel	Description	Detail Of Outgoing Feeders
DCP	Indoor	6 nos outgoing ,16 Amps DP MCB

2.2.3 Sub-Lighting Panels

Type Of Panel	Description	Detail Of Outgoing Feeders
SLP	Outdoor	4 pole 32A Isolator suitable for 400V, 50 cycles AC supply, wlith LILO facility using 8 nos terminal blocks suitable for cable upto 16 mm sq cable Enclosure shall be suitable for outdoor use with IP-55 degree of protection as per IEC:60529.

2.2.4 Lighting Fixtures

Please Refer Annexure-1

2.2.5 RECEPTACLES

Type of Receptacle	Description	Detail Of Outgoing Feeder
RO	Outdoor	15A, 230V, Receptacle 2 pole, 3- pin type

Type of Receptacle	Description	Detail Of Outgoing Feeder
RP	Outdoor	63A, 400V, Interlocked switch socket, receptacle
RI	Indoor	5/15A, 230V, Receptacle 3-pin type (Modular)

2.2.6 SWITCH BOARDS

Modular type switches, 5/15 Amp. Receptacles.

2.2.7 CONDUITS AND ACCESSORIES

Galvanised Rigid steel or Rigid PVC conduits of 20/25 /32 mm for Lighting and Telephone wiring

2.2.8 JUNCTION **BOXES -** with 5 Nos. of terminal blocks

2.2.9 **LIGHTING POLES -** (Type A1 poles & Type E1 poles)

2.2.10 **FANS-**1400 mm Sweep with Electronic regulator and 450 mm Wall Mounted fans

2.2.11 MAINTENANCE EQUIPMENT

i. A type Aluminium ladder of 3 mtr vertical height.

ii. Cartwheel mounted aluminium ladder Vertical Extendable from 5.1m to 11m.

2.2.12 Receptacles

2.2.12.1 All receptacles shall be of cast steel/aluminum, heavy duty type, suitable for fixing on wall/column and complete with individual switch.

2.2.12.2 In general the receptacles to be installed are of the following types :

i. **Type RO**-15A, 230V, 2 pole, 3 pin type with third pin grounded, metal clad with gasket having cable gland entry suitable for 2Cx6 sq.mm. PVC/aluminium armoured cable and a metallic cover tied to it with a metallic chain and suitable for installation in moist location and or outdoor. The switch shall be of rotary type. Receptacles shall be housed in an enclosure made out of 2 mm thick Gl sheet with hinged doors with padlocking arrangements. Door shall be lined with good quality gasketing. This shall conform to IP-55.

ii. **Type RI-**The 5/15 amp 6 pin receptacles with switches will be of Modular type with flush type switches and electroplated metal enclosures of approved make.

iii. **Type RP** - 63A, 400V, 3 phase, 4 pin interlocked plug and switch with earthing contacts. Other requirements shall be same as type RO. The receptacle shall be suitable for 3.5C x 35/3.5Cx70 sq.mm. aluminium conductor cable entry and shall also be suitable for loop-in and loop out connection of cables of identical size. Receptacle shall be suitable for outdoor application. Receptacles shall be housed in a box made out of 2mm thick G.I. sheet, with hinged door with padlocking arrangement. Door shall be lined with good quality gasketing. This shall conform to IP-55.

2.2.13 Lighting panels (L.P.)

2.2.13.1 Each panel shall be provided with one incoming triple pole MCB with neutral link and outgoing miniature circuit breakers as per clause 2.0. The panels shall conform to IEC: 60439.

2.2.14 Constructional Features

i. Panels shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be of thickness not less than 2.00 mm (cold rolled) smoothly finished, levelled and free from flaws. Stiffners shall be provided wherever necessary.The indoor lighting panels will be ready made DB of minimum 1.6 mm sheet thickness.

ii. The panels shall be of single front construction, front hinged and front connected, suitable for either floor mounting on channels, sills or on walls/columns by suitable M.S. brackets. Indoor panels in control room shall be flush mounted.

iii. Panels shall have a dead front assembly provided with hinged door(s) and out door panels will be with padlocking arrangement with single key supplied in duplicate.

iv. All out-door panels, removable covers, doors and plates shall be gasket all around with neoprene gaskets.

v. The outdoor panels shall be suitable for cable/conduit entry from the top and bottom. Suitable removable cable gland-plate shall be provided on the top and bottom of panels. Necessary number of double compression cable gland shall be supplied, fitted on to this gland plate. The glands shall be screwed on top and made of tinned brass.

vi. The panels shall be so constructed as to permit free access to connection of terminals and easy replacement of parts.

vii. Each panel shall have a caution notice fixed on it.

viii. Each panel will be provided with directory holder in which printed and laminated as built circuit directory would be kept inside a document holder/pasted at site.

ix. Each Outdoor lighting panel shall be provided with one no. 'ON' indicating lamp for each phase along with fuses. For indoor lighting panels din mounted phase indication lamps will be provided, mounted alongside of the MCB

2.2.15 Main Bus Bars

Bus bars shall be of aluminium alloy conforming to IEC: 60114/60105 and shall have adequate cross-section to carry the rated continuous and withstand short circuit currents. Maximum operating temperature of the bus bars shall not exceed 85 deg. C. The bus bars shall be able to withstand a fault level of 9 kA for 1 sec. for AC panels and 4 KA for 1 sec. for DC panels. The Indoor lighting panels shall have copper bus bar

2.2.16 Junction Boxes

2.2.16.1 The junction boxes shall be concealed type for indoor lighting and suitable for mounting on columns, lighting poles, structures etc., for outdoor lighting.

2.2.16.2 Junction boxes shall be of square/rectangular type of 1.6 mm sheet steel with minimum 6 mm thick pressure die cast aluminium material LM-6 and shall have bolted cover with good quality gasket lining.

2.2.16.3 The junction box and cover of sheet steel construction shall be hot dip galvanised.

2.2.16.4 The junction boxes shall be complete with conduit knockouts/threaded nuts and provided with terminal strips. The junction boxes shall be suitable for termination of Cable glands of dia 20 mm, 25 mm, 32 mm, 40 mm on all sides. The junction boxes shall be provided with 4 way terminals suitable for two numbers 10 sq. mm. wire & for street lighting/switchyard lighting suitable for 2 numbers 4C x 16 Sq.mm Al. cable.

2.2.16.5 The junction boxes shall have the following indelible markings

i. Circuit Nos. on the top.

ii. Circuit Nos. with ferrules (inside) as per drawings.

iii. DANGER sign in case of 400-volt junction box.

The junction boxes shall be weather proof type with gaskets conforming to IP 55 as per IEC: 60529.

2.2.16.6 Occupancy Sensors:

Sufficient number of occupancy sensors shall be provided in the stairs area and corridors of control room cum administrative building. Each occupancy sensor shall be used for indoor use with time delay programmable in the minimum range of 1 sec. to 2 Hour to control the illumination in the area.

2.3 DESCRIPTION OF COMMON ITEMS FOR LIGHTING

2.3.1 LIGHTING FIXTURES AND ACCESSORIES

2.3.1.1 General

All lighting fixtures and accessories shall be designed for continuous operation under atmospheric conditions existing at site, without reduction in the life or without any deterioration of materials, internal wiring.

2.3.1.2 Temperature Rise

All lighting fixtures and accessories shall be designed to have a low temperature rise according to the relevant international standard. The design ambient temperature shall be taken as 50 deg. C.

2.3.1.3 Supply Voltage

Lighting fixtures and accessories meant for 230V A.C. operation shall be suitable for operation on 230V A.C. 50Hz, supply voltage variation of ± 10%, frequency variation of ± 2.5% and combined voltage and frequency variation of ± 10%.

Lighting fixture and accessories meant for 220 V DC operation shall be suitable for operation on 220 V DC with variation between 215 to 230 Volts.

2.3.1.4 Lighting Fixtures

i. The lighting fixtures shall be Philips or equivalent International make except for fixtures type 'DSM' & 'HL' for which make has been specified elsewhere in this chapter. The different types of lighting fixtures are also indicated elsewhere in this Chapter.

ii. All fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection.

iii. All lighting fixtures shall be complete with fluorescent tubes / incandescent lamps/mercury vapour/sodium vapour lamps as specified and shall be suitably wired up.

iv. All fluorescent lamp fixture shall be complete with all accessories like ballasts, power factor improvement capacitors, lamps, starters, holders etc.

v. High beam fixtures shall be suitable for pendant mounting and flood lights shall have suitable base plate / frame for mounting on steel structural member. Hook mounted high beam fixtures are not acceptable.

vi. Each lighting fixture shall be provided with an earthing terminal suitable for connection to 16 SWG GI earthing conductors.

vii. All light reflecting surfaces shall have optimum light reflecting co-efficient such as to ensure the overall light output as specified by the manufacturer.

viii. Height of fixtures should be such that it is easy to replace the lamps with normal ladder/stool. In case the ceiling height is very high, the fixtures may be placed on the walls for ground lighting.

2.3.1.5 Accessories

2.3.1.5.1 Lamp holders and Starter Holders

i. Lamp holders/starter holders for fluorescent tubes shall be of the spring loaded, low contact resistance, bi-pin rotor type, resistant to wear and suitable for operation at the specified temperature, without deterioration in insulation value, contact resistance or retention of the lamp/starter. They shall hold the lamp/starter in position under normal condition of shock and vibration.

ii. Lamp holders/starter for incandescent lamps and HPMV/HPSV lamps shall be of screwed type, manufactured in accordance with relevant standard and designed to give long and satisfactory service.

2.3.1.5.2 Ballasts

i. All HPSV/HPMV/Metal halide lamp fixtures shall be provided with wire wound ballasts. All fluorescent fixtures shall be provided with high frequency electronic ballasts. The Ballasts shall be designed, manufactured and supplied in accordance with relevant standard and function satisfactorily under site condition specified. The ballasts shall be designed to have a long service life and low power loss.

ii. Ballasts shall be mounted using self-locking anti-vibration fixing and shall be easy to remove without dismantling the fixtures. They shall be totally enclosed units.

iii. The wire-wound ballasts shall be of the inductive, heavy-duty type, filled with thermosetting insulating moisture repellent polyester compound filled under pressure or vacuum. The ballast wiring shall be of copper wire. They shall be free from hum. Ballasts which produce humming sound shall be replaced free of cost by the Contractor. Ballasts for high pressure mercury vapor / HPSV lamps shall be provided with suitable tappings to set the voltage within the range specified. End connections and taps shall be brought out in a suitable terminal block, rigidly fixed to the ballast enclosure.

iv. Separate ballast for each lamp shall be provided in case of multi-lamp fixtures.

v. High frequency electronic ballasts shall be capable of satisfactory performance in adverse environment like that of EHV substation. Ballasts shall consist of AC/DC converter, high frequency power oscillator and low pass filter. The ballasts shall be suitable for use of nominal voltage of 230V +/- 10%, 50 Hz supply. The filter circuit shall suppress the feedback of high frequency signals to the mains. The ballast shall be rated for 36/40W fluorescent fixtures. The ballasts shall confirm to IEC 68-2-6FC, IEC 60929 for performance, IEC 60928 for safety and EN 55015, EN 55022A for RFI and EN 61003.

2.3.1.5.3 Capacitors

i. The capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.

ii. Power factor of fluorescent lamp fixtures with HF electronic ballast shall not be less than 0.90 and that of High-pressure Sodium Vapour, Mercury Vapour and Metal Halide lamp fixtures shall not be less than 0.85. The capacitors shall be suitable for operation at supply voltage as specified and shall have a value of capacitance so as to correct the power factors of its corresponding lamp circuit to the extent of 0.98 lag.

iii. The capacitors shall be hermetically sealed in a metal enclosure.

2.3.1.5.4 Lamps

i. General Lighting Services (GLS) lamps shall be provided with screwed caps and shall be of 'clear' type unless otherwise specified.

ii. The Bidder shall furnish typical wiring diagram for Fluorescent, HPMV & HPSV fitting including all accessories. The diagram shall include technical details of accessories i.e., starters, chokes, capacitors etc.

iii. Flexible conduits if required, for any fixture shall be deemed to be included in Contractor's scope.

2.3.1.5.5 SWITCH AND SWITCHBOARD

i. All Switch board/boxes, 5/15 Amp Receptacles and electronic fan regulators located in office/building areas shall be modular flush mounted type or brick wall with only the switch knob projecting outside.

ii. Switch boards/boxes shall have conduit knock outs on all the sides.

iii. The exact number of switches including regulator for fans and layout of the same in the switchboard shall be to suit the requirement during installation.

iv. The maximum number of luminaires, controlled by one no 6 amp switch would 4 nos. For DC fixtures there will be no switch and the same shall be directly controlled from DC LP

v. The luminaires shall be wired in such a fashion that luminaires on each phase are evenly distributed all over the room.

2.3.1.5.6 Conduits & conduit Accessories

i. The conduits shall conform to IEC: 61386 or IEC: 61035 or IEC: 60614 as applicable. All steel conduits shall be seemed by welding, shall be of heavy gauge and shall be hot dip galvanised.

ii. Flexible conduits wherever required shall be made with bright, cold rolled annealed and electro-galvanised mild steel strips or PVC/Plastic.

iii. All conduits accessories shall conform to relevant IEC and shall be hot dip galvanized or High quality virgin PVC.

2.3.1.5.7 Terminal Blocks

Each terminal shall be suitable for terminating upto 2 Nos. 10 sq.mm. stranded Aluminium Conductors without any damage to the conductors or any looseness of connections. Terminal strips provided in street - lighting poles shall be suitable for terminating upto 2 nos. 4C x 16 sq. mm aluminium cables.

2.3.1.5.8 PULL OUT BOXES

i. The pull out boxes shall be concealed type for indoor lighting and suitable for mounting on column, structures etc., for outdoor lighting. The supply of bolts, nuts and screws required for the erection shall be included in the installation rates.

ii. The pull out boxes shall be circular of cast iron or 16 SWG sheet steel and shall have cover with good quality gasket lining.

iii. The pull out boxes and cover shall be hot dip galvanized.

iv. The pull out boxes shall be completed with conduit knock outs/threaded hubs and provided at approximately 3 meters intervals in a conduit run.

2.3.1.5.9 Residual Current Circuit Breakers (RCCB)

For indoor panels 63A 4pole 300 ma RCCB conforming IEC 13947 will be provided along with incomer.

2.3.1.5.10 2.2.1.5.10 Miniature Circuit Breaker (MCB)

i. The miniature circuit breakers shall be suitable for manual closing, opening, automatic tripping under overload and short circuit. The MCBs shall also be trip free. MCB of Type C tripping characteristics as per IEC: 60898 will be used for Switchyard lighting.

ii. Single pole as well as three pole versions shall be furnished as required in the Schedule of Lighting Panels.

iii. The MCBs and panel MCCB together shall be rated for full fault level. In case the MCB rating is less than the specified fault level the bidder shall co-ordinate these breaker characteristics with the back up MCCB in such a way that if fault current is higher than breaker rating, the MCCB should blow earlier than the breaker. If the fault current is less than MCB breaking capacity, MCB shall operate first and not the incomer MCCB.

iv. The MCBs shall be suitable for housing in the lighting panels and shall be suitable for connection with stranded copper wire connection at both the incoming and outgoing side by copper lugs or for bus bar connection on the incoming side.

v. The terminals of the MCBs and the 'open' 'close' and 'trip' conditions shall be clearly and indelibly marked.

vi. The tenderer shall check and co-ordinate the ratings of MCBs with respect to starting characteristics of discharge lamps. The vendor has to furnish overload and short circuit curve of MCB as well as starting characteristics curves of lamps for Employer's approval.

vii. The MCB shall generally conform to IEC: 60898.

2.3.1.5.11 Contactors

Contactors shall be of the full voltage, direct-on line air break, single throw, electro-magnetic type. They shall be provided with atleast 2-'NC' and 2'NO' auxiliary contacts. Contactor shall be provided with the three element, positive acting, ambient temperature compensated time lagged, hand reset type thermal overload relay with adjustable settings to suit the rated current. Hand reset button shall be flush with the front of the cabinet and suitable for resetting with starter compartment door closed. The Contactor shall be suitable for switching on Tungsten filament lamp also. The bidder shall check the adequacy of the Contactors rating wire with respect to lighting load.

2.3.1.5.12 Push Buttons

All push buttons shall be of push to actuate type having 2 'NO' and 2 'NC' self reset contacts. They shall be provided with integral escutcheon plates engraved with their functions. Push buttons shall be of reputed make.

2.3.1.5.13 Labels

i. The lighting panels shall be provided on the front with panel designation labels on a 3 mm thick plastic plate of approved type. The letter shall be black engraved on white background.

ii. All incoming and outgoing circuits shall be provided with labels. Labels shall be made of non-rusting metal or 3 ply lamicold. Labels shall have white letters on black or dark blue background.

2.3.1.5.14 Earthing Terminals

Panels shall be provided with two separate and distinct earthing terminals suitable to receive the earthing conductors of size 50x6 G.S. Flat.

2.3.1.5.15 Type test reports for following tests on all lighting panels shall be submitted for approval.

i. Wiring continuity test

ii. High voltage (2.5 KV for 1 minute) and insulation test

iii. Operational test

iv. Degree of protection (not less than IP-55 test on outdoor Lighting Panels and IP-52 test on indoor Lighting Panels as per IEC: 60947 (part 1)

v. Heat run test

2.3.1.5.16 Lighting Poles

The Contractor shall supply, store and install the following types of steel tubular lighting poles required for street lighting.

i. Type A1 Street Lighting Pole - for one fixture

ii. Type E1 Post top lantern pole - for one fixture

Street/flood light poles shall conform to the enclosed drawings. In front of control room building, and Fire Fighting Buildings, decorative post top lantern (Type E1) poles and Bollards shall be installed.

Lighting poles shall be complete with fixing brackets and junction boxes. Junction boxes should be mounted one meter above ground level.

The lighting poles shall be coated with bituminous preservating paint on the inside as well as on the embedded outside surface. Exposed outside surface shall be coated with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium).

The galvanized sheet steel junction box for the street lighting poles shall be completely weather-proof conforming to IP-55 and provided with a lockable door and HRC fuse mounted on a fuse carrier and fuse base assembly. The fuses & junction box shall be as specified in the specification. However, terminals shall be stud type and suitable for 2 nos. 16 sq.mm. cable.

Wiring from junction box at the bottom of the pole to the fixture at the top of the pole shall be done through 2.5 sq. mm wire.

Distance of centre of pole from street edge should be approximately 1000 to 1200 mm.

Earthing of the poles should be connected to the switchyard main earth mat wherever it is available and the same should be earthed through 3M long, 20 mm dia, earth electrode.

2.3.1.5.17 CEILING & WALL MOUNTED FANS AND REGULATORS

The contractor shall supply and install 1400 mm sweep ceiling fans complete with electronic regulator and switch, suspension rod, canopy and accessories. The wall mounted fans shall be of 400 mm sweep

The contractor shall supply and install the switch, electronic regulator and board for mounting switch and electronic regulator for celling fans. The regulator will be housed in common switchboard for lighting and shall be of similar make and model as that of modular switches.

Winding of the fans and regulators shall be insulated with Class-E insulating material. Winding shall be of copper wire.

Electronic regulator with stepped control shall be provided.

2.3.1.5.18 Lighting Wires

The wiring used for lighting shall be standard products of reputed manufacturers.

The wires shall be of 1100 V grade, PVC insulated product of reputed manufacturers.

The conductor sizes for wires used for point wiring beyond lighting panels shall be 2.5 sq.mm, 4 sq.mm, 6 sq.mm and 1.5 sq.mm stranded copper wire.

The wires used for connection of a lighting fixture from a nearest junction box or for loop-in loop-out connection between two fluorescent fixtures shall be single core copper stranded conductor, 1100V grade flexible PVC insulated cords, unsheathed, conforming to IEC:60502 with nominal conductor cross sectional areas of 2.5 sq. mm.

The wires shall be colour coded as follows:

i. Red for R - Phase
ii. Yellow for Y - Phase
iii. Blue for B - Phase
iv. Black for Neutral
v. White for DC (Positive)
vi. Grey for DC (Negative)

2.3.1.5.19 Lighting System Installation Works

i. General

In accordance with the specified installation instructions as shown on manufacturer's drawings or as directed by Employer, Contractor shall unload, erect, install, test and put into commercial use all the electrical equipment included in the contract. Equipment shall be installed in a neat, workmanship manner so that it is level, Plumb Square and properly aligned and oriented. Tolerances shall be as established in manufacturers drawing or as stipulated by Employer.

All apparatus, connections and cabling shall be designed so as to minimize risk of fire or any damage which will be caused in the event of fire.

ii. Conduit System

Contractor shall supply, store and install conduits required for the lighting installation as specified. All accessories/fittings required for making the installation complete, including but not limited to pull out boxes (as specified in specification ordinary and inspection tees and elbow, checknuts, male and female bushings (brass or galvanised steel), caps, square headed make plugs, nipples, gland sealing fittings, pull boxes, conduits terminal boxes, glands, gaskets and box covers, saddle terminal boxes, and all steel supporting work shall be supplied by the Contractor. The conduit fittings shall be of the same material as conduits. The contractor shall also supply 20 mm PVC conduit and accessories for telephone wiring.

All unarmoured cables/wires shall run within the conduits from lighting panels to lighting fixtures, receptacles. etc.

Size of conduit shall be suitably selected by the Contractor.

Conduit support shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.

Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs. Wooden plug inserted in the masonary or concrete for conduit support is not acceptable.

Where conduits are along with cable trays they shall be clamped to supporting steel at an interval of 600 mm.

For directly embedding in soil, the conduits shall be coated with an asphalt-base compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.

For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.

Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.

Conduits joints and connections shall be made through water-tight and rust proof by application of a thread compound which insulates the joints. White lead is suitable for application on embedded conduit and red lead for exposed conduit.

The entire metallic/PVC conduit system, shall be embedded, electrically continuous and thoroughly grounded. Where slip joints are used, suitable bounding shall be provided around the joint to ensure a continuous ground circuit.

Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduit ends shall be plugged or capped to prevent entry of foreign material.

iii. Wiring

Wiring shall be generally carried out by PVC insulated wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawings of wires is permissible.

Wires shall not be pulled through more than two equivalent 90 deg. bends in a single conduit run. Where required, suitable junction boxes shall be used.

Wiring shall be spliced only at junction boxes with approved type terminal strip.

For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.

For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/junction box.

Maximum two wires can be terminated to each way of terminal connections.

Separate neutral wires are to be provided for each circuit.

AC and DC wiring should not run through the same conduit.

iv. Lighting Panels

The lighting panels shall be erected at the locations to be finalised during detailed engineering.

Suitable foundations/supporting structures for all outdoor type lighting panels shall be provided by the Contractor.

v. Foundation & civil works

Foundation for street lighting poles, panel foundation and transformer foundation shall be done by the Contractor. The payment towards execution, PCC & RCC shall be made under relevant items of civil work mentioned in Bid Price schedule.

All final adjustment of foundation levels, chipping and dressing of foundation surfaces, setting and grouting of anchor bolts, sills, inserts and flastening devices shall be carried out by the Contractor including minor modification of civil works as may be required for erection.

Any cutting of masonry / concrete work, which is necessary shall be done by the Contractor at his own cost and shall be made good to match the original work.

ANNEXURE 1

SN	Type of Lighting Fixture	Description	Philips Catalogue No
1	F1	2x28W T5 type fluorescent lamps in industrial reflector type fixture, complete with accessories and suitable for pendent /surface mounting.	TMS 122/228 HF
2	FF	2x28 T5 energy efficient fluorescent lamps with low glare, mirror optics suitable for recess mounting type lighting fixture.	TBS 088/228 C5 HF
3	FL	2x28W T5 energy efficient fluorescent lamps with low glare mirror optics suitable for pendent/surface mounting with all accessories	TCS 398/228 D6 HF
4	TL	Sleek and Functional electronic decobatten suitable for use with 1x'TLD'36W fluorescent lamp with dual tone end caps. Pre-phosphated & powder coated CRCA steel channel complete with all electrical accessories like electronic ballast, lamp holders all prewired up to a terminal block	TMS500/136 HF
5	IB	60/100w GLS lamp in Bulkhead fixtures with Cast Aluminium alloy body, suitable for column, wall,and ceiling mounting finished stove enameled silver grey outside	NXC101
6	BL	Aesthetic wall/ceiling mounted luminaire suitable for 1x PL-C 13W OR 11W CFL. Low loss O.C. Copper ballast.Built in high gloss anodized reflector. Twin finish UV stabilised SAN diffuser for protection & elimination of lamp glare.	FMC21/113
7	SL	Aesthetic ceiling mounted luminaire for Ecotone crystal/Décor CFL of 2x9W or 1x18W. ABS housing pre-wired with porcelain lampholder. Pre-phospated plated CRCA gear tray.	FL343/118
8	BH	Bulkhead luminaire suitable for use with PL-S 9W CFL. Single piece pressure die-cast aluminium & cover retaining Frame. Opal acrylic cover along with a gasket made of E.P.R..	FXC 101/109
9	BLD	2X9 Or 1x18 watt CFL bollard light for landscape lighting having FRP/LLDPE housing	FGC202 /118
10	DLR	2x18 watt CFL Downlighter with HF ballast suitable for recess mounting	FBH145/218L HF
11	DSM	1X13 WATT surface mounted CFL	FCS100/113
12	IF	Incandescent GLS lamp down light	DN622

SN	Type of Lighting Fixture	Description	Philips Catalogue No
13	SF1	1 X 400W HPSV lamps in high flood lighting fixture with integral control gear	SWF 330/1X400
14	SF2	2 X 400W HP sodium Vapour lamps in high flood lighting, non-integral control gear:	RVP302/2x400W
15	SF3	1 X 250W HPSV lamps in high flood lighting fixture with integral control gear:	SWF 330/1X250
16	SF4	150W HP Metal halide MHN-TD lamp in flood lighting fixture with integral control gear.	SWF230/150 MHN-TD
17	SF5	125 HP MV Lamp in weather proof post top lantern for mounting on pole top	HPC-101/125 HPF
18	SC	150W SON-T Tubular Sodium Vapour lamp in street lighting luminaire with toughned glass cover.	SRX-51/150

CHAPTER 10

LT TRANSFORMER

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CHAPTER 10: LT TRANSFORMER

1. INTENT

This specification is intended to cover outdoor type oil filled 11/0.40 kV, 315 kVA transformers.

2. SCOPE OF WORK

2.1 Scope of Supply

i. Transformers as listed above, with insulating oil, all materials and accessories, and complete in all respects.

ii. Gland plates, power cable, lugs, anchor bolts and other hardware.

iii. Mandatory & optional spares and special maintenance equipment if any.

2.2 Scope of Service

The scope includes but is not limited to the following items of work to be performed for all equipment and materials furnished under this chapter:

i. Design, manufacturing, shop testing, packing & dispatch.

ii. Transportation inclusive of insurance and delivery, FOR site basis.

iii. Unloading, handling, storing, transportation at site up to foundations, oil filling and treatment, erection, testing and commissioning.

iv. Civil Works.

v. Supply of external cables and termination as required.

vi. Fire protection system.

3. GENERAL INFORMATION

3.1 All temperature indicators, and other auxiliary devices shall be suitable for 220 V DC Control supply. All alarm and trip Contacts shall also be suitable for connection in 220 V DC Circuits.

3.2 Bidders may specifically note that transformers offered shall conform to dynamic short circuit test and dielectric test as per IEC: 60076. Test report for the same shall be submitted during detail engineering for approval.

4. TECHNICAL REQUIREMENTS

4.1 Core

The core shall be constructed from high grade, non-aging, cold rolled grain-oriented silicon steel laminations. The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that the flux density at any tap position with 10 % voltage variation from the voltage corresponding to the tap shall not exceed 1.9 Wb/sq-m.

4.2 Windings

The conductor shall be of electrolytic copper, free from scales and burrs.

4.3 Insulating Oil

The oil supplied with transformer shall be unused and have the parameters for unused new oil conforming to IEC: 60296 while tested at oil Contractor's premises, No inhibitors shall be used in oil. Ten percent (10%) extra oil shall be supplied for topping up after commissioning in nonreturnable containers suitable for outdoor storage.

4.4 Terminal Arrangement

Bushing terminals shall be provided with suitable terminal connectors of approved type and size for cable/overhead conductors termination of HV side and cable termination on LV side.

The neutral terminals of winding shall be brought out on a bushing along with the phase terminals to form a 4 wire system for the 400 volt. Additional neutral bushing shall also be provided for earthing.

4.5 Off Circuit Tap Changing Equipment

The tap change switch shall be three phase, hand operated for simultaneous switching of similar taps on the three phases by operating an external hand wheel.

4.6 Marshalling Box

A metal enclosed, weather, vermin & dust proof marshalling box shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. It shall have a degree of protection of IP 55 as per IEC: 60947 Part-1.

4.7 Cable boxes

Whenever cable connections are required, suitable cable boxes shall be provided and shall be air insulated. They shall be of sufficient size to accommodate Employer's cables and shall have suitable removable side/top cover to facilitate cable termination and inspection. Cable boxes shall be dust & vermin proof.

4.8 INSPECTION AND TESTING

The Contractor shall draw up and carry out a comprehensive inspection and testing program during manufacture and commissioning of the transformer. The programme shall be duly approved by the Employer.

The Contractor shall carryout all routine tests on all the transformers as per relevant standards. Type test report shall be submitted for approval during detail engineering.

4.9 INSPECTION

4.9.1 Tank and Accessories

i. Physical and dimensional check of transformer tank and accessories.

ii. Crack detection of major strength weld seams by dye penetration test.

4.10 Core

i. Physical inspection and check of quality of varnish, if used.

ii. Sample testing of core material for checking specific loss, bend properties, magnestisation, characteristics and thickness.

iii. Check on completed core for measurement of iron loss and check for any hot spot by exciting the core so as to induce the designed value of flux density in the core.

iv. HV Test

4.11 Insulating Material

i. Sample checks for physical properties of the material

ii. Check for dielectric strength

iii. Check for the reaction of hot oil on insulating material

4.12 Winding

Sample check on winding conductor for mechanical properties and electrical conductivity and on installation covering.

Sample check on insulation paper for pH value, Bursting strength, Electric strength.

4.13 Assembled Transformer

Check complete transformer against approved outline drawing provision for all fittings, finish etc.

Jacking test on all the assembled transformers.

4.14 Oil

All Standard tests in accordance with relevant Standards shall be carried out on oil samples taken from the transformer before and after testing of the transformer.

The contractor shall also prepare a comprehensive inspection and testing programme for all bought out sub-contracted items and shall submit the same to the Employer for approval. Such programme shall include the following components:

i. Winding temperature Indicator

ii. Bushings

iii. Marshaling Box

iv. Tap changer switch

v. Oil temperature indicator

5. FACTORY TEST

5.1 All standard routine tests in accordance with latest issue of IEC: 60076 shall be carried out on each transformer.

5.2 The transformer shall conform to all the type tests in accordance with latest issues of IEC: 60076. The manufacturer shall submit type tests & additional test reports as listed above as already carried out on transformers of identical design for Employer's acceptance. In such a case, validity of type test reports shall be as per technical specifications. Following

parameters in general shall be ensured for establishment of identical design as per IEC 60076, Part-V.

i. Same Voltage ratio, KVA rating, vector group & impedance.

ii. Same conceptual design of core and winding.

iii. Same arrangement and geometrical sequence of the main windings.

iv. Same type of winding conductors.

v. Same type of main windings.

vi. Absorbed power at short circuit (i.e rated power/per unit short circuit impedance) between 30% and 130% of that relating to the reference transformer.

vii. Axial forces and winding stresses occurring at short circuit not exceeding 120% of those relating to the reference transformer.

viii. Same manufacturing process.

ix. Same Clamping and winding support arrangement.

5.3 In addition to all type and routine tests, transformer shall also conform to following additional type tests as per IEC: 60076.

i. Measurement of zero sequence impedance

ii. Short circuit test

iii. Measurement of acoustic noise level. This shall conform to NEMA standard publication TR-1.

iv. Measurement of capacitance and tan delta of transformer winding.

v. Test on oil samples as per IS 60296

5.4 All auxiliary equipment shall be tested as per the relevant IS Test Certificates shall be submitted for bought out items.

5.5 High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.

5.6 Tank Tests:

i. Routine Tests: As per IEC: 60076 Part-1 including

ii. Vacuum Tests: As per IEC: 60076 Part-1

iii. Pressure Test: As per IEC: 60076 Part-1

5.7 In addition to the above, the following checks should be carried out at manufacturer's works before dispatch for all transformers:

i. Check for interchangeability of components of similar transformers and for mounting dimensions.

ii. Check for proper packing and preservation of accessories like radiators, bushings explosion vent, dehydrating breather, conservator etc.

iii. Check for proper provision of bracings to arrest the movements of core and

winding assembly inside the tank.

iv. Test for gas tightness and derivation of leakage rate. To ensure adequate reserve gas capacity during transit and storage.

5.8 The Contractor shall submit a detailed inspection and testing programme for field activities, covering areas right from the receipt of material stage upto commissioning stage as per IS : 1886 - Code of practice for installation and maintenance of transformers. The indicative checks and tests are given below.

i. Physical checks on each transformer on receipt at site for any damage or short supply.

ii. Tests on oil samples

iii. Oil leakage test

iv. Physical checks for colour of silica in breather

v. Check for oil level in breather housing, conservator tank, etc.

vi. Check for correct operation of all protections and alarms.

vii. Insulation Resistance Measurement for Main Winding, control wiring etc.

viii. Continuously observe the transformer operation at no load for 24 hours.

6. FITTINGS

The following fittings shall be provided with each transformer covered under this specification.

i. Conservator with drain plug and oil filling hole with blanking plate

ii. Plain oil Gauge

iii. Silica gel Breather

iv. Pressure Relief vent

v. Pocket on tank cover for Thermometer

vi. Valves

vii. Earthing Terminals

viii. Rating & Terminal Marking Plates

ix. Lifting Lugs

x. Rollers

xi. Air Release Plug

The fittings listed above are only indicative and any other fittings which generally are required for satisfactory operation of transformer are deemed to be included.

7. SPARE PARTS

7.1 The list of spares for outdoor type transformers covered under this chapter shall be as specified in Chapter 1 PSR.

7.2 In addition, the Bidder shall also recommend optional spare parts and maintenance equipment necessary for three (3) years of successful operation of the equipment. The prices of these shall be indicated in respective schedules and these shall not be considered for the purpose of evaluation.

ANNEXURE-I

8. GENERAL TECHNICAL SPECIATION OF LT TRANSFORMER

SN	Description	Unit	PARAMETERS
1.	Rated Capacity	kVA	315
2.	Rated Voltage		
a)	HV	kV	11
b)	LV	kV	0.4
3.	Type of Winding		Two Winding
4.	Service		Outdoor
5.	No.of Phase	No.	Three
6.	Frequency	Hz	50
7.	Type of Cooling		ONAN
8.	Impedance at 75 Deg C	%	4
9.	Tolerance of Impedance	%	10
10.	Duty		Continuous
11.	Overload		IEC:60076-7
12.	Max.Tempeture Rise over an ambient of 50 Deg C		
a)	Oil (Temperature rise measured by thermometer)		
b)	Winding (Temperature rise measured by resistance method)	°C	50
13.	Windings	°C	55
a)	System Apparent circuit level(kA)		As per IEC:60076-Part 1
b)	Winding Connection		
(i)	HV		Delta
(ii)	LV		Star
14.	Vector Group		Dyn11

SN	Description	Unit	PARAMETERS
15.	Insulation		Uniform
16.	Insulation Level		
a)	Power Frequency Test Level		
i)	HV	kVrms	28
ii)	LV	kVrms	3
17.	Basic Impulse Level		
i)	HV	kVp	75
ii)	LV	kVp	-
18.	Method of Earthing		Solidly earthed
19.	Tap Changer		
a)	Tap Change		+5 % to -10% in set of 2.5% on HV side
b)	Tap Control		Off Circuit Tap Change Switch
20.	HV Bushing		
a)	Rated Voltage	kV	12
b)	Rated Current	A	100
c)	Min.Total Creepage Distance	mm	300
d)	Mounting		Tank/Transformer Body
21.	LV Bushing		
a)	Rated Voltage	kV	1.1
b)	Rated Current	A	1000
c)	Mounting		Tank/Transformer Body
22.	Min. Clearance in Air		
a)	Ph-Ph (HV/LV)	mm	280/25
b)	Ph-Earth (HV/LV)	mm	280/25

CHAPTER 11

EARTHING AND LIGHTNING SYSTEM

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CHAPTER 11: EARTHING AND LIGHTNING SYSTEM

1. GENERAL

The contractor shall install and connect newly constructed earthing mat with existing earthing mat. Additionally, contractor shall provide the appropriate lightning protection scheme for the current scope of work indoor GIS, outdoor equipment and Transformers as applicable).

2. SCOPE OF WORKS

Earthing and lightning protection systems shall be provided for the entire substation with protection of all structures and buildings.

The scope of work shall comprise the following:

i. Sub-grade earthing systems;

ii. Above ground indoor and outdoor earthing systems;

iii. Potential gradient control systems;

iv. Lightning protection systems.

3. PRINCIPLE DESIGN FEATURES

3.1 The complete earthing systems shall be designed and constructed in strict compliance with the standards IEEE Std-80-2000 and IEC 60 479-1.

3.2 The lightning protection systems shall be designed and constructed in full compliance with **the IEC standards.**

3.3 The design shall be based on the following fault levels:

i. For 132 kV level, 40 kA/1s (Considering the future expansion of the substation)

ii. It shall be noted that above values are tentative and shall be verified during the detailed design.

iii. The Contractor shall carry out the necessary measurements to determine the ground and ground water resistivity to be used for the calculations and the design.

iv. The actual cross-sections of the earthing conductors shall be defined in the earthing system calculation.

v. The minimum cross-section for sub-grade earthing conductors shall be 120 mm^2 Cu.

vi. The permissible conductor temperatures under fault conditions shall be as follows:

vii. Bare conductors, embedded in concrete or buried 300°C

viii. Bare conductors above grade 200°C

ix. All equipment associated with the substation including reinforcement steel

and embedded steelwork shall be bonded to the earthing electrodes by adequately dimensioned conductors.

x. The various earthing grids shall be interconnected.

xi. Surge arresters and transformer neutrals shall be directly connected to the main earthing conductor and/or particular earthing rods.

xii. The entire earthing system shall have an earthing resistance of less than 0.5 Ω.

xiii. Test links and maintenance earthing points shall be provided

4. PARTICULAR DESIGN AND CONSTRUCTION REQUIREMENTS

4.1 Subgrade Earthing System

i. The sub-grade earthing system shall consist of flexible, bare, electrolytic copper conductors forming an interconnected meshed network.

ii. The complete system shall be buried and/or embedded in concrete with adequately spaced connections to the main earthing bus. To achieve a safe earthing system with the required overall earthing resistance, earthing electrodes of sufficient length and quantity supplemented by driven earthing rods shall be provided. Earthing rods installed in drilled holes shall be embedded in appropriate conducting material.

iii. All embedded earthing materials shall be connected with each other, with earthing electrodes or reinforcement bars with standard type bolted fittings.

iv. Construction and installation of the systems shall be closely coordinated with the civil contractor to suit his program.

v. The erection staff, drawings and materials shall arrive at site in due time according to an agreed schedule.

vi. Buried and concrete embedded earthing conductors will be installed by the contractor under the supervision and responsibility of this Contract.

4.2 Above Ground Earthing System

i. The various indoor and outdoor locations shall be provided with earthing systems consisting of common loops with branch connections to the individual equipment. The installations shall be surface-mounted.

ii. All non-current carrying but conductive components shall be bonded with the earthing system.

iii. Switchgear and equipment rooms with electrical installations shall be equipped with an earthing bus. This bus shall be installed at the circumference of the rooms with connections to the sub-grade earthing systems.

iv. Earthing conductors shall be installed along cable trays and other cable routings.

v. The earthing conductors for exposed installations shall be tinned, stranded copper conductors of specified minimum cross-sections.

vi. For earthing terminations, the conductors shall be fitted with compression type cable lugs.

vii. Earthing conductors shall be connected with compression type straight or T-joints.

viii. Steel constructions shall be earthed at least at both ends. Steel reinforcement in mass concrete, structural steel, turbine distributors, and hydro-mechanical equipment shall be connected to the earthing system at least at 2 points. Earthing connections shall be protected during concreting to avoid damage or breaking of bonds and connections. Earthing cables embedded in concrete shall have construction joints at right angles to the joint and shall be installed in such a manner that movement will not damage the cable. All connections with the sub-grade earthing systems shall be carried out with standard type, bolted fittings.

ix. All metal structures, such as metal trays, conduits, tanks, gratings, rails, pipes, louvers, staircases, doors, machine housings or enclosures (pumps, fans, compressors, etc.) which may become conductive during a fault of an electrical installation by direct contact, arc or via a creepage distance, shall be effectively connected to the protective earthing system. Rails and pipes shall have insulating joints where they leave the protected power plant area.

x. Oil tanks shall be earthed twice with the earthing conductors taken from two different points of the earthing grid. All piping shall be earthed at all service points in an approved manner.

xi. Metal enclosures and conductive structures of circuit breakers, isolating switches, measuring transformers, busbars, etc., shall be connected to the earthing grid. The housings of the operating mechanism shall be earthed at a point as near to the operating handle as possible.

xii. Power transformer tanks shall be earthed at two points diagonally. These connections shall be made from two different points of the earthing grid. Where the neutral conductor is directly brought from the neutral bushing to earth, an additional connection between bushing and tank shall be provided to ensure a straight electrical connection between tank and neutral.

xiii. The neutral conductor shall have the same current carrying capacity as the phase conductors and shall be brought directly to an earthing bus.

xiv. Surge arresters shall be connected separately to the earthing grid with 120 mm^2 earthing cable connections.

xv. Electronic equipment rooms shall have a direct connection to the sub-grade earthing system by means of an insulated earthing conductor.

4.3 Potential Gradient Control System

i. Every building floor or outdoor concrete slab, housing HV or MV switchgear, switchboards, transformers or other electrical equipment of 1 kV service voltage or above, shall be provided with a potential gradient control system composed of a mesh of round steel bars of approx. 8 mm diameter. The mesh width shall not exceed 5 m, to be laid in the final concrete slab approximately

50 mm below floor level. This system shall be connected with the main steel structures or the main earthing bus at several points. This system shall by no means be used in lieu of the protective earthing system.

ii. Outdoor potential gradient control systems consisting of bare copper conductors with a cross-section not less than 120 mm² shall be buried in the soil beside or nearby electrical components or metal structures at which a contact or step voltage can exist. Such conductors shall be connected directly to the main earthing bus and laid in approximately 1 m distance from the circumference of said electrical components or metal structures in a depth not exceeding 0.2 m.

iii. Step and touch voltages may be controlled by well-drained gravel surface dressings. Conductive buildings and lightning conductors shall be bonded to the earthing system. The site fences shall be earthed independently from the main earth electrode system.

4.4 Lightning Protection Systems

i. To protect personnel, electronic and electrical equipment from the effects of lightning strokes the plant shall be equipped with a lightning protection system.

ii. The lightning protection system shall be subdivided into lightning protection zones and consist of roof conductors, air terminals and down conductors.

iii. All materials shall especially be suitable and approved for this type of system.

iv. The lightning protection system shall be connected to the station main earthing electrodes as appropriate.

v. Due consideration shall be given to EMC and overvoltage requirements.

5. SPARE PARTS

5.1 General Spare Parts

Reference is made to the Project Specification Requirements.

5.2 Special Spare Parts

Not applicable.

5.3 Recommended Spare Parts

i. The Tenderer shall recommend the spare parts he considers necessary for a five years operation of the equipment. Workshop Tests

ii. All equipment and materials shall be standard products of competent manufacturers.

iii. Workshop tests shall be carried out according to a certified QC plan.

6. SITE TESTS

i. Testing and measurement of the earthing electrodes and rods shall be carried out and recorded both as the installation work proceeds and after covering

and flooding of the related areas.

ii. The tests shall prove the continuity of all paths and indicate the resistive value of the electrodes.

iii. The permissible step and/or touch voltages shall be verified at locations with the maximum prospective level and at random.

iv. The overall earth dissipation resistance shall be measured by the high current / low voltage injection method.

v. Remedial action at the Contractor's expense shall be agreed whenever measurements do not meet the design requirements.

CHAPTER 12

FIRE PROTECTION SYSTEM

Table of Contents

CHAPTER 12: FIRE PROTECTION SYSTEM

1. INTENT OF SPECIFICATION

This chapter covers the design and performance requirements of the following types of fire protection systems;

i. Hydrant System

ii. High Velocity Water (H.V.W) Spray System

iii. Fire Detection and alarm System

iv. Portable Fire Extinguishers

v. Wheel/ Trolley mounted Fire Extinguishers

1.1 It is not the intent to completely specify all details of design and construction. Nevertheless, the system design and equipment shall conform in all respects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Employer. The system design shall also conform to NFPA norms.

1.2 The scope of work includes complete earthwork (i.e. excavation, backfilling etc.) for the entire buried piping for the system, valve pits and pipe supports for buried, entrenched and overground piping.

1.2.1 The equipment offered shall comply with the relevant latest International Standards unless specified otherwise. The Deluge valves, HVW spray nozzles & quartzoid bulb detectors shall have the approval of any of the following agencies;

i. UL of USA

ii. FM of USA

iii. LPCB of UK or

iv. VDS of Germany,

1.3 Ambient temperature for design of all equipment shall be considered as 50°C.

1.4 The Contractor shall prepare detailed layout and piping and instrument drawing based and other drawings such as road, drainage, cable trench, switch yard layout, etc. as furnished by the Employer during detailed engineering.

2. DESIGN AND CONSTRUCTION

2.1 Hydrant System

Hydrant system of fire protection essentially consists of a large network of pipe, both underground and over ground which feeds pressurised water to a number of hydrant valves, indoor (if applicable) as well as outdoor. These hydrant valves are located at strategic locations near buildings and Transformers. Hose pipes of suitable length and fitted with standard accessories like branch pipes, nozzles etc., are kept in Hose boxes. In case of emergency, these hoses are coupled to the respective hydrant valves through instantaneous couplings and jet of water is directed on the equipment on fire. Hydrant protection shall be

provided for the following in all substations of voltage levels 132kV. At least one hydrant post shall be provided for every 60m of external wall measurement of buildings.

i. Control room building

ii. L.T. Transformer area.

iii. Fire Fighting pump House.

iv. Stores

v. Transformers

vi. GIS Building

A warning plate shall be placed near the hydrant points for the transformers and other equipment of substations to clearly indicate that water shall be sprayed only after ensuring that the power to the transformer which is on fire is switched off and there are no live parts within 20 metres of distance from the personnel using the hydrant.

2.2 High Velocity Water (H.V.W.) Spray System

2.2.1 H.V.W. spray type fire protection essentially consists of a network of projectors and an array of heat detectors around the Transformer to be protected. On operation of one or more of heat detectors, Water under pressure is directed to the projector network through a Deluge valve from the pipe network laid for this system. This shall be provided for transformers. Wet detection initiation system shall be employed for automatic operation.

2.2.2 The system shall be designed in such a way that the same can be extended to protect additional Transformer to be installed in future. However, for the purpose of design it shall be assumed that only one Transformer will be on fire. The main header pipe size in the yard shall be 200 mm NB (for 132kV switchyard). Branch to the equipment (shall not be more than 20 metres length) shall be of the same size as of deluge valve.

2.2.3 The Electrical clearance between the Emulsifier system pipe work and live parts of the protected equipment shall not be less than the values given below:

i. 145 kV bushing 1300 mm

ii. 52 kV bushing 630 mm

2.2.4 System shall be designed in such a way that the Water pressure available at any spray nozzle shall be between 3.5bar and 5.0bar and shall be demonstrated through hydraulic calculations. Water shall be applied at a minimum rate of 10.2 LPM/M^2 of the surface area of the transformer including radiator, conservator, oil pipes, bushing turrets, etc. (including bottom surface for transformer). The nozzle arrangement shall ensure direct impingement of water on all exterior surfaces of transformer tank, bushing turrets, conservator and oil pipes, except underneath the transformer, where horizontal spray may be provided.

2.2.5 Deluge Valve

Deluge Valve shall be water pressure operated manual reset type. The Deluge valve shall be closed water tight when water pressure in the heat detector pipe work is healthy and the entire pipe work shall be charged with water under pressure upto the inlet of the Deluge valve. On fall of water pressure due to opening of one or more heat detectors, the valve shall open and water shall rush to the spray water network through the open Deluge valve.

The valves shall be manually reset to initial position after completion of operation. Each Deluge Valve shall be provided with a water motor gong which shall sound an alarm when water after passing through the Deluge valve, is tapped through the water motor.

Each Deluge valve shall be provided with a local panel with provision of opening of Deluge valve from local and remote from control room. In addition to this, each valve shall be provided with local operation latch.

Deluge valves of 100mmNB size shall be used if the flow requirement is ≤ 200m^3/hr and 150mmNB size shall be used for flow requirement >200m^3/hr.

Test valves shall simulate the operation of Deluge valves and shall be of quick opening type. The general construction shall conform to requirements for piping, valves and specialities.

2.2.6 High Velocity Spray Nozzles (Projectors)

2.2.6.1 High velocity spray system shall be designed and installed to discharge water in the form of a conical spray consisting of droplets of water travelling at high velocity, which shall strike the burning surface with sufficient impact to ensure the formation of an emulsion. At the same time the spray shall efficiently cut off oxygen supply and provide sufficient cooling.

2.2.6.2 Minimum set point of the heat detectors used in the HVW spray system shall be 79°C. The optimum rating shall, however, be selected by the Bidder, keeping in mind the maximum and minimum temperature attained at site.

2.3 Fire Detection and alarm System

This system shall be provided for control room building, GIS Building and building under the scope**.**

Suitable fire detection system using smoke detectors and/or heat detectors shall be provided for the entire building, including corridor and toilets. Fire detectors shall be located at strategic locations in various rooms of the building. Each Switchyard panel room shall be considered a separate zone. Adequate number of extra zones shall be provided for Switchyard panel rooms for future bays identified in Single line diagram of the substation. The operation of any of the fire detectors/ manual call point should result in the following;

i. A visual signal exhibited in the annunciation panels indicating the area where the fire is detected.

ii. An audible alarm sounded in the panel, and

iii. An external audible alarm sounded in the building, location of which shall be decided during detailed engineering.

iv. If the zone comprises of more than one room, a visual signal shall be exhibited on the outer wall of each room.

2.3.1 Each zone shall be provided with two zone cards in the panel so that system will remain healthy even if one of the cards becomes defective.

2.3.2 Coverage area of each smoke detector shall not be more than 80 m^2 and that of heat detectors shall not be more than 40 m^2. Ionisation type smoke detectors shall be provided

in all areas except pantry room where heat detectors shall be provided. If a detector is concealed, a remote visual indication of its operation shall be provided. Manual call points (Break glass Alarm Stations) shall be provided at strategic locations in the control room building. All cabling shall be done through concealed conduits.

2.3.3 Cables used should be exclusively for fire detection and alarm system and shall be 2Cx1.5sq.mm Cu. cables. Un-armoured PVC insulated FR cables conforming to latest IEC / International standards shall be used.

2.4 Portable and Wheel/ Trolley mounted Fire Extinguishers

2.4.1 Portable Fire Extinguishers

Adequate number of portable fire extinguishers of pressurised water, dry chemical powder, and Carbon dioxide type shall be provided in suitable locations in control room building and FFPH building as indicated in the drawing. In addition to this one (1) CO2 type fire extinguisher of 4.5 kg capacity shall be provided for each Switchyard panel room. These extinguishers will be used during the early phases of fire to prevent its spread and costly damage.

The design, construction & testing of portable fire extinguishers shall meet the requirements suggested by the employer.

2.4.2 Wheel/ Trolley mounted Fire Extinguishers

Wheel/Trolley mounted Mechanical foam type fire extinguishers of 50 litre capacity, conforming to latest international standards, shall be provided for the protection of the following:

i. Three number of 132/11 kV Transformers

ii. One (1) no. for each LT transformer.

The design, construction & testing of Mechanical foam type 50 litre capacity shall meet the requirements of relevant International Codes.

2.5 Water Supply System

2.5.1 For 132 kV level substations water for HVW system shall be supplied by one electrical motor driven pump of rated capacity 100 m^3/hr. at 65 MWC head, with another pump of same capacity, driven by diesel engine, shall be used as standby. Water storage tank with two compartments of adequate capacity shall be provided. Pumps shall work under positive suction head. Annunciations of the hydrant & HVW spray systems shall be provided in fire water pump house and repeated in control room. Provision for sending data to remote control centre shall also be available. The pump and piping system shall be designed mainly for transformer HVW spray system, whereas the provision of hydrant coupling shall be provided in the same piping arrangement for transformers and control building firefighting.

2.5.2 The outdoor piping for the system in general shall be laid above ground on concrete pedestals with proper supporting arrangement. However, at road/rail crossings, in front/access of buildings, places where movement of cranes/vehicles is expected and at any other place where above ground piping is not advisable, the pipes shall be laid underground. Such locations shall be finalised during detailed engineering.

2.5.3 The whole system will be kept pressurised by providing combination of air vessel and jockey (booster) pump of 7.5 M^3/hr. capacity at 70MWC. There shall be provision of a standby Jockey pump and redundant compressed air system. The capacity of air vessel shall not be less than $3m^3$. Minor leakage will be met by Jockey pump. One additional jockey pump shall be provided as standby. All pumps shall be of horizontal centrifugal type. Pumps and air vessel with all auxiliary equipment will be located in firewater pump house. A pressure relief valve of suitable rating shall be provided in water header to release excess pressure due to atmospheric temperature variations.

2.5.4 Operation of all the pumps shall be automatic and pumps shall be brought into operation at preset pressure. Fire pumps shall only be stopped manually. Manual start/stop provision shall be provided in local control panel.

2.5.5 The general design of the fire-fighting pump sets shall meet the requirements under clause no. 5 for horizontal centrifugal pumps, no. 6 for Diesel engines and no. 12 Electrical Motors.

2.5.6 Each pump shall be provided with a nameplate indicating suction lift/delivery head, capacity and number of revolutions per minute.

2.5.7 Design, construction, erection, testing and trial operation of piping, valves, strainers, hydrant valves, hoses, nozzles, branch pipes, hose boxes, expansion joints etc. shall conform to the requirements approved by the employer.

2.6 Instrumentation and Control System

2.6.1 All instruments like pressure indicators, differential pressure indicators, pressure switches, level indicators, level switches, temperature indicators, alarms and all other instruments and panels as indicated in the specification and drawings and those needed for safe and efficient operation of the whole system shall be furnished according to the requirements of clause no. 11. Pump running/ fails to start signal shall be taken from the pressure switch immediately after the discharge of the pump.

2.6.2 Control Panel

Power feeder for motors will be from switchgear board located in control building but control supply for all local control panels, annunciation panels, battery charger units, space heaters etc. shall be fed from the AC and DC distribution boards located in pump house. These AC & DC distribution boards will be fed from the switchgears and DCDBs located in control building.

2.6.2.1 Panel for motor driven fire water pump

The panel shall be provided with the following:

i.	TPN switch	1 No.
ii.	Auto/manual selection facility Start/Stop facility with indication lamp	1 Set
iii.	DOL starter with thermal O/L relay	
iv.	Indicating lamp showing power ON	1 Set
v.	Indication lamp with drive ON OFF	1 Set
vi.	Indication lamp showing Motor Trip	1 No.

2.6.2.2 Additional provisions shall be made for controlling the following from the remote-control centre:

i. Auto/manual selection facility

ii. Start/Stop facility

2.6.2.3 Main power cable from breaker feeder of main switchboard shall be terminated in this panel and another cable shall emanate from this panel which shall be terminated at motor terminals.

Panel for Two nos. Jockey Pump 1 No.

The panel shall be provided with the following:

1.	Fuse-switch unit for Jockey pumps	1 Set for each pump
2.	Auto/manual selection facility for each pump	
3.	Selector switch for selecting either jockey pump	1 No.
4.	D.O.L. starter with overload relay self-resetting type, for all the drives.	1 No. each
5.	Start/stop push button for Jockey Pump with indication for all the drives lamp with pad-locking arrangements in stop position	1 Set for each pump
6.	Indication lamp for trip pump indication	1 No. each for

Additional provisions shall be made for controlling the following from the remote-control center:

1. Auto/manual selection facility for each pump**.**

a)	Panel for 2 Nos. battery charger & Diesel Engine driven fire water pump	1 No.

2.6.2.4 The panel shall be provided with the following:

1.	Auto/Manual selection facility for Diesel Engine driven pump	1 No.
2.	Start/Stop facility with indication lamp	1 Set
3.	Indicating lamp showing drive ON/OFF	1 Set
4.	D.C. Voltmeter/Ammeter in the battery charger circuit	1 No. each
5.	Battery charger will be as per specification described	1 Set
6.	Selector switch for selecting either of battery chargers for the battery sets.	1 No.
7.	Selector switch for selecting either set of batteries for Diesel engine starting.	1 No.
8.	Selector switch for boost Charging/Trickle charging of battery set.	1 Set

Additional provisions shall be made for controlling the following from the remote-control centre:

2.6.3 Manual Start/Stop of Diesel Engine

Individual local control panel is to be considered for each transformer deluge system wherever this equipment is envisaged. This panel shall contain push buttons with indicating lamps for spray ON/OFF operation in the valve operation circuit. Push buttons shall be concealed behind glass covers, which shall be broken to operate the buttons. Provision shall be made in the panel for the field signal for the annunciations such as spray ON and fire in the Transformer. A signal for spray ON shall also be provided in the control room fire alarm panel for employer's event logger. Remote operation facility to open the Deluge valve from control room/ remote centre shall also be provided.

2.6.4 Annunciation Panels

Location: Fire Water Pump House

i. Indicating lamps showing power supply "ON".

ii. Annunciation windows complete with buttons.

Details are as follows:

1.	Electric motor driven fire water pump running	1
2.	Electric motor driven fire water pump fails to start	1
3.	Diesel engine driven fire water pump running.	
4.	Diesel engine driven water pump fails to start	1
5.	Jockey pump-1 running	1
6.	Jockey pump-1 fails to start	1
7.	Jockey pump-2 running	1
8.	Jockey pump-2 fails to start	1
9.	Fire in Transformer equipment	1 for each
10.	Deluge system operating for Transformer equipment	1 for each
11.	Header pressure low	1
12.	Fire in smoke detection system zone (Common Fire Signal)	1
13.	Water storage tank water level low	2
14.	High speed diesel tank level low	1
15.	Spare	10

Location: Substation Control Room

i) Indication lamp showing power supply 'ON'

i. Provision shall be made in the panel for a signal for spray ON for each Transformer for employer's use for event logger.

ii. Each Switchyard panel room shall be considered as separate zone for fire detection and alarm system.

iii. Following annunciations shall be provided.

1. Fire in Transformer	1 for each equipment
2. Diesel engine driven fire water pump in operation	1
3. Motor driven fire water pump in operation	1

4. Jockey pump in operation 1
5. Firefighting Water storage tank level Low 2
6. Fire/Fault (zone alarm module) 1+1(duplicate) 2
   For each zone as applicable
7. Spare windows complete in all respect, with relays 10
8. Spare zone alarm modules
9. Number of future A/c Kiosks required for the bays identified as per SLD

Each annunciation panel shall be provided with a hooter. A hooter in parallel to the hooter in fire panel shall be provided in the security room of substation for alert in case of fire.

Indication for fault in respective areas shall also be provided. Each zone alarm module shall exhibit 'FIRE' and 'FAULT' conditions separately.

Provision for sending data to Remote Control Unit for the following:

i. Fire in Switchyard Panel Room (Switchyard Panel room shall be considered as separate zone for fire detection and alarm system).

ii. Fire in Transformer (1 for each equipment)

iii. Diesel engine driven fire water pump in operation.

iv. Motor driven fire water pump in operation

v. Fire/Fault in Control Room.

vi. Water Storage tank level (low and very low for each storage tank).

vii. High Speed Diesel tank level (low & very low)

viii. AC Mains Supply Healthy/Fail for Main Pump & Jockey Pump

ix. DC Control Supply Healthy/Fail for Main Pump & Jockey Pump

x. DC Control Supply Healthy/Fail for Diesel Engine driven pump.

2.6.5 The control and interlock system for the fire protection system shall meet the following requirements:

1. Electric Motor Driven Fire water Pump

Pump should start automatically when the System header pressure is low.
Pump should be stopped manually only. Pump should also be started manually if required from local control panel.

2. Diesel Engine Driven Standby Pump

The pump should automatically start under any of the following conditions:

a) System Header pressure low.

b) Electric motor operated fire water pump fails to start.

Pump should be stopped manually only. Pump should also be started manually if required from the local control panel. The battery set which is connected for starting of Diesel engine shall not be subjected to boost charge.

3. Jockey Pump

It shall be possible to select any one of the Jockey pumps as main and the other as standby. Main Jockey pump shall start automatically when water pressure in header falls below the set value. If the main jockey pump fails to start then the standby should start. Jockey pump shall stop automatically when the pressure is restored to its normal value. Manual starting/stopping shall be possible from the local control panel.

3. TESTS

3.1 Shop Tests

3.1.1 Shop tests of all major equipment centrifugal pumps, diesel engines, electrical drive motors, piping, valves and specialties, pressure and storage vessels, MCC, electrical panels, controls, instrumentation etc. shall be conducted as specified in various clauses and as per applicable standards/codes.

3.1.2 Shop tests shall include all tests to be carried out at Contractor's works, works of his sub-contractor and at works where raw materials supplied for manufacture of equipment are fabricated. The tests to be carried out shall include but not be limited to the tests described as follows :

i. Materials analysis and testing.

ii. Hydrostatic pressure test of all pressure parts, piping, etc.

iii. Dimensional and visual check.

iv. Balancing test of rotating components.

v. Response of heat/smoke detectors.

vi. Performance characteristics of HVW spray nozzles (projectors).

vii. Flow rate and operational test on Flow control valves.

viii. Operational test of alarm valve (water-motor gang).

ix. Calibration tests on instruments and tests on control panel.

x. Destruction/burst tests on 2% or minimum one (1) no. of hoses and portable type fire extinguishers for each type as applicable. Any fraction number shall be counted as next higher integer.

xi. Performance test on fire extinguishers as required in the code.

3.1.3 In the absence of any Code/Standard, equipment shall be tested as per mutually agreed procedure between the supplier and the Employer.

3.1.4 A comprehensive visual and functional check for panels would be conducted and will include a thorough check up of panel dimensions, material of construction, panel finish, compliance with tubing and wiring specifications, quality of workmanship, proper tagging & locations of instruments/accessories. The wiring check shall be complete point to point ring out and check for agreement with installation drawings and equipment vendor prints of the complete system and an inspection of all field connection terminals and levelling.

3.1.5 All test certificates and reports shall be submitted to the Employer for approval.

3.1.6 The Employer's representative shall be given full access to all tests. The manufacturer shall inform the Employer allowing adequate time so that, if the Employer so desires, his representatives can witness the test.

3.2 Pre-commissioning Tests

3.2.1 General

i. All piping and valves, after installation will be tested hydraulically at a pressure of 150% of design pressure for a period of 30 minutes to check against leak tightness.

ii. All manually operated valves/gates shall be operated throughout 100% of the travel and these should function without any trouble whatsoever, to the satisfaction of the Employer.

iii. All pumps shall be run with the specified fluid from shut off condition to valve wide open condition. Head developed will be checked from the discharge pressure gauge reading. During the test, the pumps and drives shall run smoothly without any undue vibration, leakage through gland, temperature rise in the bearing parts, noise, flow pulsation etc.

iv. All pressure vessels should be tested hydraulically at the specified test pressure, singly or in the system.

v. Painting shall be checked by dry type thickness gauges.

vi. Visual check on all structural components, welding, painting etc. and if doubt arises, these will be tested again.

vii. All test instruments and equipment shall be furnished by the Contractor to the satisfaction of the Employer.

viii. Automatic starting of all the fire pumps by operating the test valves.

ix. Automatic operation of the Jockey pump

x. Operation of the Deluge valve by breaking a detector as well as manual and remote operation of the deluge valve.

xi. Operation of entire annunciation system.

Replacement of fused/damaged quartzoid bulb detectors during the test shall be responsibility of contractor.

3.2.2 After erection at site, the complete HVW spray protection and hydrant system shall be subject to tests to show satisfactory performance for which detailed procedure shall be submitted for Employer's approval.

Full flow tests with water shall be done for the system piping as a means of checking the nozzle layout, discharge pattern and coverage, any obstructions and determination of relation between design criteria and actual performance, also to ensure against clogging of the smaller piping and the discharge devices by foreign matter carried by the water.

Rigidity of pipe supports shall also be checked during the water flow.

3.2.3 All the detectors installed shall be tested for actuation by bringing a suitable source of heat/smoke near the detector and creating a stream of hot air/ smoke over the detector.

The exact procedure of this test shall be detailed out by the Employer to the successful Bidder.

4. SPARE PARTS

The Contractor shall indicate in his scope of supply all the mandatory spares in the relevant schedules. The list of mandatory spares is indicated in 'Chapter 1 – Project Specific Requirement'.

5. HORIZONTAL CENTRIFUGAL PUMPS

5.1 This clause covers the design, performance, manufacturing, construction features and testing of horizontal centrifugal pumps used for the purpose of firefighting.

The materials of the various components shall conform to the applicable BS/ASTM/DIN Standards.

In case of any contradiction with the aforesaid standards and the stipulations as per the technical specification as specified hereinafter, the stipulations of the technical specification shall prevail.

5.2 General Performance Requirements

5.2.1 The pump set shall be suitable for continuous operation at any point within the "Range of operation".

5.2.2 Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum being at shut off.

5.2.3 Pumps shall be capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of rated head. Range of operation shall be 20% of rated flow to 150% of rated flow.

5.2.4 The pump-motor set shall be designed in such a way that there is no damage due to the reverse flow through the pump which may occur due to any mal-operation of the system.

5.2.5 Drive Rating

The drive rating shall not be less than the maximum power requirement at any point within the "Range of Operation" specified.

During starting under reverse flow condition, the motor shall be capable of bringing the pump to rated speed at normal direction with 90% rated voltage at motor terminals.

Pump set along with its drive shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall guided by applicable standards.

The Contractor under this specification shall assume full responsibility in the operation of the pump and drive as one unit.

5.3 Design & Construction

5.3.1 Pump casing may be axially or radially split. The casing shall be designed to withstand the maximum pressure developed by the pump at the pumping temperature.

5.3.2 Pump casing shall be provided with adequate number of vent and priming connections with valves, unless the pump is made self-venting & priming. Casing drain, as required, shall be provided complete with drain valves.

5.3.3 Under certain conditions, the pump casing nozzles will be subjected to reactions from external piping. Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610.

5.3.4 Pump shall preferably be of such construction that it is possible to service the internals of the pump without disturbing suction and discharge piping connections.

5.3.5 Impeller

The impeller shall be secured to the shaft and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft impellers shall be secured to the shaft by an additional locknut or cap screw. All screwed fasteners shall tighten in the direction of normal rotation.

5.3.6 Wearing Rings

Replaceable type wearing rings shall be furnished to prevent damage to impeller and casing. Suitable method of locking the wearing ring shall be used.

5.3.7 Shaft

Shaft size selected shall take into consideration the critical speed, which shall be at least 20% away from the operating speed. The critical speed shall also be atleast 10% away from runaway speed.

5.3.8 Shaft Sleeves

Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing or seal and plate so as to distinguish between the leakage between shaft & shaft sleeve and that past the seals/gland.

5.3.9 Shaft sleeves shall be securely fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.

5.3.10 Bearings

Bearings of adequate design shall be furnished for taking the entire pump load arising from all probable conditions of continuous operation throughout its "Range of Operation" and also at the shut-off condition. The bearing shall be designed on the basis of 20,000 working hours minimum for the load corresponding to the duty point.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.

5.3.11 Stuffing Boxes

Stuffing box design shall permit replacement of packing without removing any part other than the gland. Stuffing boxes shall be sealed/cooled by the fluid being pumped and necessary piping, fittings, valves, instruments, etc. shall form an integral part of the pump assembly.

5.3.12 Shaft Couplings

All shafts shall be connected with adequately sized flexible couplings of suitable design. Necessary guards shall be provided for the couplings.

5.3.13 Base Plates & Sole Plate

A common base plate mounting both for the pump and drive shall be furnished.

The base plate shall be of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimise misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc. Suitable drain taps and drip lip shall be provided.

5.3.14 Material of Construction

All materials used for pump construction shall be of tested quality. Material of construction of the major parts of the pumps shall be as given below or superior as per relevant latest International standards:

a)	Casing	Casting Grade 17 of BS 1452
b)	Impeller	Bronze Grade LG2-C of BS1400
c)	Wearing ring	Bronze Grade LG2-C of BS1400
d)	Shaft	Mild Steel.
e)	Shaft sleeve	Bronze Grade LG2-C of BS1400
f)	Stuffing box	2.5% Nickel CI Grade 17 of BS 1452
g)	Gland	--- do ---

5.3.15 Balancing

All rotating components shall be statically and dynamically balanced at shop.

5.3.16 All the components of pumps of identical parameters supplied under this specification shall be interchangeable.

5.4 Tests and Inspection

5.4.1 The manufacturer shall conduct all routine tests required to ensure that the equipment furnished conform to the requirements of this specification and are in compliance with the requirements of applicable Codes and Standards. The particulars of the proposed tests and the procedures for the tests shall be submitted to the Employer/Engineer for approval before conducting the tests.

5.4.2 Where stage inspection is to be witnessed by Employer, in addition to above, the Bidder shall submit to the Employer/Engineer at the beginning of the contract, the detailed PERT-Chart showing the manufacturing programme and indicating the period where Employer or his authorised inspecting agency are required at the shop.

5.4.3 Material of Construction

All materials used for pump construction shall be of tested quality. Materials shall be tested as per the relevant standards and test certificates shall be made available to the Employer/Engineer.

5.4.4 Where stage inspection is to be witnessed by Employer, all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication, by Employer's Inspector who shall stamp the material. In case mill test certificates for the material are not available, the Contractor shall carry out physical and chemical tests at his own cost from a testing agency approved by the Employer, as per the requirements of specified material standard. The samples for physical and chemical tests shall be drawn up in presence of Employer's inspector who shall also witness the tests.

5.4.5 Shaft shall be subjected to 100% ultrasonic test and machined portion of the impeller shall be subject to 100% DP test. On finished shaft DP test will also be carried out.

5.4.6 Hydraulic test at shop

All pressure parts shall be subjected to hydraulic testing at a pressure of 150% of maximum pressure generated by the pump at rated speed or 200% of total dynamic head whichever is higher, for a period not less than one (1) hour.

5.4.7 Performance test at shop

Pumps shall be subjected to routine tests to determine the performance of the pumps. These tests shall be conducted in presence of Employer/Engineer's representative as per the requirements of the ASME Power Test Code PTC 8.2/BS- 599/I.S.S., latest edition. Routine tests shall be done on all the pumps.

5.4.8 Performance tests shall be conducted to cover the entire range of operation of the pumps. These shall be carried out to span 150% of rated capacity upto pump shut-off condition. A minimum of five combinations of head and capacity are to be achieved during testing to establish the performance curves, including the design capacity point and the two extremities of the Range of operation specified.

5.4.9 Tests shall preferably be conducted along with the actual drives being supplied.

5.4.10 The Bidders shall submit in his proposal the facilities available at his works to conduct performance testing. If because of limitations of available facilities, a reduced speed test or model test has to be resorted to establish pump performance, the same has to be highlighted in the offer.

5.4.11 In case of model testing, the stipulations of latest edition of applicable standards shall be binding. Prototype or model tests, however, shall be conducted with the suction condition identical to the field conditions i.e., sigma values of prototype and model is to be kept same.

5.4.12 Prior to conducting model testing, calculations establishing model parameters, sizes and test procedure will be submitted to Employer/Engineer for approval.

5.4.13 All rotating components of the pumps shall be subjected to static and dynamic balancing tests.

5.4.14 The Employer or his authorised representative shall have full access to all tests. Prior to performance tests, the Contractor shall intimate the Employer allowing adequate time so that if the Employer so desires, his representative can witness the test.

5.4.15 Report and test certificates of the above tests shall be submitted to the Employer/Engineer for approval.

5.4.16 Pre commissioning tests.

After installation, pumps offered may be subjected to testing at field also by Employer. If the performances at field are not found to meet the requirement, then the equipment shall be rectified by the Contractor without any extra cost. Prior to performance testing, the procedure for such tests will be mutually agreed between Employer and Contractor. The Contractor shall furnish all necessary instruments, accessories and personnel for testing. Prior to testing, the calibration curves of all instruments and permissible tolerance limit of instruments shall be mutually agreed upon.

6. DIESEL ENGINE

This Clause covers the design, performance, manufacturing construction features and testing of compression ignition diesel engines, used primarily for driving centrifugal pumps, used for the purpose of firefighting.

6.1 Design and Construction - General

6.1.1 The diesel engine shall be of multicylinder type four-stroke cycle with mechanical (airless) injection, cold starting type.

6.1.2 The continuous engine brake horse power rating (after accounting for all auxiliary power consumption) at the site conditions shall be at least 20% greater than the requirement at the duty point of pump at rated RPM and in no case, less than the maximum power requirement at any condition of operation of pump.

6.1.3 Reference conditions for rated output of engine shall be as per ISO: 3046, part I.

6.1.4 The engine shall be designed with regard to ease of maintenance, repair, cleaning and inspection.

6.1.5 All parts subjected to substantial temperature changes shall be designed and supported to permit free expansion and contraction without resulting in leakage, harmful distortion or misalignment.

6.2 Starting

6.2.1 The engine shall be capable of both automatic and manual start. The normal mode of starting is automatic but in the event of failure of automatic start or at the discretion of the operator, the engine can be started manually from the LCP.

Since the fire pumping unit driven by the diesel engine is not required to run continuously for long periods and the operation will not be frequent, special features shall be built into the engine to allow it to start within a very short period against full load even if it has remained idle for a considerable period.

6.2.2 If provision for manual start (cranking) is provided, all controls/ mechanisms, which have to be operated during the starting process, shall be within easy reach of the operator.

6.2.3 Automatic cranking shall be effected by a D.C. motor having high starting torque to overcome full engine compression. Starting power will be supplied from either of the two (2) sets of storage batteries. The automatic starting arrangement shall include a 'Repeat Start' feature for 3 attempts. The battery capacity shall be adequate for 3 (three) consecutive starts without recharging with a cold engine under full compression.

6.2.4 The batteries shall be used exclusively for starting the diesel engine and be kept fully charged all the time in position. Arrangement for both trickle and booster charge shall be provided.

6.2.5 Diesel engine shall be provided with two (2) battery charger units of air-cooled design. The charger unit shall be capable of charging one (1) set of battery at a time. Provision shall, however, be made so that any one of the charger units can be utilised for charging either of the two (2) batteries.

6.2.6 For detail design of battery and battery charger, sub- section Electrical may be referred to.

6.3 Governing System:

The engine shall be fitted with a speed control device, which will control the speed under all conditions of load.

6.3.1 The governor shall offer following features:

i. Engine should be provided with an adjustable governor capable of regulating engine speed within 5% of its rated speed under any condition of load between shut-off and maximum load conditions of the pumps. The governor shall be set to maintain rated pump speed at maximum pump load.

ii. Engine shall be provided with an over speed shut- down device. It shall be arranged to shut-down the engine at a speed approximately 20% above rated engine speed and for manual reset, such that the automatic engine controller will continue to show an over speed signal until the device is manually reset to normal operating position (Vol.II, NFPA, 1978).

6.3.2 The governor shall be suitable for operation without external power supply.

6.4 Fuel System

6.4.1 The diesel engine will run-on High-Speed Diesel.

6.4.2 The engine shall be provided with fuel oil tank of 250 litres capacity. The fuel oil tank shall preferably be mounted near the engine. No fuel oil tank will be provided by the Employer.

6.4.3 The fuel oil tank shall be of welded steel constructed to relevant standards for mild steel drums. The outlet of the tank shall be above the inlet of fuel injection pump of the diesel engine to ensure adequate pressure at suction of injection pump.

6.4.4 The fuel oil tank shall be designed in such a way that the sludge and sediment settles down to the tank bottom and is not carried to the injection pump. A small sump shall be provided and fitted with drain plug to take out sludge/sediment and to drain oil. Adequate hand holes (greater than 80 mm size) shall be provided to facilitate maintenance.

6.4.5 Pipeline carrying fuel oil shall be gradually sloped from the tank to the injection pump. Any valve in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and it shall be locked in the open position. A filter shall be incorporated in this pipeline, in addition to other filters in the fuel oil system. Pipe joints shall not be soldered and plastic tubing shall not be used. Reinforced flexible pipes may also be used.

6.4.6 The complete fuel oil system shall be designed to avoid any air pocket in any part of the pipe work, fuel pump, sprayers/injectors, filter system etc. No air relief cock is permitted. However, where air relief is essential, plugs may be used.

6.4.7 A manual fuel pump shall be provided for priming and releasing of air from the fuel pipelines.

6.5 Lubricating Oil System

Automatic pressure lubrication shall be provided by a pump driven by the crank shaft, taking suction from a sump and delivering pressurised oil through cooler and fine mesh filters to a main supply header fitted in the bed plate casing. High pressure oil shall be supplied to the main and big end bearings, cam-shaft bearings, cam-shaft chain and gear drives, governor, auxiliary drive gears etc. Valve gear shall be lubricated at reduced pressure through a reducing valve and the cams by an oil bath.

6.6 Cooling Water System

Direct cooling or heat exchanger type cooling system shall be employed for the diesel engine. Water shall be tapped from the fire pump discharge. This water shall be led through duplex strainer, pressure breakdown orifice and then after passing through the engine, the water at the outlet shall be taken directly to the sump through an elevated funnel.

6.7 Testing & Inspection

6.7.1 The manufacturer shall conduct all tests required, to ensure that the equipment furnished conforms to the requirement of this sub-section and in compliance with requirements of applicable codes. The particulars of the proposed tests and the procedure for the tests shall be submitted to the Employer for approval before conducting the tests.

6.7.2 At manufacturer's works, tests shall be carried out during and after completion of manufacture of different component/parts and the assembly as applicable. Following tests shall be conducted.

i. Material analysis and testing.

ii. Hydrostatic pressure testing of all pressure parts.

iii. Static and dynamic balance tests of rotating parts at applicable over-speed and determination of vibration level.

iv. MPI/DPT on machined parts of piston and cylinder.

v. Ultrasonic testing of crankshaft and connecting rod after heat treatment.

vi. Dimensional check of close tolerance components like piston, cylinder bore etc.

vii. Calibration tests of all fuel pumps, injectors, standard orifices, nozzles, instruments etc.

viii. Over speed test of the assembly at 120% of rated speed.

ix. Power run test.

x. Performance test of the diesel engine to determine its torque, power and specific fuel consumption as function of shaft speed. Performance test of the

engine shall be carried for 12 hours out of which 1 hour at full load and one hour at 110% overload.

xi. Measurement of vibration & noise.

xii. Adjustment of speed governor as per BS:5514.

xiii. Diesel engine shall be subjected to routine tests as per BS:5514.

7. PIPING, VALVES AND SPECIALITIES

This clause covers the design, manufacture, shop testing, erection, testing and commissioning of piping, valves and specialities.

7.1 Scope

The piping system which shall include but not be limited to the following:

i. Plain run of piping, bends, elbows, tees, branches, laterals, crosses, reducing unions, couplings, caps, expansion joints, flanges, blank flanges, thrust blocks, anchors, hangers, supports, saddles, shoes, vibration dampeners, sampling connections, hume pipes etc.

ii. Gaskets, ring joints, backing rings, jointing material etc. as required. Also all welding electrodes and welding consumables including special ones, if any.

iii. Instrument tapping connections, stubs etc.

iv. Gate and globe valves to start/stop and regulate flow and swing check valves for one directional flow.

v. Basket strainers and Y-type strainers

vi. Bolts, nuts, fasteners as required for interconnecting piping, valves and fittings as well as for terminal points. For pipe connections into Employer's R.C.C. works, Bidder will furnish all inserts.

vii. Painting, anti-corrosive coatings etc. of pipes and equipment.

7.1.1 Adequate number of air release valves shall be provided at the highest points in the piping system to vent any trapped air in the system.

7.2 Design

Material of construction of various pipes shall be as follows:

7.2.1 Buried Pipes

Mild steel black pipes as per ASTM A53 medium grade suitably lagged on the outside to prevent soil corrosion, as specified elsewhere.

7.2.2 Overground Pipes normally full of water

Mild steel black pipes as per ASTM A53 medium grade.

7.2.3 Overground pipes normally empty, but periodic charge of water and for detector line for HVW System**.**

Mild steel galvanised pipes as per ASTM A53 medium grade.

7.2.4 All fittings to be used in connection with steel pipe lines upto a size of 80 mm shall be as per ASTM A53 Mild steel tubulars and other wrought steel pipe fittings, Heavy grade. Fittings with sizes above 80 mm upto 150 mm shall be fabricated from ASTM A53 Heavy grade pipes or steel plates having thickness not less than those of ASTM A53 Heavy grade pipes. Fittings with sizes above 150 mm shall be fabricated as per ASTM A53 standard. All fitting used in GI piping shall be threaded type. Welding shall not be permitted on GI piping.

7.2.5 Pipe sizes shall not be less than the sizes indicated in the attached drawings.

7.2.6 For steel pipeline, welded construction should be adopted unless specified otherwise.

7.2.7 All piping system shall be capable of withstanding the maximum pressure arising from any condition of operation and testing including water hammer effects.

7.2.8 Gate/sluice valve shall be used for isolation of flow in pipe lines and construction shall be as per BS 5150. Valves shall be of rising spindle type and of PN 1.6 class

7.2.9 Gate Valves shall be provided with the following:

i. Hand wheel.

ii. Position indicator.

iii. Locking facility (where necessary).

7.2.10 Gate valves shall be provided with back seating bush to facilitate gland removal during full open condition.

7.2.11 Globe valves shall be provided with contoured plug to facilitate regulation and control of flow. All other requirements should generally follow those of gate valve.

7.2.12 Non-return valves shall be swing check type. Valves will have a permanent "arrow" inscription on its body to indicate direction of flow of the fluid.

7.2.13 Whenever any valve is found to be so located that it cannot be approached manually from the nearest floor/gallery/platform hand wheel with floor stand or chain operator shall be provided for the same.

7.2.14 Valves below 50 mm size shall have screwed ends while those of 50 mm and higher sizes shall have flanged connections.

7.2.15 Basket Strainer

i. Basket strainers shall be of 30 mesh and have the following materials of construction:

ii. Body: Fabricated mild steel (Tested Quality). Strainer Wires: stainless steel (AISI : 316), 30 SWG, suitably reinforced.

iii. Inside of basket body shall be protected by two (2) coats of heavy duty bitumastic paint.

iv. Strainers shall be Simplex design. Suitable vent and drain connections with valves shall be provided.

v. Screen open area shall be at least 4 times pipe cross sectional area at inlet.

vi. Pressure drop across strainer in clean condition shall not exceed and 1 MWC at 273 M3/hr flow (for 220 kV & 132 kV substations). Pressure drop test

report of strainer of same design shall be furnished.

7.2.16 Y-type On-line Strainer

Body shall be constructed of mild steel (tested quality). Strainer wires shall be of stainless steel AISI:316, 30 SWG, 30 mesh. Blowing arrangement shall be provided with removable plug at the outlet. Screen open area shall be at least 4 times pipe cross-sectional area at inlet. Pressure drop test report of strainer of same design shall be furnished.

7.2.17 Hydrant Valve (Outdoor) and Indoor Hydrant Valves (Internal Landing Valves).

The general arrangement of outdoor stand post assembly, consisting of a column pipe and a hydrant valve with a quick coupling end shall be as per TAC requirement.

Materials of construction shall be as follows or superior:

i. Column pipe M.S. ASTM A53 med. grade.

ii. Hydrant Valve - Body Stainless steel**,** Trim Leaded tin bronze.

iii. Hand Wheel - Cast Iron.

iv. Washer, gasket, etc. Rubber.

v. Quick coupling Leaded tin bronze connection

vi. Spring Phosphor Bronze.

vii. Cap and chain Leaded tin bronze

The general design of hydrant valve shall conform to relevant latest international standards.

7.2.18 Hoses, Nozzles, Branch pipes and Hose boxes

i. Hose pipes shall be of reinforced rubber-lined canvas construction with nominal size of 63 mm (2 1/2") and lengths of 15 metre or 7.5 metre, as indicated elsewhere.

ii. Hosepipes shall be capable of withstanding an internal water pressure of not less than 35**.7** kg/cm2 without bursting. It must also withstand a working pressure of 8.5 kg/cm2 without undue leakage or sweating.

iii. Each hose shall be fitted with instantaneous spring lock type couplings at both ends. Hose shall be fixed to the coupling ends by copper rivets and the joint shall be reinforced by 1.5 mm galvanised mild steel wires and leather bands.

iv. Branch pipes shall be constructed of copper and have rings of leaded tin bronze at both ends. One end of the branch pipe will receive the quick coupling while the nozzles will be fixed to the other end.

v. Nozzles shall be constructed of leaded tin bronze.

vi. Suitable spanners of approved design shall be provided in adequate numbers for easy assembly and dismantling of various components like branch pipes, nozzles, quick coupling ends etc.

vii. Hose pipes fitted with quick coupling ends, branch pipes, nozzles spanner etc. will be kept in a hose box, which will be located near point of use.

viii. All instantaneous couplings shall be of identical design (both male and

female) so that anyone can be interchanged with another. One male, female combination shall get locked in by mere pushing of the two halves together but will provide leak tightness at a pressure of 8 kg/cm2 of water. Designs employing screwing or turning to have engagement shall not be accepted.

7.3 Fabrication & Erection

7.3.1 The contractor shall fabricate all the pipe work strictly in accordance with the related approved drawings.

7.3.2 End Preparation

i. For steel pipes, end preparation for butt welding shall be done by machining.

ii. Socket weld end preparation shall be sawing/machining.

iii. For tees, laterals, mitre bends, and other irregular details cutting templates shall be used for accurate cut.

7.3.3 Pipe Joints

i. In general, pipes having sizes over 25 mm shall be joined by butt welding. Pipes having 25 mm size or less shall be joined by socket welding/screwed connections. Galvanised pipes of all sizes shall have screwed joints. No welding shall be permitted on GI pipes. Screwed joints shall have tapered threads and shall be assured of leak tightness without using any sealing compound.

ii. Flanged joints shall be used for connections to vessels, equipment, flanged valves and also on suitable straight lengths of pipe line of strategic points to facilitate erection and subsequent maintenance work.

7.3.4 Overground Piping

i. Piping to be laid overground shall be supported on pipe rack/supports. Rack/supports details shall have to be approved by Employer.

ii. Surface of overground pipes shall be thoroughly cleaned of mill scale, rust etc. by wire brushing. Thereafter one (1) coat of red oxide primer shall be applied. Finally two (2) coats of synthetic enamel paint of approved colour shall be applied.

7.3.5 Buried Pipe Lines

iii. Pipes to be buried underground shall be provided with protection against soil corrosion by coating and wrapping with two coats of coal tar hot enamel paint and two wraps of reinforced fibre glass tissue. The total thickness of coating and wrapping shall not be less than 3 mm. Alternatively, corrosion resistant tapes can also be used for protection of pipes against corrosion.

iv. For Coating and wrapping, holiday testing to be performed in line with latest ASTM standards.

v. Buried pipelines shall be laid with the top of pipe one meter below ground level.

vi. At site, during erection, all coated and wrapped pipes shall be tested with an approved Holiday detector equipment with a positive signalling device to

indicate any fault hole breaks or conductive particle in the protective coating.

7.4 General Instruction for Piping Design and Construction

7.4.1 While erecting field run pipes, the contractor shall check, the accessibility of valves, instrument tapping points, and maintain minimum headroom requirement and other necessary clearance from the adjoining work areas.

7.4.2 Modification of prefabricated pipes, if any, shall have to be carried out by the contractor at no extra charge to the Employer.

7.4.3 Welding

i. Welding shall be done by qualified welders only.

ii. Before welding, the ends shall be cleaned by wire brushing, filing or machine grinding. Each weld-run shall be cleaned of slag before the next run is deposited.

iii. Welding at any joint shall be completed uninterrupted. If this cannot be followed for some reason, the weld shall be insulated for slow and uniform cooling.

iv. Welding shall be done by manual oxyacetylene or manual shielded metal arc process. Automatic or semi-automatic welding processes may be done only with the specific approval of Employer/ Consultant.

v. As far as possible welding shall be carried out in flat position. If not possible, welding shall be done in a position as close to flat position as possible.

vi. No backing ring shall be used for circumferential butt welds.

vii. Welding carried out in ambient temperature of 5°C or below shall be heat-treated.

viii. Tack welding for the alignment of pipe joints shall be done only by qualified welders. Since tack welds form part of final welding, they shall be executed carefully and shall be free from defects. Defective welds shall be removed prior to the welding of joints. Electrodes size for tack welding shall be selected depending upon the root opening.

Tacks should be equally spaced as follows **:**

for 65 NB and smaller pipes	:	2 tacks
for 80 NB to 300 NB pipes	:	4 tacks
for 350 NB and larger pipes	:	6 tacks

ix. Root run shall be made with respective electrodes/filler wires. The size of the electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG) and should preferably be 2.3 mm (12 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.

x. Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxyacetylene welding is recommended.

xi. The root run of butt joints shall be such as to achieve full penetration with the

complete fusion of root edges. The weld projection shall not exceed 3 mm inside the pipe.

xii. On completion of each run craters, weld irregularities, slag etc. shall be removed by grinding or chipping.

xiii. Fillet welds shall be made by shielded metal arc process regardless of thickness and class of piping. Electrode size shall not exceed 10 SWG. (3.25 mm). At least two runs shall be made on socket weld joints.

7.5 Tests at Works

7.5.1 Pipes

i. Mechanical and chemical tests shall be performed as required in the codes/standards.

ii. All pipes shall be subjected to hydrostatic tests as required in the codes/standards.

iii. 10% spot Radiography test on welds of buried pipes shall be carried out as per ASME

7.5.2 Valves

i. Mechanical and chemical tests shall be conducted on materials of the valve as required in the codes/standards.

ii. All valves shall be tested hydrostatically for the seat as well as required in the code/standards for a period of ten minutes.

iii. Air test shall be conducted to detect seat leakage.

iv. Visual check on the valve and simple operational test in which the valve will be operated thrice from full open to full close condition.

v. No repair work on CI valve body, bonnet or wedge shall be allowed.

7.5.3 Strainers

i. Mechanical and chemical tests shall be conducted on materials of the strainer.

ii. Strainers shall be subjected to a hydrostatic test pressure of 1.5 times the design pressure or 10 kg/cm^{2}g whichever is higher for a period of one hour.

7.5.4 Hydrant valves and Indoor Hydrant Valves (Internal Landing Valves)

i. The stand post assembly along with the hydrant valve (valve being open and outlet closed) shall be pressure tested at a hydrostatic pressure of 10.5 kg/cm^{2}g to detect any leakage through defects of casting.

ii. Flow test shall be conducted on the hydrant valves at a pressure of 7 kg/cm^{2}g and the flow through the valve shall not be less than 900 litres/min.

iii. Leak tightness test of the valve seat shall be conducted at a hydrostatic test pressure of 7 kg/cm^{2}g.

7.5.5 Hoses, Nozzles, Branch Pipes and Hose Boxes

Reinforced rubber-lined canvas hoses shall be tested hydrostatically. Following tests shall be included as per relevant latest International standard.

i. Hydrostatic proof pressure test at 10.5 kgf/cm2g

ii. Internal diameter

The branch pipe, coupling and nozzles shall be subjected to a hydrostatic test pressure of 10.5 kg/cm2g for a period of $2^1/_2$ minutes and shall not show any sign of leakage or sweating.

Dimensional checks shall be made on the hose boxes and nozzle spanners.

8. AIR VESSELS

8.1 Air vessels shall be designed and fabricated of mild steel as class-II vessels as per BS 5500 for a pressure of 7kg/cm^2 and shall be minimum 3 m^3 capacity.

8.2 Inside surface of the tank shall be protected by anti-corrosive paints/coatings/linings as required.

8.3 Outside surfaces of the vessels shall be provided with one (1) coat of red lead primer with two (2) coats of synthetic enamel paint of approved colour and characteristics.

8.4 Tests & Inspection

8.4.1 Air vessels shall be hydraulically tested at 10.5 kg/cm2 for a period not less than one (1) hour.

8.4.2 All materials used for fabrication shall be of tested quality and test certificates shall be made available to the Employer.

8.4.3 Welding procedure and Welder's qualification tests will be carried out as per relevant International Standard.

8.4.4 NDE tests, which will include 100% Radiography on longitudinal seams and spot Radiography for circumferential seams, for pressure vessel will be carried out.

9. HEAT DETECTORS/FIRE DETECTORS AND SPRAY NOZZLES

9.1 Intent of Specification

This specification lays down the requirements of the smoke detectors, heat detectors and spray nozzles for use in various sub-systems of the fire protection system.

9.2 Codes and Standards

All equipment supplied shall conform to internationally accepted codes and standards.

9.3 Heat Detectors, Quartzoid bulb type. (Used in HVW spray system)

i. Heat detectors shall be of any approved and tested type. Fusible chemical pellet type heat detectors are however not acceptable.

ii. Temperature rating of the heat detector shall be selected by the Bidder taking into consideration the environment in which the detectors shall operate. Minimum set point shall, however, be 79°C.

iii. Heat detectors shall be guaranteed to function properly without any maintenance work for a period of not less than twenty-five (25) years.

iv. The heat detectors shall be mounted on a pipe network charged with water at

suitable pressure. On receipt of heat from fire, the heat detector will release the water pressure from the network. This drop in water pressure will actuate the Deluge valve.

9.4 HVW Spray Nozzles (Projectors)

High velocity water spray system shall be designed and installed to discharge water in the form of a conical spray consisting of droplets of water travelling at high velocity which shall strike the burning surface with sufficient impact to ensure the formation of an emulsion. At the same time the spray shall efficiently cut off oxygen supply and provide sufficient cooling. Integral non-ferrous strainers shall be provided in the projectors ahead of the orifice to arrest higher size particle, which are not allowed to pass through the projectors.

9.5 Fire Detectors (Used in fire detection and alarm system)

9.5.1 Fire detectors shall be approved by FOC-London or similar international authorities.

9.5.2 Both smoke and heat type fire detectors shall be used. Bidder shall clearly indicate the mode of operation of detectors in his proposal.

9.5.3 The set point shall be selected after giving due consideration for ventilating air velocity and cable insulation.

9.5.4 Fire detectors shall be equipped with an integral L.E.D. so that it shall be possible to know which of the detectors has been operated. The detectors, which are to be placed in the space above the false ceiling or in the floor void shall not have the response indicators on the body but shall be provided with remote response indicators.

9.5.5 Approval from competent authority shall be made available for ionisation type smoke detectors. All required accessories shall also be included in the scope of supply.

9.5.6 Fire detectors shall be guaranteed to function properly without any maintenance work for a period of not less than ten (10) years.

10. PORTABLE AND WHEEL/ TROLLEY MOUNTED FIRE EXTINGUISHERS

10.1 This specification lays down the requirement regarding fire extinguishers of following types:

Portable fire extinguishers.

i. Pressurised water type.

ii. Dry chemical powder type

iii. Carbon Dioxide type

iv. Wheel/ Trolley mounted fire extinguishers.

v. Mechanical foam type

All the extinguishers offered by the Bidder shall be of reputed make.

10.2 Design and Construction

i. All the portable extinguishers shall be of freestanding type and shall be

capable of discharging freely and completely in upright position.

ii. Each extinguisher shall have the instructions for operating the extinguishers on its body itself.

iii. All extinguishers shall be supplied with initial charge and accessories as required.

iv. Portable type extinguishers shall be provided with suitable clamps for mounting on walls or columns.

v. All extinguishers shall be painted with durable enamel paint of fire red colour conforming to relevant International Standards.

vi. Pressurisation of water type fire extinguishers shall either be done by compressed air or by using gas cartridge. Both constant air pressure and the gas pressure type shall conform to their latest relevant International standards.

vii. Dry chemical powder type portable extinguisher shall conform to its latest relevant International standards.

viii. Carbon Dioxide type portable extinguisher and Carbon Dioxide type trolley mounted extinguisher shall conform to their latest relevant International standards.

ix. Wheel/ trolley mounted fire extinguishers of 50 litre capacity Mechanical foam type shall conform to its latest relevant International standards.

10.3 Tests and Inspection

i. A performance demonstration test at site of five (5) percent or one (1) number whichever is higher, of the extinguishers shall be carried out by the Contractor. All consumable and replaceable items require for this test would be supplied by the Contractor without any extra cost to Employer.

ii. Performance testing of extinguisher shall be in line of applicable International Standards. In case where no International Standard is applicable for a particular type of extinguisher, the method of testing shall be mutually discussed and agreed to before placement of order for the extinguishers.

10.4 Painting

Each fire extinguisher shall be painted with durable enamel paint of fire red colour conforming to relevant International Standards.

11. INSTRUMENTS

11.1 Intent of Specification

The requirements given in the sub-section shall be applicable to all the instruments being furnished under this specification.

11.2 All field mounted instruments shall be weather and dust tight, suitable for use under ambient conditions prevalent in the subject plant. All field mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance can be achieved.

11.3 Local Instruments

Pressure/ Differential Gauges & Switches.

11.3.1 The pressure sensing elements shall be continuous 'C' bourdon type.

11.3.2 The sensing elements for all gauges/switches shall be properly aged and factory tested to remove all residual stresses. They shall be able to withstand at least twice the full scale pressure/vacuum without any damage or permanent deformation.

11.3.3 For all instruments, connection between the pressure sensing element and socket shall be braced or hard soldered.

11.3.4 Gauges shall be of 150 mm diameter dial with die-cast aluminium, stoved enamel black finish case, aluminium screwed ring and clear plastic crystal cover glass. Upper range pointer limit stop for all gauges shall be provided.

11.3.5 All gauges shall be with stainless steel bourdon having rotary geared stainless steel movements.

11.3.6 Weatherproof type construction shall be provided for all gauges. This type of construction shall be fully dust tight, drip tight, weather resistant and splash proof with anti-corrosive painting conforming to NEMA- 4.

11.3.7 All gauges shall have micrometer type zero adjuster.

11.3.8 Neoprene safety diaphragm shall be provided on the back of the instruments casing for pressure gauges of ranges 0-10 Kg/cm^2 and above.

11.3.9 Scales shall be concentric, white with black lettering and shall be in metric units.

11.3.10 Accuracy shall be + 1.0 percent of full range or better.

11.3.11 Scale range shall be selected so that normal process pressure is approximately 75 percent of full-scale reading. For pressure gauges and pressure switches, the range shall not be less than 0 -16 Kg/cm^2.

11.3.12 All gauges shall have 1/2-inch NPT bottom connection.

11.3.13 All instruments shall conform to their latest relevant International standards.

11.3.14 All instruments shall be provided with 3-way gauge isolation valve or cock. Union nut, nipple and tail pipe shall be provided wherever required.

11.3.15 Switch element contact shall have two (2) NO and two (2) NC contacts rated for 240 Volts, 10 Amperes A.C. or 220 Volts, 5 Amperes D.C. Actuation set point shall be adjustable throughout the range. ON-OFF differential (difference between switch actuation and de-actuation pressures) shall be adjustable. Adjustable range shall be suitable for switch application.

11.3.16 Switches shall be sealed diaphragm, piston actuated type with snap action switch element. Diaphragm shall be of 316 SS.

11.3.17 Necessary accessories shall be furnished.

11.4 Timers

11.4.1 The timers shall be electro-mechanical type with adjustable delay on pick-up or reset as required.

11.4.2 Each timer shall have two pairs of contacts in required combination of NO and NC.

11.5 Level Gauges/Indicator/Switches

11.5.1 Level Gauges

i. Gauge glasses shall be used for local level indication wherever shown in the flow diagram.

ii. Gauge glasses, in general, shall be flag glass type with bolted cover. Body and cover material shall be of carbon steel with rubber lining.

iii. Level coverage shall be in accordance with operating requirements. Maximum length of a single gauge glass shall not exceed 1.4 M. Should a larger gauge glass be required, multiple gauges of preferably equal length shall be used with 50 mm overlap in visibility.

iv. Reflex type gauge glasses shall be used for colourless liquids and transparent type gauge glasses shall be used for all liquids having colour.

v. Each gauge glass shall be complete with a pair of offset valves. Valves shall have union bonnet, female union level connection, flanged tank connection, and vent and drain plug.

vi. Offset valves shall have corrosion resistant ball-check to prevent fluid loss in the event of gauge glass breakage. Valve body shall have a working pressure of 200 percent of the maximum static pressure at the maximum process fluid temperature. Valve body materials shall be of carbon steel with rubber lining.

11.5.2 Level Indicators

i. Float type mechanical level gauges with linear scale type indicator shall be offered for measuring level of tanks wherever shown in the flow diagram.

ii. AISI-316 stainless steel float, guide rope and tape shall be used. Housing shall be of mild steel painted with anti-corrosive painting.

iii. The scale indicator shall be provided at a suitable height for ease of reading.

iv. Accuracy shall be + 1% of scale range or better.

11.5.3 Level Switches

i. Level switches shall be of ball float operated magnetic type complete with cage.

ii. Materials of construction shall be suitable for process and ambient conditions. The float material shall be AISI-316 stainless steel.

iii. Actuating switches shall be either hermetically sealed mercury type or snap acting micro-switches. Actuation set point shall be adjustable. ON-OFF differential (difference between switch actuation and de-actuation levels) shall be adjustable. Adjustable range shall be suitable for switch application. All switches shall be repeatable within + 1.0 percent of liquid level change required to activate switch. Contacts shall be rated for 50 watts resistive at 240 V A.C. Number of contacts shall be two NO and two NC for each level switch.

11.6 Solenoid Valves

i. The body of the valves shall be Forged brass or stainless steel.

ii. The coil shall be continuous duty, epoxy moulded type Class-F, suitable for high temperature operation.

iii. The enclosure shall be watertight, dust-tight and shall conform to NEMA-4 Standard.

iv. The valves shall be suitable for mounting in any position.

11.7 Switches, Lamps, Meters Etc.

All electrical components on the panel namely push buttons, switches, lamps, meters etc. shall meet the requirements of sub-section Electrical enclosed with the specification.

11.8 All local instruments shall be inspected by Employer/Consultant as per the agreed quality plan.

11.9 Makes of control panel and local instruments, accessories shall be as per Employer's approval.

12. ELECTRIC MOTORS

12.1 General

12.1.1 This clause covers the requirements of three phase squirrel cage induction motors and single-phase induction motors.

12.1.2 12.01.02 The motors to be furnished, erected and commissioned as covered under this specification shall be engineered, designed, manufactured, erected, tested as per the requirements specified herein. These requirements shall however be read along with the requirements of the respective driven equipment being supplied under the specification of which this specification forms a part.

12.1.3 The motor supplied under this specification shall conform to the standards specified in GTR.

12.1.4 Terminal point for all motors supplied under this specification shall be at the respective terminal boxes.

12.1.5 Materials and components not specifically stated in this specification but are necessary for satisfactory operation of the motor shall be deemed to be included in the scope of supply of this specification.

12.1.6 Notwithstanding anything stated in this motor specification, the motor has to satisfy the requirement of the mechanical system during normal and abnormal conditions. For this the motor manufacturer has to co-ordinate with the mechanical equipment supplier and shall ensure that the motor being offered meets the requirements.

12.2 Codes & Standards

12.2.1 The design, manufacture, installation and performance of motors shall conform to the provisions of latest Electricity Act and Electricity Rules. Nothing in these specifications shall be construed to relieve the Contractor of his responsibility.

12.2.2 In case of contradiction between this specifications and IEC, the stipulations of this specification shall be treated as applicable.

12.2.3 National Electrical code for hazardous location and relevant NEMA standard shall also be applicable for motors located in hazardous location.

12.3 Design Features

12.3.1 Rating and type

i. The induction motors shall be of squirrel cage type unless specified otherwise.

ii. The motors shall be suitable for continuous duty in the specified ambient temperature.

iii. The MCR KW rating of the motors for 50oC ambient shall not be less than the power requirement imposed at the motor shaft by the driven equipment under the most onerous operation conditions as defined elsewhere, when the supply frequency is 51.5 Hz (and the motor is running at 103% of its rated speed).

iv. Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously in the system having the following particulars:

a)	Rated terminal voltage	
	From 0.2 to 200 KW	400V (3 Phase, solidly earthed)
	Below 0.2 KW	230 V (1 Phase, solidly earthed)
	Variation in voltage	$\pm$ 6%.
b)	Frequency	50 Hz $\pm$ 3%.
c)	Any combination of (a) & (b)	

12.3.2 Enclosure

Motors to be installed outdoor and semi-outdoor shall have hose proof enclosure equivalent to IP-55. For motors to be installed indoor, the enclosure shall be dust proof equivalent to IP-54.

12.3.3 Cooling method

Motors shall be TEFC (totally enclosed fan cooled) type.

12.3.4 Starting requirements

12.3.4.1.1 Induction motor

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

ii. Motors shall be capable of withstanding the electro-dynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

iii. The starting current of the motor at rated voltage shall not exceed six (6) times the rated full load current subject to tolerance as given in IEC 60034.

iv. Motors when started with the driven equipment imposing full starting torque under the supply voltage condition specified under Clause 12.3.1 (iv) (a) shall

be capable of withstanding at least two successive starts with coasting to rest between starts and motor initially at the rated load operating temperature. The motors shall also be suitable for three equally spread starts per hour, the motor initially at a temperature not exceeding the rated operating temperature.

v. The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than the starting time with the driven equipment at minimum permissible voltage (clause 12.3.4 (i) (a) by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

12.3.5 Running requirements

i. When the motors are operating at extreme condition of voltage and frequency given under clause no.12.3.1 (iv), the maximum permissible temperature rise over the ambient temperature of 50oC shall be within the limits specified in IEC 60034 after adjustment due to increase ambient temperature specified herein.

ii. The double amplitude of motor vibration shall be within the limits specified in IEC/International standards. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

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

iv. Induction motors shall be so designed as to be capable of withstanding the voltage and torque stresses developed due to the difference between the motor residual voltage and incoming supply voltage during fast changeover of buses. The necessary feature incorporated in the design to comply with this requirement shall be clearly indicated in the proposal.

v. Motors shall be capable of developing the rated full load torque even when the supply voltage drops to 70% of rated voltage. Such operation is envisaged for a period of one second. The pull out torque of the induction motors to meet this requirement shall not be less than 205% of full load torque.

vi. The motors shall be capable of withstanding for 10 seconds without stalling or abrupt change in speed (under gradual increase of torque) an excess torque of 60 percent of their rated torque, the voltage and frequency being maintained at their rated value.

vii. Guaranteed performance of the motors shall be met with tolerances specified in respective standards.

12.4 Construction Features

12.4.1 Stator

12.4.1.1 Stator frame

The stator frames and all external parts of the motors shall be rigid fabricated steel or of casting. They shall be suitably annealed to eliminate any residual stresses introduced during the process of fabrication and machining.

12.4.1.2 Stator core

The stator laminations shall be made from suitable grade magnetic sheet steel varnished on both sides. They shall be pressed and clamped adequately to reduce the core and teeth vibration to minimum.

12.4.1.3 Insulation and winding

All insulated winding conductor shall be of copper. The overall motor winding insulation for all 400 volts motors shall be of epoxy thermosetting type i.e., class 'F' but limited to class-B operating from temperature rise consideration. Other motors may be of conventional class-B type. The windings shall be suitable for successful operation in hot, humid, tropical climate with the ambient temperature of 50°C.

12.4.2 Rotor

i. Rotors shall be so designed as to keep the combined critical speed with the driven equipment away from the running speed by at least 20%.

ii. Rotors shall also be designed to withstand 120 % of the rated speed for 2 minutes in either direction of rotation.

12.4.3 Terminal box leads

i. For motors of 400 Volts and below a single terminal box may be provided for power and accessories leads.

ii. Terminal boxes shall be of weatherproof construction designed for outdoor service. To eliminate entry of dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame.

iii. Terminal box shall be suitable for top and bottom entry of cables.

iv. Unless otherwise approved, the terminal box shall be capable of being turned through 360o in steps in 90o.

v. The terminals shall be complete with all accessories for connecting external cables. They shall be designed for the current carrying capacity and shall ensure ample phase to phase to ground clearances.

vi. Suitable tinned brass compression type cable glands and cable lugs shall be supplied by the Contractor to match Employer's cable.

vii. Terminal box for single core cable shall be of non- magnetic material.

viii. Marking of all terminals shall be in accordance with IEC / International standard..

12.4.4 Rating Plates

12.4.4.1 Rating plates shall be provided for all motors giving the details as called for in IEC 60034 (for three phase squirrel cage induction motors).

12.4.4.2 In addition to above, the rating plate shall indicate the following:

i. Temperature rise in °C under normal working conditions.

ii. Phase sequence corresponding to the direction of rotation for the application.

iii. Bearing identification number (in case of ball/ roller bearing) and recommended lubricants.

12.4.5 Other Constructional Features

i. Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of Employer's earthing conductor to be specified to the successful Bidder.

ii. Motor weighing more than 25 kg shall be provided with eyebolts, lugs or other means to facilitate lifting.

12.5 Paint and Finish

12.5.1 Motor external parts shall be finished and painted to produce a neat and durable surface, which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all sharp edges and scales removed and treated with one coat of primer and two coats of grey enamel paint.

12.5.2 Motor fans shall also be painted to withstand corrosion.

12.5.3 All fasteners used in the construction of the equipment shall be either of corrosion resistant material or heavy cadmium plated.

12.5.4 Current carrying fasteners shall be either of stainless steel or high tensile brass.

12.6 Tests at Manufacturers Works

12.6.1 Motors shall be subject to routine tests in accordance with IEC 60034.

12.6.2 In addition, the following tests shall also be carried out :

i. 20% over speed test for 2 minutes on all rotors.

ii. Measurement of vibration.

iii. Measurement of noise level.

iv. Phase sequence and polarity checks relative to mechanical rotation.

12.6.3 Tests after installation at site

i. After installation and commissioning at site, the motors along with the driven equipment shall be subject to tests to ascertain their conformity with the requirement of this specification and those of the driven equipment specification and the performance data quoted by the Bidder.

ii. In case of non-conformity of the motor with these specifications and performance requirement, the Engineer may at his discretion reject or ask for necessary rectification/replacement as detailed in general Terms and Conditions of Contract (GCC) Volume-I.

13. BATTERY & BATTERY CHARGERS

This clause covers the design, performance, manufacturing, construction features and testing of Battery and Battery charger used primarily for starting the diesel engine driving the fire water pumps. Battery Chargers shall be housed in Diesel Engine Panel.

13.1 General Information

i. The equipment specified hereinafter are required for starting the diesel engines and other operation of the plant as required.

ii. For each diesel engine there shall be two (2) sets of Battery and two (2) sets of Battery Charger.

iii. The D.C. voltage shall be obtained normally after necessary rectification by battery charger. The Battery Charging system shall be capable of meeting the following requirements:

iv. Float charging the Battery.

v. Boost Charging the Battery.

vi. The battery shall be large enough to crank the engine 3 times without charging in between and without getting drained to an extent which will affect its life.

vii. The Bidder shall indicate the battery voltage and battery capacity in Ampere-Hour at ten (10) hour discharge rate. The battery voltage at any time during operation shall not be less than the minimum voltage required for operation of the D.C. loads.

13.2 General Design

The Battery shall be located indoor.

13.2.1 Battery

i. The cells shall be lead-acid type. The Battery shall be automotive type.

ii. The cells shall be sealed in type with anti-splash type vent plug.

iii. The cell terminal posts shall be provided with connector bolts and nuts, effectively coated with lead to prevent corrosion. Lead or lead coated copper connectors shall be furnished to connect up cells of battery set.

iv. Positive and Negative terminal posts shall be clearly and indelibly marked for easy identification.

v. The electrolyte shall be of battery grade Sulphuric Acid. Water for storage batteries conforming to relevant standards shall be used in the preparation of the electrolyte.

13.2.2 Battery Charger

i. The Bidder shall furnish the battery charging scheme complete with all necessary accessories such as transformers, switches, fuses, starters, contactors, diodes, ammeters, voltmeters and other devices as required for trouble free operation. All devices and equipment shall conform to relevant International Standard or shall be Superior to it.

ii. The scheme of the battery charger shall be such that the battery can be

charged automatically as well as manually.

iii. The boost charger shall have sufficient capacity to restore a fully discharged Battery to a state of full charge in eight (8) hours with some spare margin over maximum charging rate. Suitable provision shall be kept so that, for a particular engine, any of the two (2) charger units can be used for charging any of the two (2) batteries.

iv. The instruments, switches and lamps shall be flush/semi-flush mounted on the front panel. Name plate of approved type shall be provided for each of these equipment.

v. The panel shall be complete with internal wiring and input-output terminal block. Terminal blocks shall be clip on type of suitable rating. All equipment and wire terminals shall be identified by symbols corresponding to applicable schematic/wiring diagram.

vi. Space heaters of adequate capacity shall be provided to prevent moisture condensation in the panel.

13.3 Testing

13.3.1 The Battery Charger shall also be subjected to the following tests at manufacturer's works as per IEC 60146.

i. Insulation test.

ii. Connection checking.

iii. Measurement of voltage regulation.

iv. Auxiliary of devices.

v. Alternating current measurement.

vi. Performance test.

vii. Temperature rise test.

13.3.2 Following acceptance tests shall be carried out in batteries as per IEC/International standard.

i. Marking and packing

ii. Verification of dimensions

iii. Test for capacity

iv. Test for voltage during discharge

Battery and battery charger shall be checked for auto charging and providing sufficient power for three consecutive starting kicks to diesel engine within five minutes with A.C. supply switched off.

14. CONTROL & ANNUNCIATION PANELS

14.1 Intent of Specification

The following requirement shall be applicable to the control and annunciation panels furnished under these specifications.

14.2 General Information

The equipment specified herein are required for controlling, metering, monitoring and indication of electrical systems of the plant offered.

The selection and design of all the equipment shall be so as to ensure reliable and safe operation of the plant and shall be subjected to approval by the Employer.

The reference ambient temperature outside the panel shall be taken as 50oC and relative humidity 100%.

14.3 Equipment to be Furnished

Control & annunciation panels shall be furnished complete with all accessories and wiring for safe and trouble-free operation of the plant. Details are included in sub-section General.

14.4 Constructional Details

i. The panel frames shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2.5 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary.

ii. Panels shall be of free-standing type and shall be provided with hinged door with locking arrangement. The access doors, cutest and covers shall be equipped with neoprene/synthetic rubber gaskets (conforming to IEC 60149) all around and the latches sufficiently strong to hold them in alignment when closed. The panels to be installed outdoor or semi outdoor shall have a degree of protection of IP:55 and those installed indoor shall have a degree of protection of IP:52 as per IEC 60947.

iii. If a panel consists of a number of panels, each panel should be mounted side by side and bolted together to form a compact unit, when two panels meet, the joints shall be smooth, close fittings and un-obstructive.

iv. Removable eye bolt or lifting lugs shall be provided on all panels to facilitate easy lifting.

v. The heights of all operating equipment on the panel shall be between 800 mm to 1600 mm from the finished floor level. The proper supporting arrangement shall be provided by the Contractor.

vi. Cable entries to the panel may be from bottom or top. The cable entry required will be intimated to the successful Bidder. A suitable removable gland plate of 3 mm thick shall be mounted not less than 200 mm above the floor level.

vii. All equipment mounted on the front face of the panels shall be flush or semi-flush type. All equipment shall be so located that their terminal and adjustment are readily accessible for inspection or maintenance and their removal and replacement can be done without interruption of service to other equipment. The contractor shall submit the panel general arrangement drawings clearly bringing out internal mounting details, dimensions of equipment, clearance between the equipment and the edges of the panel, for approval.

14.5 Name Plates and Labels

i. Each panel shall be provided with prominent, engraved identification plates for all front mounted equipment. Panel identification name plate shall be provided at front and rear as required.

ii. All name plates shall be of non-rusting metal or 3 ply lamicold, with white engraved lettering on black background. Inscription and lettering sizes shall be subjected to Employer's approval.

iii. Suitable plastic sticker labels shall be provided for easy identification of all equipment located inside the panel. These labels shall be positioned so as to be clearly visible and shall give the device number, as mentioned in the wiring drawings.

14.6 AC/DC Power Supply

i. The Employer will provide one feeder each for AC and DC to the panel. The Contractor shall make for his own arrangements for providing these power supplies to different panels.

ii. The Contractor shall provide suitable isolating switch fuse unit in the control panel for receiving the above incoming AC and DC supplies. Fuse and link shall be provided for isolating of individual circuit without disturbing other circuits.

14.7 Wiring

i. All inter panel wiring and connections between panels (if there is group of panels) including all bus wiring for AC & DC supplies shall be provided by the Contractor.

ii. All internal wiring shall be carried out with 1100 V grade, single core, 1.5 square mm or larger stranded copper wires having colour-coded PVC insulation. CT circuits shall be wired with 2.5 square mm copper wires, otherwise similar to the above.

iii. Extra-flexible wire shall be used for wiring to devices mounted on moving parts such as doors.

iv. Spare contacts of auxiliary relays, timers and switches shall be wired out to the terminal blocks as required by the Employer/Engineer at the time of detailed engineering.

14.8 Terminal Blocks

i. Terminal Blocks shall be of 650V grade, rated for 10 Amps and in one-piece moulding. It shall be complete with insulating barriers, clip-on-type terminals, and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be similar to 'Elmex-Standard' type terminals.

ii. Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal block.

iii. The terminal blocks shall have at least 20% spare terminals.

14.9 Grounding

A continuous copper bus 25 x 3 mm size shall be provided along the bottom of the panel structure. It shall run continuously throughout the length of the panel and shall have provision at both ends for connection to the station grounding grid (25 x 6 mm MS Flat).

14.10 Space Heater and Lighting

i. Space heaters shall be provided in the panels for preventing harmful moisture condensation.

ii. The space heaters shall be suitable for continuous operation on 230V AC, 50 Hz, and single-phase supply and shall be automatically controlled by thermostat. Necessary isolating switches and fuses shall also be provided.

iii. Free standing panel shall have a 230 V AC, plug point and a fluorescent light operated by door switch.

14.11 Control and Selector Switches

i. Control and selector switches shall be of rotary type, with escutcheon plates clearly marked to show the function and positions.

ii. Control/selector switches shall be spring return or stay put type as per the requirements. Handles of control/selector switches shall be black in colour. Shape and type of handles shall be to the approval of the Employer.

iii. The contact ratings shall be at least the following:

- Make and carry continuously 10 Amp.
- Breaking current at 240V DC 1 Amp. (Inductive)
- Breaking current at 240V DC 5 Amp. at 0.3 p.f. lagging

14.12 Push Buttons

i. Push buttons shall be spring return, push to actuate type and rated to continuously carry and break 10A at 230V AC and 0.5A (Inductive) at 220V DC. The push buttons shall have at least 1 NO and 1 NC contact. All contact faces shall be of silver or silver alloy.

ii. All push buttons shall be provided with integral escutcheon plates marked with its function.

iii. The colour of buttons shall be as follows:

Green For motor START, Breaker CLOSE, Valve/ damper OPEN.

Red For motor TRIP, Breaker OPEN, Valve/ damper CLOSE.

Black For all annunciation functions, overload reset and miscellaneous.

iv. Red push buttons shall always be located to the left of green push buttons. In case of clinker grinder etc. the push buttons would be black-red-green from left to right.

14.13 Indicating Lamps

i. Indicating lamps shall be of the panel mounting, filament type and of low-

watt consumption. Lamps shall be provided with series resistors preferably built-in- the lamps assembly. The lamps shall have escutcheon plates marked with its function, wherever necessary.

ii. Lamp shall have translucent lamp covers of the following colours :

Red for motor OFF, Valve/damper OPEN, Breaker CLOSED.
Green for motor ON, Valve/damper CLOSED, Breaker OPEN.
White for motor AUTO-TRIP.
Blue for all healthy conditions (e.g. control supply, lub oil pressure and also for spring charged).
Amber for all ALARM conditions (e.g. pressure low, over load and also for 'service' and 'Test' position indication).

iii. Bulbs and lamps covers shall be easily replaceable from the front of the panel.

iv. Indicating lamps should be located directly above the associated push button/control switches. Red lamps shall variably be located to the right of the green lamp. In case a white lamp is also provided, it shall be placed between the red and green lamps. Blue and amber lamps should normally be located above the red and green lamps.

14.14 Fuses

i. All fuses shall be of HRC cartridge plug-in-type and shall be of suitable rating, depending upon circuit requirements.

ii. All fuses shall be mounted on fuse carriers, which shall be mounted on fuse-bases.

14.15 Contactors

i. Contactors shall be of air break, electromagnetic type rated as per requirement.

ii. Operating coils of AC contactors shall be of 230 V AC or 220 V DC as required. AC contactors shall operate satisfactorily between 85 % to 110 % of the rated voltage. The Contactor shall not drop out at 70 % of the rated voltage.

iii. DC contactors shall have a coil voltage of 220 V DC and shall be suitable for satisfactory continuous operation at 80% to 110% of the rated voltage.

14.16 Relays and Timers

i. All auxiliary relays & timers shall be of proven design and of reputed make. Contacts of relays and timers shall be of solid silver or silver cadmium oxide or solid silver faced. Timers shall have the provision to adjust the delay on pick-up or reset as required.

ii. All relays and timers shall have at least two NO and two NC contacts.

iii. All relays and timers shall be suitable for 230V AC and 220V DC as required. DC relays shall operate satisfactorily between 70 % to 110 % and AC relays shall be suitable for voltage variation between 80 % to 110 %.

14.17 Indication Instruments

i. All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90 degree scales and shall have an accuracy class of 2.0 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.

ii. All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment removing or dismantling the instruments.

iii. All instruments shall have white dials with black numerals and lettering. Black knife edge pointer with parallax free dials will be preferred.

iv. Ammeters provided on motor feeders shall have a compressed scale at the upper current region to cover the starting current.

14.18 Annunciation System

i. The annunciation system shall be complete with all necessary relays, flashers and other accessories required for the proper operation of the equipment and shall be completely solid state. The control circuit shall be mounted on plug-in type glass epoxy printed circuit boards. Audible alarms for the system shall be mounted inside the panel. One set of acknowledge, test and reset push buttons shall be mounted on the panel.

ii. Indications shall be engraved on Acrylic inscription plate window and shall be visible clearly when the indication lamp is lighted (black letters on white background). Each window shall be provided with two lamps.

iii. Audible hooter shall sound when a trouble contact operates and shall continue to sound until the acknowledge button is pressed. In addition to the hooters provided on annunciation panels, a hooter shall be provided outside FFPH which shall sound in any fire alarm condition.

iv. Indication lamps shall flash when trouble contact operates and shall continue flashing until acknowledge button is pressed.

v. After acknowledge button is pressed, the hooter and flashing shall stop but the indication lamp shall remain lighted.

vi. After trouble is cleared indication lamps shall be ready and shall go off only when reset.

vii. Silencing the hooter in conjunction with one trouble contact shall not stop and hooter sounding if another trouble contact operates.

viii. When test button is pressed, all lamps shall flash and hooter shall sound.

ix. Annunciator systems shall operate on 220V DC Systems.

x. The annunciation system shall include alarm for AC control system failure (working on DC supply), DC supply failure (working on AC supply) and test facilities for these alarms.

xi. List of annunciations required on the panels has been listed elsewhere. The Contractor shall also provide additional annunciations if desired by the Employer/Engineer during Vendor drawing review stage and for such

additional annunciations no extra charges shall be claimed by the Contractor, if the number of such additions are within 10% of the number stipulated in this specification.

xii. 20 % spare windows shall be provided on the panel.

14.19 Painting

Painting procedure adopted shall conform to requirements given in GTR. The paint thickness shall not be less than 60 microns. Finished parts shall be coated by peelable compound by spraying method to protect the finished surface from scratches, grease, dirt and oily spots during testing, transportation handling and erection.

14.20 Tests

Following tests/inspection shall be carried out by the Contractor in the presence of Employer's representative:

14.20.1.1 Factory Tests

i. Compliance with approved drawings, data and specification.

ii. Visual check for workmanship.

iii. Wiring continuity and functional checks.

iv. Calibration of instruments, relays and metres wherever required by inspector.

v. HV test

vi. Insulation resistance measurement before and after HV test.

14.20.1.2 Inspection/Testing at site:

i. IR test before and after HV test

ii. HV Test

14.20.1.3 Functional Testing.

i. The Fire detection and annunciation panel shall be subjected to functional tests.

ii. The Annunciation System shall be routine tested.

CHAPTER 13

POWER AND CONTROL CABLES

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CHAPTER 13: POWER & CONTROL CABLES

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

1.1 CRITERIA FOR SELECTION OF POWER AND CONTROL CABLES

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

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

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

1.1.4 Employer has standardized the sizes of power cables for various feeders. Bidders are to estimate the quantity of cables and quote accordingly. The sizes of power cables to be used per feeder in different application shall be as follows:

SN	From	To	Cable size	Cable type
1.	Main Switch Board	LT Transformer	1-1C X 400 mm2	XLPE
2.	Main Switch Board	AC Distribution Board	1-3½C X 300 mm2	XLPE
3.	Main Switch Board	HVW pump LCP	1-3½C X 300 mm2	XLPE
4.	Main Switch Board	Main Lighting distribution board	1-3½C X 95 mm2	XLPE
5.	AC Distribution Board	Emergency Lighting distribution board	1-3½C X 70 mm^2	PVC
6.	AC Distribution Board	Transformer MB	1-3½C X 70 mm^2	PVC
7.	AC Distribution Board	Bay MB	1-3½C X 70 mm^2	PVC
8.	Bay MB	AC Kiosk	1- 3 ½ x 70 mm^2	PVC
9.	AC Distribution Board	Battery Charger	1-3½C X 70 mm^2	PVC
10.	DCDB	Battery	2-1C X 150 mm^2	PVC
11.	DCDB	Battery Charger	2-1C X 150 mm^2	PVC
12.	DCDB	Protection Panel	1-4C X 16 mm^2	PVC
13.	Main Lighting DB	Lighting panels (Indoor)	1-3½C X 35 mm^2	PVC
14.	Main Lighting DB	Lighting panels (outdoor)	1-3½C X 70 mm^2	PVC
15.	Main Lighting DB	Receptacles (Indoor)	1-3½C X 35 mm^2	PVC
16.	Main Lighting DB	Receptacles (Outdoor)	1-3½C X 70 mm^2	PVC
17.	Lighting Panel	Sub lighting panels	1-4C X 16 mm^2	PVC
18.	Lighting Panel	Street Lighting Poles	1-4C X 16 mm^2	PVC
19.	Lighting Panel/ Sub lighting panels	Lighting Fixtures (Outdoor)	1-2C X 6 mm^2	PVC
20.	Bay MB	Equipment	1-4C X 16 mm^2 /1-4C X 6 mm^2 /1-2C X 6 mm^2	PVC

Specify cable size as per requirement and LT transformer capacity of 315 kVA and fault level of 31.5 kA at 11 kV.

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

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

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

Separate cables shall be used for AC & DC.

Separate cables shall be used for DC1 & DC2.

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

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

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

1.2 TECHNICAL REQUIREMENTS

1.2.1 General

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

1.2.1.2 They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE /PVC insulated L.T. power cables of sizes 240 sq. mm. and above shall withstand without damage a 3-phase fault current of at least 45 kA for at least 0.12 second, with an initial peak of 105 kA in one of the phases at rated conductor temperature (70 degC for PVC insulated cables and 90 degC for XLPE insulated cables). The armour for these power cables shall be capable of carrying 45 kA for at least 0.12 seconds without exceeding the maximum allowable temperature of PVC outer sheath.

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

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

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

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

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

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

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

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

1.2.1.11 Repaired cables shall not be accepted.

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

1.3 XLPE Power Cables

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

1.4 PVC Power Cables

The PVC (70°C) insulated power cables shall be of FR type, C1 category, conforming to IEC: 60502 (Part-I) and its amendments read alongwith this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IEC: 60502. A distinct inner sheath shall be provided in all multicore cables. For multicore armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IEC: 60502 for all cables.

1.5 PVC **Control** Cables

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

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

2. HV POWER CABLES [FOR WORKING VOLTAGES FROM 6.6 KV AND INCLUDING 11 KV]

2.1 *HV* POWER CABLE FOR AUXILIARY POWER SUPPLY

The 11 kV HV cable of 3Cx 240 mm^2 (Copper Conductor) of voltage class as specified for 315 kVA LT transformer for interconnecting LT transformer to the 11 kV busbar and 1Cx 800 mm^2 copper cable for Main transformer incomer to 11 kV bus bar shall be XLPE insulated, armoured cable conforming to IEC: 60502 (Part-2).

Terminating accessories shall conform to IEC 61442-1997/IEC60502-4 1998.

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

2.3 Aluminium conductor XLPE insulated armoured cables shall be used for main power supply purpose for LV System, between distribution boards and for supply for switchgear and control room.

2.4 Constructional Requirements

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

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

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

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

3. CABLE DRUMS

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

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

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

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

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

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

4. TESTS

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

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

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

4.1 Physical tests for insulation

i. Hot set test

ii. Shrinkage test

4.2 Physical tests for outer sheath

i. Shrinkage test

ii. Hot deformation

iii. Heat shock test

iv. Thermal stability

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

i. Water absorption (gravimetric) test.

ii. Ageing in air oven

iii. Loss of mass in air oven

iv. Short time current test on power cables of sizes 240 sq mm and above on

Conductors.
Armours.

v. Test for armouring wires/strips.

vi. Oxygen and Temperature Index test.

vii. Flammability test.

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

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

4.4.1.1 Physical tests for insulation and outer sheath

i. Shrinkage test

ii. Hot deformation

iii. Heat shock test

iv. Thermal stability

4.4.2 High voltage test.

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

i. Ageing in air oven.

ii. Loss of mass in air oven.

iii. Short time current test on power cables of sizes 240 sq mm and above on

Conductors.
Armours.

iv. Test for armouring wires/strips.

v. Oxygen and Temperature Index test.

vi. Flammability test.

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

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

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

CHAPTER 14

HV XLPE POWER CABLE

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CHAPTER 14: HV XLPE POWER CABLE (132 KV)

1. CABLE CONSTRUCTION DETAILS

1.1 The XLPE insulated HV cable shall conform to the requirements of IEC 60502-2 (applicable clauses only) for construction and IEC 60840/IEC 62067 (as applicable) for testing. The terminating accessories shall conform to IEC 60840/ IEC 62067 (as applicable). The offered cables and its terminating accessories shall be compatible with each other.

1.2 The 400 mm2 XLPE cable with 145 kV grade shall be supplied by the contractor. Furthermore, the actual cable sizing can be done by the contractor during Detail Engineering Design as more techno-economical solution.

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

1.4 The cable shall be suitable for lying under the climate conditions (as specified in Chapter 1-Project Specific Requirement) and underground buried installation with uncontrolled back fill and chances of flooding by water.

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

1.6 Progressive sequential marking of the cable length (in meters), at every one meter, shall be provided on the outer sheath of the cable.

1.7 Repaired cables shall not be accepted.

1.8 Allowable tolerance on the overall diameter of the cables shall be + 2 mm.

1.9 CONDUCTOR

The conductor shall be of Copper wires as specified in the Bid Price Schedule. The shape of conductor shall be compacted segmental having high compactness and smooth surface finish.

1.10 CONDUCTOR SCREEN

The conductor screen shall consist of extruded semi-conducting materials and semi-conducting separator tapes may be applied between conductor and the extruded semi-conductor XLPE. The conductors screen (non-metallic semi-conductive) shall be extruded in a single one-time process to ensure homogeneity and absence of voids.

1.11 INSULATION

The extruded XLPE insulation shall be applied over the conductor screen to the desired thickness in a void free manner.

1.12 INSULATION SCREEN

The insulation screen shall consist of extruded semi-conducting material. Suitable bedding tapes shall be applied over the extruded semi-conducting screen.

1.13 MOISTURE BARRIER

i. Longitudinal water barrier:

The longitudinal water barrier shall be applied over insulation screen by a layer of non-woven synthetic tape with suitable water swellable absorbent.

ii. Radial Moisture Barrier:

This shall be of extruded Lead alloy "E" sheath.

1.14 METALLIC SCREEN:

The metallic screen shall be of plain copper wires, helically applied over the radial moisture barrier. A binder tape of annealed plain copper shall be applied in the form of an open helix over the copper wire screen. The combination of the metallic sheath (lead sheath) in combination with wire screen shall be designed to meet the requirement of the system short circuit rating.

1.15 OUTER SHEATH

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

1.16 RATING

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

1.17 CABLE JOINTING ACCESSORIES

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

1.17.2 The straight through joint shall preferably be built up from the same material as the main cable and shall have electrical and mechanical withstand capabilities same as or better than the main cable. The joints shall be suitable for tropical conditions as specified in Chapter 1.

1.17.3 The straight through joints and cable end terminations shall be of proven design and should have been type tested as per relevant IEC. A list of supply of cable jointing accessories which are in successful operation in projects, shall be furnished.

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

1.17.5 The cable end terminations shall be of anti-fog type and shall be of Polymer type/Porcelain type suitable for withstanding the climatic conditions with required Creepage distance as specified in **bidding documents**. The cable end terminals for terminating the cables shall be complete with accessories & fully compatible with the cables to be supplied. The terminations shall also be capable to withstand mechanical forces during normal and short circuit operations.

1.17.6 The cable end terminations envisaged for **mounting on Transmission Line (T/L) Towers** shall necessarily be of Composite Polymer type to reduce the weight on T/L towers. The cable end terminations envisaged for **GIS interface,** shall comply to IEC 60840. It will be the responsibility of the contractor to ensure smooth interface with GIS equipment.

2. CABLE DRUMS

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

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

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

3. TESTS ON CABLES

All XLPE insulated HV cables shall conform to all Type, Routine and Acceptance tests listed in the relevant IEC & shall submit the type test reports for Employer's approval. If specified in Chapter 1-Project Specific Requirement, Type tests shall be carried out on the HV cable as per relevant standard. In addition, following Type Test and Routine Test shall be provided for HV Power Cables.

3.1 Type Test

i. Voltage Test.

ii. Partial discharge test at ambient temperature.

iii. Tan §measurement.

iv. Heating cycle voltage test.

v. Lightning impulse voltage test followed by power frequency voltage test.

vi. Resistivity of semi-conducting screens.

vii. Bending test.

3.2 Routine Tests:

i. Spark test on over sheath.

ii. Dimensional test.

iii. Conductor resistance test.

iv. Conductor screen test.

v. Partial discharge test.

vi. Cable marking and measurement.

vii. Voltage test.

viii. HIPOT Test.

4. TESTS ON ACCESSORIES

Contractor shall submit type test reports for accessories, as per IEC 60840:1999/ IEC 62067 for Employer's acceptance. Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Chapter 2: GTR for Employer's acceptance.

5. TESTS AFTER INSTALLATION

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

6. LAYING AND INSTALLATION

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

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

i. In ducts

ii. In HDPE pipes (pipes to be filled with sand/suitable material after cabling)

iii. In air at terminations

iv. At varying depths due to obstructions

v. As per approved drawings

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

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

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

7. TRENCHING

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

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

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

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

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

8. TREFOIL/FLAT FORMATION

Cables shall be laid in trefoil/flat formation **(as per bidding documents)** for entire route. The contractor shall submit drawings and arrangements for Employer approval.

9. CABLE HANDLING

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

10. DAMAGE TO PROPERTY

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

11. CABLE ROUTE MARKERS/CABLE JOINT MARKERS

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

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

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

12. DEPTH OF LAYING OF CABLES

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

13. PAYING OUT THE CABLE

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

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

14. SAND BEDDING

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

15. SNAKING

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

16. THERMAL BACKFILL

If specifically mentioned in Chapter 1-Project Specific Requirement, Thermal Backfilling shall be carried out based on the evaluation of soil thermal resistivity along the cable route and after approval from the Employer the contractor shall design, specify, supply, lay and monitor the installation of thermal backfill surrounding the cables. Thermal back fill shall be of thermal resistivity of 1.20 Km/W or better.

17. IMMEDIATE ENVELOPE TO CABLE

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

18. BACK FILLING

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

19. WARNING TAPE

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

20. PREVENTION OF DAMAGE DUE TO SHARP EDGES

After the cables have been laid in the trench and until the cables are covered with protective covering, no sharp metal tool shall be used in the trench or placed in such a position that may fall into the trench. Straight and curved rollers used shall have no sharp projecting parts liable to damage the cable. While pulling through pipes and ducts, the cable shall be protected to avoid damage due to sharp edges. The cables shall never be bent, beyond the specified bending radius.

21. ROAD, RAIL & CANAL CROSSINGS

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

21.2 Trenchless Digging:

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

i. Excavation and backfilling of trial pits and verification of soil condition

ii. Excavation of entry and Exit pits

iii. Erection of drill machine for Drilling of pilot hole

iv. Placement and driving hand augur

v. Placement and carrying out impact moling

vi. Reaming and widening of bore holes in steps (if required)

vii. Pulling of product pipe

22. FOOTPATH CUTTING

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

23. REINSTATEMENT

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

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

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

24. MANHOLES

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

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

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

25. TOOLS AND PLANTS

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

26. BENDING RADIUS

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

27. JOINTING AND TERMINATION OF CABLES

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

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

27.3 Sufficient overlap of cables shall be allowed for making the joints.

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

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

27.6 SUMP-HOLES

When jointing cables in water logged ground or under unforeseen rainy conditions, a sump-hole should be made at one end of the joint bay, in such a position so that the accumulated water can be pumped or baled out by buckets, without causing interference to the jointing operation.

27.7 TENTS/COVERS

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

27.8 PRECAUTIONS BEFORE MAKING A JOINT

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

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

27.9 MEASUREMENT OF INSULATION RESISTANCE

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

27.10 IDENTIFICATION

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

27.11 MAKING A JOINT

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

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

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

28. CABLE LAYING & TERMINATIONS

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

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

i. A sufficient length of spare cable shall be left in the ground, for future needs.

ii. The rise of the cable immediately from the ground shall be enclosed in PVC/PE pipe of suitable diameter to protect against direct exposure to the sun.

iii. The cable shall be properly fastened using non-metallic clamps.

iv. Appropriate labels shall be fixed identifying the phase circuit, voltage and date of commissioning etc., on the cable supporting structure.

v. The sealing end shall be mounted on pedestal insulators to isolate them from their supporting steel work.

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

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

29. BONDING OF SCREEN/ SHEATH

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

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

30. CONNECTION OF RADIAL WATER BARRIER AND CABLE SCREEN

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

31. CABLE TERMINATING STRUCTURES

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

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

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

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

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

32. MEASUREMENT (FOR CIVIL WORKS)

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

33. DISTRIBUTED TEMPERATURE MONITORING SYSTEM (DTS)

33.1 The bidder shall include and provide separate “Distributed Temperature Monitoring System (DTS)” for entire route for HV cables complete in all respects along with terminal coupling equipment, workstation and all required hardware & software for real time monitoring of conductor temperature profile and to provide load predictions. The offered

system should be able to provide maximum possible transmission capacity of the cable for each circuit. The distributed temperature monitoring system shall be optical fibre based, must be of proven technology and should be in operation for similar use along with HV cables as per latest practices. The "terminal coupling equipment" and "workstation" shall preferably be microprocessor based with HMI, for displaying temperature along the length of the cable system. System shall provide potential free output contact for signalling to SCADA. The bidder shall provide brochures and catalogues for offered distributed temperature monitoring system along with the bid.

33.2 Optical fibre cables along with all jointing accessories etc required for DTS shall also be included in the scope of bidder. Optical fibre cables associated with DTS shall be laid in the same HV cable trench.

34. OPTICAL FIBRE CABLE (FOR COMMUNICATION EQUIPMENT)

If specified in the bidding documents, Optical fibre cable required for Communication Equipment shall also be laid in the same cable trench in separate HDPE pipe.

CHAPTER 15

AIR CONDITIONING AND VENTILATION SYSTEM

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CHAPTER 15: AIR CONDITIONING AND VENTILATION SYSTEM

1. GENERAL

1.1 This specification covers supply, installation, testing and commissioning and handing over to Employer of Air conditioning system for the control room building and Ventilation system for GIS hall.

1.2 Air conditioning units for control room building shall be set to maintain the inside DBT at 24 o C ± 2oC and the ventilation system shall furnish clean air to the GIS hall.

1.3 Controllers shall be provided in Control room and Battery room for controlling and monitoring the AC units in these rooms as detailed in clause no.2.3.4.

1.4 Each switchgear panel room shall be provided with temperature transducer to monitor the temperature of the panel room. The Temperature transducer shall have the following specification:

i.	Sensor:	Air temperature sensor (indoor use)
ii.	Output:	4 to 20mA
iii.	Temperature range:	-5^{o}C to 60^{o}C
iv.	Resolution:	0.1^{o}C
v.	Accuracy:	0.5^{o}C or better.

2. AIR CONDITIONING SYSTEM FOR CONTROL ROOM BUILDING.

2.1 Air conditioning requirement of control room building shall be met using a combination of following types Air Conditioning units as required.

i. Cassette type split AC units of 2TR.

ii. High wall type split AC units of 2TR and 1.5 TR.

2.2 Scope

2.2.1 The scope of the equipment to be furnished and services to be provided under the contract are outlined hereinafter and the same is to be read in conjunction with the provision contained in other sections/ clauses. The scope of the work under the contract shall be deemed to include all such items, which although are not specifically mentioned in the bid documents and/or in Bidder's proposal, but are required to make the equipment/system complete for its safe, efficient, reliable and trouble-free operation.

i. Required number of Cassette type split AC units of 2TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor unit with cordless remote controller.

ii. Required number of High wall type split AC units of 2TR or 1.5TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor and high wall type indoor evaporator unit with cordless remote controller.

iii. Copper refrigerant piping complete with insulation between the indoor and outdoor units as required.

iv. First charge of refrigerant and oil shall be supplied with the unit.

v. GSS/Aluminium sheet air distribution ducting for distributing conditioned dehumidified air along with supply air diffusers and return air grilles with volume control dampers and necessary splitters etc., suitable fixtures for grilles/diffusers and supports for ducting complete with insulation.

vi. Local start/stop facility for local starting/ stopping of all electrical equipment/ drives.

vii. All instruments and local control panels along with controls and interlock arrangements and accessories as required for safe and trouble-free operation of the units.

viii. PVC drain piping from the indoor units upto the nearest drain point.

ix. Supply and erection of Power and control cable and earthing.

x. MS Brackets for outdoor condensing units, condensers as required.

2.3 Technical specifications.

2.3.1 Cassette type split AC units.

i. The Cassette type AC units shall be complete with indoor evaporator unit, outdoor condensing units and cordless remote-control units.

ii. Outdoor unit shall comprise of hermetically/ semi hermetically sealed compressors mounted on vibration isolators, fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.

iii. Indoor units shall be of 4-way, ceiling mounted cassette type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi-function cordless remote-control unit with special features like programmable timer, sleep mode etc.

iv. Cooling capacity of 2TR AC units shall not be less than 24000btu/hr. and their EER shall not be less than 2.7.

2.3.2 High wall types split AC units

i. The split AC units shall be complete with indoor evaporator unit, outdoor condensing units and cordless remote-control units.

ii. Outdoor unit shall comprise of hermetically/semi hermetically sealed compressors mounted on vibration isolators, propeller type axial flow fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.

iii. The indoor units shall be high wall type. The indoor unit shall be compact

and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi-function cordless remote-control unit with special features like programmable timer, sleep mode and soft dry mode etc.

iv. Cooling capacity of 2TR AC units shall not be less than 24000btu/hr. and 1.5TR AC units shall not be less than 18000btu/hr and shall have energy efficiency rating of 3 star or above.

v. Controllers shall be provided in Control room and Battery room, one controller for each room, to control and monitoring of AC units and shall have the following facilities;

- Standby units shall come in to operation automatically when the running main unit fails
- Main and standby units shall be changed over periodically which shall be finalised during detailed engineering.

vi. Following alarms shall be provided:

- Compressor On/OFF condition of each unit
- Compressor failure of each unit
- Power OFF to AC unit
- High temperature in room.

3. VENTILATION SYSTEM FOR GIS.

3.1 Ventilation system shall be provided in the GIS hall. The ventilation system shall be rugged, reliable, maintenance free and designed for long life. The ventilation system consists of several sets of air supply fans, exhaust fans, air ducts, dehumidifying units. The outside air is blown inside and absorbs heat produced by the electrical equipment and exhaust to outside by natural convection. In case they are required, water cooled chillers shall be delivered and installed within this scope of work (Freon-free refrigerant included). All fans connected with air ducts are centrifugal type.

3.2 The dampers of the Air handling Unit (AHU) room shall be automatically closed by receiving the signal from the fire alarm system, when fire alarm notices a fire in the powerhouse.

3.3 Centrifugal Fan

3.3.1 Motors for V-belt drives shall be provided with adjustable rails or bases. Fans shall be provided with personnel screens or guards on both suction and supply ends except where ducts or dampers are connected to the fan. Fans and motors shall be provided with vibration isolation supports or mountings. Vibration isolation units under floor mounted equipment shall be standard products with published loading ratings, and shall one from be single rubber-in-shear, double rubber-in-shear springs, or springs under inertia base. Each fan shall be selected to produce the specified capacity at outlet velocity not exceeding the recommended one in an applicable code.

3.3.2 The centrifugal fan shall be well balanced both dynamically and statically, and shall operate with low noise and vibration.

3.3.3 The runner vanes shall be made of steel plate, with sufficient protection against corrosion, shall be formed precisely in a uniformly curved shape, and shall be attached sturdily to the side plates which are either riveted or welded to the cast iron boss. The runner shall have sufficient strength to withstand high speed operation without deforming. The side plate of runner shall be reinforced with stay rods as required.

3.3.4 Housing of the fan shall be made of steel plate and shall be so fabricated by riveting or welding as not to permit any leakage, vibration and deformation. A water drain outlet shall be provided at the lower portion of the housing.

3.3.5 Shaft of runner shall be made of high grade carbon steel or special steel with sufficient strength.

3.3.6 Bearings shall be capable of withstanding radial and thrust loads and shall be durable for long and continuous operation for 20,000 hours.

3.3.7 The following accessories shall be provided:

i. Belt cover: complete set;

ii. Flanges for connecting air duct: complete set;

iii. Channel base with bolts: complete set; and

iv. Other necessary accessories: complete set

3.3.8 Air Flow Balancing and Testing

3.3.8.1 Cleaning and adjusting: Inside of ducts, plenums and casing shall be thoroughly cleaned of all debris and blown free of all small particles and dust before the operation commence. Equipment shall be wiped clean free of traces of oil, dust, dirt or paint spots. Bearings shall be properly lubricated and belts tightened to proper tension and control valves adjusted. Fans shall be adjusted to the speed indicated by the manufacturer to meet the specified conditions.

3.3.8.2 Testing: All supply, return and exhaust ducts, plenums and casings shall be tested and made substantially air-tight at the static pressure indicated by the Employer before being covered with insulation or concealed in masonry. “Substantially air-tight” shall mean that no air leakage is noticeable through the senses of feeling or hearing at all duct joints.

3.3.8.3 Balancing: Duct systems shall be balanced to produce air quantities within 10% deviation from that indicated.

3.3.8.4 Noise: Noise generated from any part of the air conditioning system shall not exceed NC 35 in rooms for normal occupancy.

3.3.8.5 Draught: Air velocity in air-conditioned areas for permanent occupancy shall not exceed 0.2 m/s in occupied spaces.

3.3.8.6 Performance tests: Performance tests to demonstrate the capacity specified and general operating characteristics of all equipment shall be conducted including the items below. The tests shall cover a period of not less than 3 days for each system under normal operating conditions of the plant.

i. Fan Air quantity and static pressure, Electric power output

ii. Air outlets and inlets Air quantity, Air velocity

iii. Controls Setting and performance of automatic or safety controls

3.3.8.7 Other than above, abnormal vibration, noise etc. if any, shall be observed during testing and shall be rectified them if those are beyond the allowable limits.

3.4 Duct Work

3.4.1 General: Ducts shall be constructed with galvanized steel sheets. Ducts, unless otherwise approved, shall conform to the dimensions indicated and shall be straight and smooth on the inside, with joints neatly finished. All edges and lips shall be hammered down to leave a smooth interior duct finish. Ducts shall be so constructed and installed as to be completely free from vibration under all conditions of operation. Joints shall be made substantially air-tight to the satisfaction of the Employer at all joint connections, grilles, register, or diffusers. Ducts shall be securely supported with the building structures. Where supports are required between structural members, suitable intermediate metal framing shall be provided. During construction, openings in the air duct shall be covered with a suitable material to prevent dusts from accumulating in the duct. All materials used for duct works shall be approved by the Employer.

3.4.2 Material and Installation

3.4.2.1 Air Duct: Curved elbows shall have a centreline radius of not less than 1.5 times the width or diameter of the ducts.

3.4.2.2 Laps at the joints shall be made in the direction of air flow. Button punch or bolt connections in standing seams shall be spaced at fixed centres not greater than 150 mm. Horizontal locks or seams of the type known as "Button Punch Snap Lock" may be used in lieu of "Pittsburgh Lock".

3.4.2.3 Transformations shall be made with sides pitched not to exceed the maximum of 20 degrees and 40 degrees included the angle for diverging air flow.

3.4.2.4 Other details of duct construction, access doors, hangers, anchors and supports, duct joints, volume dampers, and hood construction shall be as indicated in the approved design.

3.4.2.5 Ducts and stiffeners shall be fabricated in accordance with the following table:

Galvanized Sheet Gauge (thickness in mm)	Longer Side of Duct in cm	Bracing
26 (0.5)	15 x 40	None
24 (0.6)	41x 75	25 x 25 x 3 mm girth angle reinforcing spaced at 180 cm maximum centres
22 (0.8)	76 x 150	30 x 30 x 3 mm girth angle reinforcing spaced at 90 cm maximum centres
20 (1.0)	151 x 225	40 x 40 x 3 mm girth angle reinforcing spaced at 90 cm maximum centres
18 (1.2)	≥ 226	40 x 40x 5 mm girth angle reinforcing spaced at 90 cm maximum centres

Note: ducts with longer sides of 500 mm and over shall have angle flanged joint.

3.4.2.6 The duct supports shall be supported with not less than 2 steel hangers per section and spaced on each section of the duct in accordance with the following table. Support on the risers shall allow free vertical movement of the duct.

Galvanized Sheet Gauge (thickness in mm)	Angle Support	Maximum Spacing
26 (0.5)	25 x 25 x 3 mm	300 cm
24 (0.6)	25 x 25 x 3 mm	300 cm
22 (0.8)	30 x 30 x 3 mm	300 cm
20 (1.0)	40 x 40 x 3 mm	300 cm
18 (1.2)	40 x 40 x 5 mm	300 cm

Hangers shall be steel rod 9 mm in diameter.

3.4.2.7 Air Deflectors: Air deflectors shall be provided in all square elbows, duct-mounted supply outlets, and takeoff of extension collars to supply outlets, and tap-in branch-takeoff connections. Air deflectors shall be factory-fabricated and factory-or-field assembled units consisting of curved turning vanes or louver blades for uniform air distribution and change of direction with minimum turbulence and pressure loss. Square elbows shall be provided with curved vanes.

3.4.3 Diffusers, Registers and Grilles

3.4.3.1 General: Diffusers, registers and grilles shall be the approved products of a manufacturer regularly engaged in the manufacture of such products, and shall be of factory-fabricated of steel or aluminum, and shall distribute the specified quantity of air evenly over space intended, without causing noticeable drafts, or dead spots anywhere in the conditioned area. The Contractor shall be responsible for diffusion, spread, drop, and throw. If, according to the certified data of the manufacturer of the proposed units, the sizes indicated will not perform satisfactorily, the units shall be re-selected to perform quietly and effectively in accordance with the approved manufacturer's recommendations. A schedule of all air inlets and outlets shall be submitted indicating location, types, specified air quantity, neck or face velocity, sound power level values, pressure drop, throw and drop for registers, and maximum and minimum diffusion range for diffusers. Diffusers and registers shall be provided with an opposed-blade volume controller with accessible key operation unless otherwise indicated or, if standard with the manufacturer, an automatically controlled device.

3.4.3.2 Diffusers: Diffusers shall be round and shall be provided with air deflectors of the type indicated. Ceiling mounted units shall be installed with rims tight against ceiling whichever flushed, recessed or surface mounted. Sponge-rubber gasket shall be provided between ceiling and surface mounted diffusers. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to the diffuser shall be air-tight and shall not interfere with volume controller.

3.4.3.3 Registers: Registers shall be of four-way directional control type but return and exhaust registers may be of fixed horizontal or vertical louver type similar in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 15 cm below the ceiling, unless otherwise indicated. Return and exhaust registers shall be located 15 cm above the floor unless otherwise indicated. Four-way directional control may be achieved by grille face which can be rotated in four positions or by adjustment of horizontal and vertical vanes.

3.4.3.4 Grilles: Grilles shall be of type as specified herein for registers, without volume-control damper.

3.4.3.5 Louvres: Louvre blades shall be fabricated with aluminium or stainless-steel sheets, and shall be provided with frames of structural shapes. Blades shall be accurately fitted and firmly secured to frames. Edges of louvre blades shall be folded or beaded for rigidity and baffled to exclude driving rain. Louvres shall be provided with bird screens. Sheet metal thickness shall be as indicated in the approved Drawings or as directed by the Employer.

3.4.4 Dampers

3.4.4.1 Multi-leaf Dampers (MD) : Multi-leaf dampers shall be provided for outside air inlets, for exit air outlets, for mixing of air chambers, for stand-by equipment and as face and by-pass damper, to be used in air chambers, air-handling units and air ducts. Multi-leaf damper shall comprise a frame with built-in aero-foil section blades, made of galvanised sheet steel, which shall be coupled contra-rotating by an external linkage. Including an external lever for manual or motor actuation and combined with an external blade position indicator. All multi-leaf dampers shall be equipped with an electric motor for remote-control. The individual blades shall be installed in dustproof ball bearings which are enclosed by external plastic caps and charged with special grease for maintenance-free operation; the axles shall be made of stainless steel.

3.4.4.2 All blades shall be suitable to close air-tight by packing washers made of profiled rubber strips. All outside air inlet dampers and exit air outlet dampers shall be made of stainless steel. All multi-leaf dampers shall be equipped with electric limit switches to indicate the final position at the control panel.

3.4.4.3 Adjustable Dampers (AD): Adjustable dampers shall be provided in all branch pipes and branch ducts of the air distribution and collecting systems to balance the air-flow rates individually. Louvre dampers shall be used for rectangular air ducts and circular flaps shall be used for air pipes. The construction of the louvre dampers shall be the same as specified for the multi-leaf dampers. The circular flaps shall comprise a cylindrical casing with a built-in flap made of reinforced and stiffened sheet steel or cast steel including an external lever to regulate the flap position. All parts shall be fully hot dip galvanised. All louver dampers and circular flaps shall be equipped with an additional notched locking quadrant with locking screw to adjust the individual dampers and flaps in final position.

3.4.4.4 Check Dampers / Gravity Shutters (GS): Only the heavy-duty type dampers shall be used as gravity operated shutters. They shall be made of galvanised steel with an extruded aluminium frame and wing stops, rigid aluminium blades, stainless steel shafts with bronze bearings, roll-formed blade edged with felt sealer. Blades shall be linked with a tie bar and adjustable counterweight to allow full blade position parallel to airflow under full

airflow, with automatic gravity powered closing of the damper under reverse flow conditions, or in case the pressure falls below a certain value.

3.4.5 Fire Dampers (FD) : Fire dampers shall be installed:

i. in all ducts leaving or entering the central air-conditioning and ventilation rooms;

ii. in all ducts passing any fire sections in the buildings.

The shut-off damper shall be designed and constructed in accordance with German Standard DIN 4102, fire-resistance class K90. Fire dampers shall be closed by magnetic trip initiated by smoke detectors via fire alarm panel. The fire dampers shall comprise housings with connecting frames made of welded steel of 1.75 mm thickness and fully hot dip galvanised, including external inspection and access door, solenoid release devices (e.g. 24 VDC), thermal and manual action, unlocking device for manual action, an electrical limit switch for position indication and an external blade position indicator. The fire dampers shall be motorised and buffered by a suitable battery system, to avoid any general falling of all fire dampers in case of any electricity failure. The damper blade shall be made of fire-resistant and non-combustible fibre-silicate plates, minimum thickness 40 mm, covered by an aluminium sheeting against abrasion, including an axle made of stainless steel supported by sintered bronze bearing and locked by a locking bolt made of stainless steel and equipped with a fusible link for thermal release at 72°C.

The complete locking and release devices shall be installed on a separate mounting plate at the housing of the damper for easy removal and access from outside. The fire damper shall be embedded in concrete or bricked up with fire-resistant cement mortar according to the DIN 4102 standard. All fire dampers shall be arranged, placed and installed for easy inspection, checking, service and manual actuation.

3.4.6 Flexible Connections: Where sheet-metal connections are made to fan or where ducts or dissimilar metal are connected, a non-combustible flexible connection of approved non-combustible material shall be installed having gap of approximately 150 mm. Flexible connections shall be securely fastened with zinc-coated iron clinch-type draw bands, for round ducts. For rectangular ducts the flexible connections locked to metal collars shall be installed using normal duct construction methods.

3.4.7 Duct Painting: Ducts for exposed surface shall be painted with 1 coat of primer and 2 coats of vinyl paint approved by the Employer.

3.4.8 Maintenance during Construction: During the period of construction, the ventilation and air-conditioning system can be operated to support the installation works. The ventilation and air-conditioning system shall be operated, maintained and protected by the Contractor in a satisfactory condition until the Employer's final acceptance. Defective materials and equipment damage in the course of installation or testing shall be replaced or repaired at the expense of the Contractor in a manner as approved by the Employer. Filters shall be changed by the Contractor whenever necessary during the maintenance period.

CHAPTER 16

SWITCHYARD ERECTION

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CHAPTER 16: SWITCHYARD ERECTION

1. GENERAL

The detailed scope of work includes design, engineering, manufacture, testing at works, supply on FOR destination site basis, insurance, handling, storage, erection testing and commissioning of various items and works as detailed herein.

The works are under the upgradation of the existing substation system and hence requires site clearance including the dismantling of existing building, 11 kV Switchgear panels, outdoor gantry, BPI structures, transformers and their foundation; and proper storage of dismantled items in the nearby yard.

This Chapter covers the description of the following items.

1.1 Supply of

i. Earthing & Earthing materials

ii. Lightning protection materials

iii. Cabling material

iv. Other items

2. GROUNDING SYSTEM

2.1 GENERAL

2.1.1 This specification covers the design, supply, delivery, installation and testing of the complete grounding system as described below.

2.1.2 The complete station grounding work shall be in accordance with the recommendation in the "Guide for Safety in Substation Grounding" IEEE No. 80 and the requirements of this chapter.

2.2 GROUNDING INSTALLATION FEATURES

2.2.1 The installation shall be complete in all respects for efficient and trouble-free service. All work shall be carried out in a first-class neat workman like manner. Grounding conductors shall be handled carefully to avoid kinking and cutting of the conductors during laying and installation. All exposed ground conductors runs shall be taken in a neat manner, horizontal, vertical and parallel to building walls or columns and shall not be laid haphazardly.

2.2.2 For all connections made to equipment or to the structures, the grounding conductor, connectors and equipment enclosures shall have good clean contact surfaces. Grounding conductor connection to all electrical equipment, switchgear, transformers, motors, panels, conduit system, equipment enclosures, cable trays, distribution boards, equipment frames, bases, steel structure, etc. shall be by pressure type or bolting type connectors.

2.2.3 All lap, cross and tee connections between two grounding conductors shall be made by thermo-welding process or compression type connector. The various joints shall have adequate mechanical strength as well as necessary electrical conductivity not less than that of the parent conductors of the joints. All accessories for grounding installation shall

be of quality and design approved by the Employer. The earthing connection between earthing pad of equipment/structures shall be made by two earthing leads.

2.2.4 Ground conductors, when crossing underground trenches, directly laid underground pipe and equipment foundation, if any, shall be at least 300mm below the bottom elevation of such trenches/pipes.

2.2.5 The maximum size of each grid of grounding mat shall not exceed 4X4 meters. The terminals for connecting ground mat and equipment shall be terminated whenever necessary. The new grounding shall be bonded with existing grounding network at the existing Substations.

2.3 GROUNDING CONDUCTOR

2.3.1 Main Ground Grid

The main ground system shall consist of a grounding grid buried minimum 0.6 meter below grade level. The grounding grid shall consist of copper flat conductor cable or stranded copper wire of minimum size (cross sectional area) 120sq. mm.

2.3.2 Ground Electrodes

The ground electrodes shall be 16mm diameter and 3.0 meter long (min.) copper clad steel. These shall be driven into ground and connected to the main ground grid.

2.3.3 Risers

The risers shall consist of copper conductor of adequate size (but not less than 160 sq. mm.) connected at one end to the main ground mat and at the other end to the equipment. There shall be at least two risers connected to equipment.

2.4 DESIGN REQUIREMENTS

2.4.1 The Contractor shall measure the soil resistivity in presence of the Employer. Based on the resistivity the contractor shall calculate the total length of buried ground conductor, number of grounding electrode and their depth and spacing to achieve a grounding system resistance of less than 1.0 (One) Ohm.

2.4.2 The Contractor shall calculate the cross-section considering the maximum fault level of 40 kA.

2.4.3 The Contractor shall submit the details of calculations of the grounding system for the Employer's approval. The earthing system shall be of single earthing system for the whole substation i.e. all earthings shall be connected to main earthing grid.

2.5 TESTS

On completion of the installation, either wholly or in sections, it shall be tested in compliance with relevant Code by the Contractor in presence of the Employer. The cost of any test including labor, material and equipment charges shall be borne by the Contractor. If the ground grid resistance cannot be obtained as per his design, then additional grounding conductors shall be buried in the earth, or if necessary, buried in treated soil to obtain the required low ground resistance without any additional cost.

2.6 LIGHTNING PROTECTION

The outdoor equipment of the substation and the substation building shall be protected against lightning. The lightning protection shall be achieved by an overhead lightning

shield system of galvanized steel wire of 7/3.35 mm, which shall be connected to the main grounding grid by steel conductor of 7/3.35 mm. Lighting mast with electrode length of 2.5mtr (maximum) may be used in switchyard area for lighting protection as per requirement. The above electrode may be connected to the main grounding grid by steel conductor of 7/3.35 mm. In case of transformer protection against lightening, lightning arrester shall provided. The design of the lightning protection system shall be subject to the approval of the Employer during detail engineering.

2.7 DRAWINGS

After award of the Contract, the Contractor shall furnish the grounding layout drawing with dimensions showing the location of grounding grids, electrodes, test link chambers and risers, backed up by necessary calculations for Employer's approval. The work shall have to be started at site only after getting approval from the Employer. If alteration is required for any work done before getting Employer's approval, the same shall have to be done by the Contractor at no extra cost to the Employer.

STATION GROUNDING SYSTEM

DESCRIPTION	UNIT	REQD
Main ground grid conductor material		Copper
Main ground grid conductor size	Sq.mm	≥120
Cross section of riser conductors	Sq mm	≥ 120
Ground electrodes		
-Material		Copper clad steel
-Diameter	mm	≥16
-Length	meter	3
Material of risers		Copper
Earthing system designed for	ohm	≤ 1

3. CABLING MATERIAL

3.1 CABLE TAGS AND MARKERS

3.1.1 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

3.1.2 The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

3.1.3 Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanised iron plate.

3.1.4 Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable joints".

3.1.5 The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.

3.1.6 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry and at each end & turning point in cable tray/trench runs. Cable tags shall be provided inside the switchgear, motor control centers, control and relay panels etc., wherever required for cable identification, where a number of cables enter together through a gland plate.

3.2 Cable Supports and Cable Tray Mounting Arrangements

3.2.1 The Contractor shall provide embedded steel inserts on concrete floors/walls to secure supports by welding to these inserts or available building steel structures.

3.2.2 The supports shall be fabricated from standard structural steel members.

3.2.3 Insert plates will be provided at an interval of 750 mm wherever cables are to be supported without the use of cable trays, such as in trenches, while at all other places these will be at an interval of 2000 mm.

3.2.4 Vertical run of cables on equipment support structure shall be supported on perforated cable trays of suitable width which shall be suitably bolted/clamped with the equipment support structure.

3.3 Cable Termination and Connections

3.3.1 The termination and connection of cables shall be done strictly in accordance with cable and termination kit manufacturer's instructions, drawing and/or as directed by the Employer.

3.3.2 The work shall include all clamping, fittings, fixing, plumbing, soldering, drilling, cutting, taping, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job.

3.3.3 Supply of all consumable material shall be in the scope of Contractor.

3.3.4 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for drilling of gland plates, painting and touching up. Holes shall not be made by gas cutting.

3.3.5 Control cable cores entering control panel/switchgear/MCCB/MCC/ miscellaneous panels shall be neatly bunched, clamped and tied with nylon strap or PVC perforated strap to keep them in position.

3.3.6 The Contractor shall tag/ferrule control cable cores at all terminations, as instructed by the Employer. In panels where a large number of cables are to be terminated and cable identification may be difficult, each core ferrule may include the complete cable number as well.

3.3.7 Spare cores shall be similarly tagged with cable numbers and coiled up.

3.3.8 All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively closed.

3.3.9 Double compression type nickel plated (coating thickness not less than 10 microns) brass cable glands shall be provided by the Contractor for all power and control cables to provide dust and weather proof terminations.

3.3.10 They shall comprise of heavy-duty brass casting, machine finished and nickel plated, to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and of tested quality. Cable glands shall be of approved make.

3.3.11 The cable glands shall also be suitable for dust proof and weather proof termination. The test procedure, if required, has to be discussed and agreed to between Employer and cable gland manufacturer.

3.3.12 If the cable-end box or terminal enclosure provided on the equipment is found unsuitable and requires modification, the same shall be carried out by the Contractor, as directed by the Employer.

3.3.13 Crimping tool used shall be of approved design and make.

3.3.14 Cable lugs shall be tinned copper solderless crimping type conforming to IS-8309 & 8394/ Equivalent International standard. Bimetallic lugs shall be used depending upon type of cables used.

3.3.15 Solderless crimping of terminals shall be done by using corrosion inhibitory compound. The cable lugs shall suit the type of terminals provided.

3.4 STORAGE AND HANDLING OF CABLE DRUMS

Cable drums shall be unloaded, handled and stored in an approved manner and rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum.

4. DIRECTLY BURIED CABLES

4.1 The Contractor shall construct the cable trenches required for directly buried cables. The scope of work shall include excavation, preparation of sand bedding, soil cover, supply and installation of brick or concrete protective covers, back filling and ramming, supply and installation of route markers and joint markers. The Bidder shall ascertain the soil conditions prevailing at site, before submitting the bid.

4.2 The cable (power and control) between LT station, control room and fire lighting pump house shall be laid in the buried cable trenches. In addition to the above, for lighting purpose also, buried cable trench can be used in outdoor area.

4.3 Cable route and joint markers and RCC warning covers shall be provided wherever required. The voltage grade of cables shall be engraved on the marker.

5. INSTALLATION OF CABLES

5.1 Cabling in the control room shall be done on ladder type cable trays for vertical runs.

5.2 All cables from bay cable trench to equipment's including and all interpole cables (both power and control) for all equipment, shall be laid in PVC pipes of minimum 50 mm

nominal outside diameter which shall be buried in the ground at a depth of 250mm below finish formation level. Separate PVC pipes shall be laid for control and power cables. Cable pull boxes of adequate size shall be provided if required.

5.3 Cables shall be generally located adjoining the electrical equipment through the pipe insert embedded in the floor. In the case of equipment located away from cable trench either pipe inserts shall be embedded in the floor connecting the cable trench and the equipment or in case the distance is small, notch/opening on the wall shall be provided. In all these cases necessary bending radius as recommended by the cable manufacturer shall be maintained.

5.4 Cable racks and supports shall be painted after installation with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminium paint.

5.5 Suitable arrangement should be used between fixed pipe / cable trays and equipment terminal boxes, where vibration is anticipated.

5.6 Power and control cables in the cable trench shall be laid in separate tiers. The order of laying of various cables shall be as follows, for cables other than directly buried.

i. Power cables on top tiers.

ii. Control instrumentation and other service cables in bottom tiers.

5.7 Single core cables in trefoil formation shall be laid with a distance of three times the diameter of cable between trefoil centre lines. All power cables shall be laid with a minimum centre to centre distance equal to twice the diameter of the cable of higher size of cables.

5.8 Trefoil clamps for single core cables shall be of pressure die cast aluminium (LM-6), Nylon -6 or fibre glass and shall include necessary fixing GI nuts, bolts, washer etc. These are required at every 2 metre of cable runs.

5.9 Power and control cables shall be securely fixed to the trays/supports with self-locking type nylon ties with deinterlocking facility at every 5 metre interval for horizontal run. Vertical and inclined cable runs shall be secured with 25 mm wide and 2 mm thick aluminium strip clamps at every 2m.

5.10 Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows:

	Table of Cable	Minimum bending radius
i.	Power cable	12 D
ii.	Control cable	10 D

D is overall diameter of cable

5.11 Where cables cross roads, drains and rail tracks, these shall be laid in reinforced spun concrete or steel pipes buried at not less than one meter depth.

5.12 In each cable run some extra length shall be kept at a suitable point to enable one (for LT cables)/two (for H.T. cables) straight through joints to be made in case the cable develop fault at a later date.

5.13 Selection of cable drums for each run shall be so planned as to avoid using straight through joints. Cable splices will not be permitted except where called for by the drawings, unavoidable or where permitted by the Employer. If straight through joints are unavoidable, the Contractor shall use the straight through joints kit of reputed make.

5.14 Control cable terminations inside equipment enclosures shall have sufficient lengths so that changing of termination in terminal blocks can be done without requiring any splicing.

5.15 Metal screen and armour of the cable shall be bonded to the earthing system of the station, wherever required by the Employer.

5.16 Rollers shall be used at intervals of about two metres while pulling cables.

5.17 All due care shall be taken during unreeling, laying and termination of cable to avoid damage due to twist, kinks, sharp bends, etc.

5.18 Cable ends shall be kept sealed to prevent damage. In cable vault, fire resistant seal shall be provided underneath the panels.

5.19 Inspection on receipt, unloading and handling of cables shall generally be in accordance with relevant international standard.

5.20 Wherever cable pass through floor or through wall openings or other partitions, GI/PVC wall sleeves with bushes having a smooth curved internal surface so as not to damage the cable, shall be supplied, installed and properly sealed by the Contractor at no extra charges.

5.21 Contractor shall remove the RCC/Steel trench covers before taking up the work and shall replace all the trench covers after the erection-work in that particular area is completed or when further work is not likely to be taken up for some time.

5.22 Contractor shall furnish three copies of the report on work carried out in a particular week, indicating cable numbers, date on which laid, actual length and route, testing carried out, terminations carried out, along with the marked-up copy of the cable schedule and interconnection drawing wherever any modifications are made.

5.23 Contractor shall paint the tray identification number on each run of trays at an interval of 10 m.

5.24 In case the outer sheath of a cable is damaged during handling/installation, the Contractor shall repair it at his own cost to the satisfaction of the Employer. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable at no extra cost to the Employer, i.e. the Contractor shall not be paid for installation and removal of the damaged cable.

5.25 All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Contractor shall cover the exposed part of all cable lugs whether supplied by him or not with insulating tape, sleeve or paint.

5.26 Cable trays

5.26.1 The cable trays shall be of G.S. sheet and minimum thickness of sheet shall be 2mm

5.26.2 The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards.

5.26.3 A 2.5 metre straight section of 300mm, 600mm wide cable tray shall be simply supported at two ends. A uniform distributed load of 76 kg/m shall be applied along the length of the tray. The maximum deflection at the mid-span shall not exceed 7mm.

5.27 Conduits, Pipes and Duct Installation

5.27.1 Contractor shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes etc. including all necessary sundry materials such as tees, elbows, check nuts, bushing, reducers, enlargers, coupling cap, nipples, gland sealing fittings, pull boxes etc as specified and to be shown in detailed drawing. The size of the conduit/pipe shall be selected on the basis of 40% fill criterion.

5.27.2 Contractor shall have his own facility for bending, cutting and threading the conduits at site. Cold bending should be used. All cuts & threaded ends shall be made smooth without leaving any sharp edges. Anticorrosive paint shall be applied at all field threaded portions.

5.27.3 All conduit/pipes shall be extended on both sides of wall/floor openings. The fabrication and installation of supports and the clamping shall be included in the scope of work by Contractor.

5.27.4 When two lengths of conduits are joined together through a coupling, running threads equal to twice the length of coupling shall be provided on each conduit to facilitate easy dismantling of two conduits.

5.27.5 Conduit installation shall be permanently connected to earth by means of special approved type of earthing clamps. GI pull wire of adequate size shall be laid in all conduits before installation.

5.27.6 Each conduit run shall be painted with its designation as indicated on the drawings such that it can be identified at each end.

5.27.7 Embedded conduits shall have a minimum concrete cover of 50 mm.

5.27.8 Conduit run sleeves shall be provided with the bushings at each end.

5.27.9 Metallic conduit runs at termination shall have two locknuts and a bushing for connection. Flexible conduits shall also be suitably clamped at each end with the help of bushings. Bushings shall have rounded edges so as not to damage the cables.

5.27.10 Where embedded conduits turn upwards from a slab or fill, the termination dimensions shown on the drawings, if any, shall be taken to represent the position of the straight extension of the conduit external to and immediately following the bend. At least one half of the arc length of the bend shall be embedded.

5.27.11 All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed in an approved manner to prevent damage to threaded portions and entrance of moisture and foreign material.

5.27.12 For underground runs, Contractor shall excavate and back fill as necessary.

5.27.13 Contractor shall supply, unload, store and install conduits required for the lighting installation as specified. All accessories/fittings required for making the installation complete, including but not limited to pull out boxes, ordinary and inspection tees and elbow, checknuts, male and female bushings (brass or galvanised steel), caps, square headed male plugs, nipples, gland sealing fittings, pull boxes, conduits terminal boxes,

gaskets and box covers, saddle terminal boxes, and all steel supporting work shall be supplied by the Contractor. The conduit fittings shall be of the same material as conduits.

5.27.14 All unarmoured cables shall run within the conduits from lighting panels to lighting fixtures, receptacles etc.

5.27.15 Size of conduit for lighting shall be selected by the Contractor during detailed engineering.

5.27.16 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls. Unnecessary bends and crossings shall be avoided to present a neat appearance.

5.27.17 Conduit supports shall be provided at an interval of 750mm for horizontal runs and 1000mm for vertical runs.

5.27.18 Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U- bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs. Wooden plug inserted in the masonary or concrete for conduit support is not acceptable.

5.27.19 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.

5.27.20 Spacing of embedded conduits shall be such as to permit flow of concrete between them.

5.27.21 Where conduits are placed along with cable trays, they shall be clamped to supporting steel at an interval of 600mm.

5.27.22 For directly embedding in soil, the conduits shall be coated with an asphalt-base compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.

5.27.23 Conduit shall be installed in such a way as to ensure against trouble from trapped condensation.

5.27.24 Conduits shall be kept, wherever possible, at least 300mm away from hot pipes, heating devices etc. when it is evident that such proximity may reduce the service life of cables

5.27.25 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run.

5.27.26 For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.

5.27.27 Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.

5.27.28 Conduits joints and connections shall be made thoroughly water-tight and rust proof by application of a thread compound which insulates the joints. White lead is suitable for application on embedded conduit and red lead for exposed conduit.

5.27.29 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations of flattened surfaces. Heat shall not be applied in making any conduit bend. Separate bends may be used for this purpose.

5.27.30 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded. Where slip joints are used, suitable bounding shall be provided around the joint to ensure a continuous ground circuit.

5.27.31 After installation, the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.

5.27.32 Lighting fixtures shall not be suspended directly from the junction box in the main conduit run.

6. JUNCTION BOX

6.1 The Contractor shall supply and install junction boxes complete with terminals as required. The brackets, bolts, nuts, screws etc required for erection are also included in the scope of the Contractor.

6.2 Junction boxes having volume less than 1600 cubic centimeters may be installed without any support other than that resulting from connecting conduits where two or more rigid metallic conduits enter and accurately position the box. Boxes shall be installed so that they are level, plumb and properly aligned to present a pleasing appearance.

6.3 Boxes with volumes equal to or greater than 1600 cubic cm, and smaller boxes terminating on less than two rigid metallic conduits or for other reasons not rigidly held, shall be adequately supported by auxiliary steel of standard steel shapes or plates to be fabricated and installed. The Contractor shall perform all drilling, cutting, welding, shimming and bolting required for attachment of supports.

7. TESTING AND COMMISSIONING

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

7.2 GENERAL CHECKS

i. Check for physical damage.

ii. Check from name plate that all items are as per order/specification.

iii. Check tightness of all bolts, clamps and connecting terminals using torque wrenches.

iv. For oil filled equipment, check for oil leakage, if any. Also check oil level and top up wherever necessary.

v. Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanised surfaces.

vi. Check cleanliness of insulator and bushings.

vii. All checks and tests specified by the manufacturers in their drawings and manuals as well as all tests specified in the relevant code of erection.

7.3 STATION EARTHING

i. Check soil resistivity

ii. Check continuity of grid wires

iii. Check earth resistance of the entire grid as well as various sections of the same.

iv. Dip test on earth conductor prior to use.

CHAPTER 17

STRUCTURES

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CHAPTER 17: STRUCTURE

1. GENERAL

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

1.2 The structures are to be build inside existing substation area. The line diagram of all new structures of 132kV and 11 kV inside the existing switchyards shall be prepared by the contractor based on their design during detailed engineering stage. The fabrication drawing/line diagram of new structure on the existing switch yards shall be furnished by contractor to the NEA/Consultant during detailed engineering stage so that the interface between the new and existing structure is as per NEA requirement. The bidder shall mention in their bid for the type of proposed structure i.e., Pipe or lattice type structure. The fabrication drawings, proto corrected drawings along with Bill of Material (BOM) for all the structures (Equipment support structures) shall be prepared by the contractor during detailed engineering for submission to NEA/Consultant for their approval.

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

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

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

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

2. DESIGN REQUIREMENTS FOR STRUCTURES

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

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

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

Members	Min Thickness (mm)
i. Leg members, Ground wire	5
ii. Peak members / Main members	5
iii. Other members	4
iv. Redundant members	4

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

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

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

3. DESIGN CRITERIA

3.1 All equipment support structures shall be designed for the worst combination of dead loads, live loads, wind loads and Seismic forces as per relevant British standard Codes (BS Codes) / equivalent International Standards. (Latest), loads due to deviation of conductor, load due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including "snatch" in the case of bundled conductors etc. Short circuit forces shall be calculated considering a fault level of 40 kA for 132kV and 31.5 kA for 11kV or as applicable. Relevant British standard Codes (BS Codes) / equivalent International Standards. May be followed for evaluation of short circuit forces.

3.2 Factor of safety of 2.0 under normal conditions and 1.5 under short circuit condition shall be considered on all external loads for the design of switchyard structures.

3.3 Vertical load of half the span of conductors/string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with tools shall be considered as 150 kgs. for the design of structures.

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

4. DESIGN, DRAWINGS, BILL OF MATERIALS AND DOCUMENTS

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

modified even after its approval, Contractor shall modify the designs & drawings and resubmit the same for approval.

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

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

4.4 The contractor shall submit editable soft copy of all designs preferably in Staad / excel form and drawings in AutoCAD to NEA/Consultant. The list of British standard codes relevant to steel structures have been given in Chapter-17-Civil section of technical specification This list is illustrative but not exhaustive. The contractor shall submit the copy of relevant portion of BS codes/equivalent international standard referred to NEA/Consultant for reference if necessary, during detailed engineering stage.

5. FABRICATION AND ERECTION

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

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

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

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

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

6. BOLTING

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

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

7. WELDING

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

8. FOUNDATION BOLTS

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

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

8.3 All foundation bolts for lattice structure, pipe structure is to be supplied by the Contractor.

8.4 All foundation bolts shall be fully galvanized so as to achieve minimum 610 grammes Per sq. m. of Zinc Coating as per relevant British standard Codes (BS Codes) / equivalent International Standards.

8.5 All foundation bolts and its material shall conform to relevant British standard Codes (BS Codes) / equivalent International Standards. All foundation bolts shall be provided with two number standard nuts, one check nut, one plain washer and MS plate at the bottom of foundation bolt.

9. STABILITY OF STRUCTURE

The Supplier shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

10. GROUTING

The method of grouting the column bases shall be subject to approval of NEA/Consultant and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base. No additional payment for grouting shall be admissible.

11. GALVANIZING

11.1 All structural steel works (Equipment support structures) and foundation bolts shall be galvanized after fabrication. The galvanization shall be done as per requirement relevant British standard Codes (BS Codes) / equivalent International Standards.

11.2 Zinc required for galvanizing shall have to be arranged by the Contractor/manufacturer. Purity of zinc to be used shall be 99.95% as per relevant British standard Codes (BS Codes) / equivalent International Standards.

11.3 The Contractor shall be required to make arrangement for frequent inspection by the employer as well as continuous inspection by a resident representative of the employer, if so desired for fabrication work.

12. TOUCH-UP PAINTING

Minor defects in hot dip galvanized members shall be repaired by applying zinc rich primer and two coats of enamel paint to the satisfaction of NEA/Consultant before erection.

13. INSPECTION BEFORE DISPATCH

Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by NEA/Consultant or his authorized representative as satisfactory before it is dispatched to the erection site. Such certification shall not relieve the Contractor of his responsibility regarding adequacy and completeness of fabrication.

The contractor shall submit the detailed MQP for employers' approval. Acceptance tests shall be carried out at the suppliers / manufacturers / third party accredited lab as per the latest international standards in the presence of Employer / consultant.

14. TEST CERTIFICATE

Copies of all test certificates relating to material procured by the Contractor for the works shall be submitted to NEA/Consultant.

15. MODE OF MEASUREMENT

The measurement of the structure, fasteners (Nuts, Bolts, and Washers) and foundation bolts including its nuts washers and MS Plate at bottom shall be done as per Bid price schedule (BPS). The weight of all structural members and foundation bolts (Bolt, Nuts, washer and MS steel plates welded at bottom of bolt) shall be measured under one head in Metric ton. The weight of fasteners (Nuts, bolts and washers) used to erect/complete structures shall be measured under another head in Metric tons.

16. SAFETY PRECAUTIONS

The Contractor shall strictly follow all precautions at all stages of fabrication, transportation and erection of steel structures. The stipulations contained in relevant

British standard Codes (BS Codes) / equivalent International Standards. for Safety during erection of structural steel work shall also be adhered to.

17. MANUFACTURING QUALITY PLAN

The material specification shall also be as per relevant British standard Codes (BS Codes) / equivalent International Standards.

The Contractor shall prepare the manufacturing quality plan to accept/check the material, galvanization and welding as per relevant international standards/BS codes within 1 month after award of work and submit the same to NEA/ Consultant for approval.

CHAPTER 18

CIVIL WORKS

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CHAPTER 18: CIVIL WORKS

1. GENERAL

The intent of specification covers the following:

1.1 Design, engineering, drawing and construction of all civil works at sub-station. All civil works shall also satisfy the general technical requirements specified in other Sections of Specification and as detailed below. They shall be designed to the required service conditions/loads as specified elsewhere in this Specification or implied as per relevant British standard codes (B S Codes)/ Indian Standard Code (IS Code)/ equivalent International Standards.

1.2 All civil works shall be carried out as per applicable Standards and Codes. All materials shall be of best quality conforming to relevant International Standards and Codes. In case of any conflict between Standards/ Code and Technical Specification, the provisions of Technical Specification shall prevail.

1.3 The Contractor shall furnish all design, drawings, labour, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with approved drawings, specifications and direction of NEA.

The work shall be carried out according to the design/drawings to be developed by the Contractor and approved by the NEA. For all buildings, structures, foundations etc. necessary layout and details shall be developed by the Contractor keeping in view the functional requirement of the substation facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this specification for guidance purposes only. However, the Contractor shall quote according to the complete requirements.

1.5 The works are under the upgradation of the existing substation system and hence requires site clearance including the dismantling of existing building, 11 kV Switchgear panels, outdoor gantry, BPI structures, transformers and their foundation; and proper storage of dismantled items in the nearby yard.

2. GEOTECHNICAL INVESTIGATION

2.1 The employer will provide the detailed soil investigation and soil electrical resistivity report of site during detail engineering.

3. CONTOUR SURVEY, SITE LEVELLING

3.1 The land for construction of substation will be handed over to the successful bidder as on where basis progressively after award of work. The contractor shall carry out survey work by taking spot level at 05 m x05 m grid interval with respect to temporary bench mark transferred from permanent bench mark in the locality if available either on bridge, government buildings of local authorities or any other permanent structure. The contractor shall submit the spot levels (in grid format) in editable soft copy in excel format and contour map with contour interval of 0.5 m in editable auto cad soft drawing.

3.2 The contractor will level the area required for construction of substation work either at single level, multi-level or gradual slope with the finished ground level as approved by Employer during detailed engineering based on highest flood level. The levelling area shall be decided by Employer during detailed Engineering stage.

3.3 The layout and levels of all structure etc. shall be made by the Contractor at his own cost from the general grids of the plot and benchmarks set by the Contractor and approved by Employer. The Contractor shall provide all assistance in instruments, materials and personnel to Employer for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels.

3.4 SCOPE

This clause covers clearance of site, contour survey, site levelling, maintaining finished ground level by cutting/filling in all types of soil and soft/ disintegrated rock, supplying and compaction of fill material if required. Cutting/felling of trees and their disposal has not been envisaged under the present scope.

3.5 GENERAL

3.5.1 Site shall be cleared, surveyed and levelled/sloped by the contractor as per approved general arrangement drawing or levelling area decided during detailed engineering after award of work.

3.5.2 Work covered under this clause comprises the site clearance, survey work/setting out and making profiles (preparation of plot plan, setting up Bench Mark and taking spot levels at 05m x 05 m interval, preparation of contour plan with contour interval of 0.50 m), Earth work in Excavation & filling in specified area with all lifts and leads and earth work in filling with borrowed earth with all leads and lifts (Borrow areas including payment of royalty for borrowed earth shall be arranged by the contractor at his own cost). During detailed engineering stage, the contractor will prepare the levelling proposal for optimum levelling and submit to Employer for approval. Contractor shall submit the hard copy and editable soft copy of levelling proposal (levelling quantity calculation in Excel form and levelling drawing in Auto CAD) to Employer for approval.

3.5.3 Filling material shall conform to relevant British standard codes (BS Codes)/ IS/ equivalent International Standards. Unsuitable filling material if any shall be removed and replaced by suitable fill material. The filling shall be compacted in layers to achieve 95% of standard Proctor's density at Optimum moisture contents (OMC). Cohesion less material shall be compacted to 70% relative density (minimum). Levelling/Filling shall be carried out as per relevant British standard codes (B S Codes)/ equivalent International Standards.

3.6 All materials involved in excavation shall be classified by Employer in the following groups:

3.6.1 All kinds of soils and soft/disintegrated rocks (Not requiring blasting): The material which can be quaried /excavated with pick, shovel, jumpers, scarifiers, crowbars and mechanical implements and will include various types of soils, plain cement concrete, shingle, river/nallah boulders, soling of road/foot path, stone masonary, soft conglomerate and laterite stone, lime stone and hard conglomerate etc.

3.6.2 Hard Rocks: All kinds of rocks which can only be excavated by machines and requires blasting, chiselling in edging or in another agreed method and will also include reinforcement cement concrete.

3.6.3 The quantity of excavation in all types of soils and soft/disintegrated rock shall be worked out by using initial and final level and no void deduction shall be made to calculate net quantity of earth work with 95% compaction.

3.6.4 The volume of hard rock shall be computed on the basis of stack of excavated rubble after making 50 % deduction for voids.

3.6.5 The surface of excavation or filling shall be neatly dressed to the required formation level with tolerance of (±) 100 mm.

4. SITE PREPARATION, EXCAVATION, BACKFILL & DISPOSAL OF SURPLUS EARTH.

4.1 SITE PREPARATION

The layout and levels of all structure etc shall be made by the Contractor at his own cost from the general grids of the plot and benchmarks set by the Contractor and approved by the Employer. The Contractor shall give all help in instruments, materials and personnel to the Employer for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels.

4.2 SCOPE

This clause covers clearing of the site, maintaining the finished ground level with available surplus excavated suitable back fill material generated from foundation works etc.

4.3 GENERAL

4.3.1 The Contractor shall develop the site area to meet the requirement of the intended purpose. The site preparation shall conform to the requirements of relevant sections of this specification or as per stipulations of relevant British standard codes (B S Codes)/IS/ equivalent International Standards.

4.3.2 The fill material shall be suitable for the above requirement. The fill shall be with such a material that the site so designed shall not be affected by erosion from wind and water from its final compacted position or the in-situ position of undisturbed soil.

4.3.3 Material unsuitable for founding of foundations shall be removed and replaced by suitable fill material to be approved by the Employer.

4.3.4 Backfill material around foundations or other works shall be suitable for the purpose for which it is used and compacted to the density described under Compaction. Excavated material not suitable or not required for backfill shall be disposed off in areas as directed by employer up to a maximum lead of 2 km.

4.4 EXCAVATION AND BACKFILL

4.4.1 SCOPE

4.4.1.1 This clause covers excavation for foundation works of Equipment support structures, Transformer foundations, Cable trenches, Buildings, Fire Wall, etc, backfilling of Foundations Works.

4.4.1.2 Excavation and backfill for foundations shall be in accordance with the relevant British standard codes (B S Codes)/IS/ equivalent International Standards.

4.4.1.3 Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, concreting and backfilling.

4.4.1.4 When embankments are to be constructed on slopes of 15% or greater, benches or steps with horizontal and vertical faces shall be cut in the original slope prior to placement of embankment material. Vertical faces shall measure not more than 1 m in height.

4.4.1.5 Embankments adjacent to abutments, culverts, retaining walls and similar structures shall be constructed by compacting the material in successive uniform horizontal layers not exceeding 15 cm in thickness. (Of loose material before compaction). Each layer shall be compacted as required by means of mechanical tampers approved by the Employer. Rocks larger than 10 cm in any direction shall not be placed in embankment adjacent to structures.

4.4.1.6 Earth embankments of roadways and site areas adjacent to buildings shall be placed in successive uniform horizontal layers not exceeding 20 cm in thickness in loose stage measurement and compacted to the full width specified. The upper surface of the embankment shall be shaped so as to provide complete drainage of surface water at all times.

4.5 COMPACTION

4.5.1 The density to which fill materials shall be compacted shall be as per relevant BS and as per direction of Employer. All compacted sand filling shall be confined as far as practicable. Backfilled earth shall be compacted to minimum 95% of the Standard Proctor's density at OMC. The sub grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor's density at OMC. Cohesion less material sub grade shall be compacted to 70% relative density (minimum).

4.5.2 At all times unfinished construction shall have adequate drainage upon completion of the road's surface course, adjacent shoulders shall be given a final shaping, true alignment and grade.

4.5.3 Each layer of earth embankment when compacted shall be as close to optimum moisture content as practicable. Embankment material which does not contain sufficient moisture to obtain proper compaction shall be wetted. If the material contains any excess moisture, then it shall be allowed to dry before rolling. The rolling shall begin at the edges overlapping half the width of the roller each time and progress to the centre of the road or towards the building as applicable. Rolling will also be required on rock fills. No compaction shall be carried out in rainy weather.

4.6 REQUIREMENT FOR FILL MATERIAL UNDER FOUNDATION

The thickness of fill material under the foundations shall be such that the maximum pressure from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil. For expansive soils, the fill materials and other protections etc. to be used under the foundation is to be got approved by the Employer.

4.7 DISPOSAL OF SURPLUS EARTH

The surplus earth generated from foundation work shall be disposed away from levelling area boundary at low lying areas within 2Km lead. The surplus earth if disposed within substation main boundary, the same shall be spread in uniform layers and compacted with suitable compacting equipment to achieve 95% compaction at O.M.C.

5. ANTIWEED TREATMENT & STONE SPREADING

5.1 SCOPE OF WORK

5.1.1 The Contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings, specification.

5.1.2 Stone spreading along with cement concrete layer shall be done in the areas of the switchyard under present scope of work within boundary area. However, the stone spreading along with cement concrete layer in future areas within fenced area shall also be provided in case step potential without stone layer is not well within safe limits.

5.2 GENERAL REQUIREMENT

5.2.1 The material required for site surfacing/stone filling shall be free from all types of organic materials and shall be of standard quality, and as approved by the Employer.

5.2.2 The material to be used for stone filling/site surfacing shall be uncrushed/crushed/broken stone of 40 mm nominal size (ungraded single size) conforming to relevant BS. Hardness, flakiness shall be as required for wearing courses shall be as are per relevant BS.

1. Hardness

   Abrasion value as per relevant BS.
   Impact value as per relevant BS.

2. Flakiness Index

   One test shall be conducted as per relevant British standard codes (B S Codes)/ equivalent International Standards.

5.2.3 After all the structures/equipment are erected, anti-weed treatment shall be applied in the switchyard where ever stone spreading along with cement concrete is to be done and the area shall be thoroughly de-weeded including removal of roots. The recommendation of local agriculture or horticulture department may be sought where ever feasible while choosing the type of chemical to be used. The anti-weed chemical shall be procured from reputed manufacturers. The doses and application of chemical shall be strictly done as per manufacturer's recommendation. Nevertheless, the effectiveness of the chemical shall be demonstrated by the contractor in a test area of 10mX10m (appx.) and shall be sprinkled with water at least once in the afternoon every day after forty-eight hours of application of chemical. The treated area shall be monitored over a period of two to three weeks for any growth of weeds by the Employer. The final approval shall be given by Employer based on the results.

5.2.4 Owner shall decide final formation level so as to ensure that the site appears uniform devoid of undulations. The final formation level shall however be very close to the formation level indicated in the approved drawing.

5.2.5 After anti weed treatment is complete, the surface of the switchyard area shall be maintained, rolled/compacted to the lines and grades as decided by Employer. The sub grade shall be consolidated by using half ton roller with suitable water sprinkling

arrangement to form a smooth and compact surface. The roller shall run over the sub grade till the soil is evenly and densely consolidated and behaves as an elastic mass.

5.2.6 In areas that are considered by the Owner to be too congested with foundations and structures for proper rolling of the site surfacing material by normal rolling equipment, the material shall be compacted by hand, if necessary. Due care shall be exercised so as not to damage any foundation structures or equipment during rolling compaction.

5.2.7 The sub grade shall be in moist condition at the time the cement concrete is placed. If necessary, it should be saturated with water for not less than 6 hours but not exceeding 20 hours before placing of cement concrete. If it becomes dry prior to the actual placing of cement concrete, it shall be sprinkled with water and it shall be ensured that no pools of water or soft patches are formed on the surface.

5.2.8 Over the prepared sub grade, 75 mm thick base layer of cement concrete in 1:5:10 (1 cement :5 sand: 10 Stone aggregates) shall be provided in the area excluding roads, drains, cable trenches as per detailed engineering drawing. For easy drainage of water, the slope of 1:1000 is to be provided from the ridge to the nearest drain. The ridge shall be suitably located at the centre of the area between the nearest drains. The above slope shall be provided at the top of base layer of cement concrete in 1:5:10. A layer of cement slurry of mix 1:6 (1 cement: 6 sand) shall be laid uniformly over cement concrete layer. The cement consumption for cement slurry shall not be less than 150 kg. Per 100 sq.m.

5.2.9 A final layer of 100 mm thickness of uncrushed/crushed/broken stone of 40mm nominal size (ungraded size) shall be spread uniformly over cement concrete layer after curing is complete.

6. SITE DRAINAGE

6.1 Preparation of overall drainage layout, design, drawing and providing rain water drainage system within the substation boundary under the present scope including connection at one or more points to the outfall point located outside the substation boundary wall is in the scope of contractor. Invert level of drainage system at outfall point shall be decided in such a way that the water can easily be discharged outside the substation boundary wall. In case outfall point is more than 50M away from boundary wall, only 50 metre drain outside the boundary wall is in the scope of contractor. Outfall point shall be got approved from Employer before commencement of construction. While designing the drainage system following points shall be taken care of:

i. The surface of the switchyard shall be sloped to prevent accumulation of water.

ii. Drain shall be constructed at suitable locations in such a way that substation is not flooded and roads are not affected with ponding of surface water. In the switchyard maximum spacing between two drains shall not be more than 100 meter. It will be ensured that no area is left undrained.

iii. Open surface drains having 300 mm bottom width and 300 mm depth at starting point of drain shall be provided. The depth of drain shall be measured with respect to finished ground level of switch yard i.e. from bottom of switch yard stone filling.

iv. Longitudinal slope shall not be less than 1 in 1000.

v. Open surface drains shall be constructed with brick masonry or concrete blocks. As per design of contractor. PCC (1:2:4) shall be laid over 40 mm thick layer of PCC 1:4:8 (1 cement: 4 coarse sand: 8 stone aggregate 20 mm nominal size.)

vi. The side wall of the drains shall be 25 mm above the gravel level to prevent falling of gravel into drain. Groove of 125 mm width shall be provided at 2000 mm spacing with suitable mild steel grating.

vii. The maximum velocity for pipe drains and open drains shall be limited to 2.4 m/sec and 1.8 m/sec respectively. However, minimum non-silting velocity of 0.6 m/sec shall be ensured.

viii. Pipe drains shall be provided in areas of switchyard where movement of crane will be necessary in operating phase of the substation.

ix. For pipe drains, concrete pipe of class NP2 shall be used. However, for road crossings etc. higher strength pipe of class NP3 shall be provided. For rail crossings, RCC pipes of class NP4 shall be provided. For design of RCC pipes for drains and culverts, relevant British standard codes (B S Codes)/ equivalent International Standards. Shall be followed.

x. Two Nos. of portable pumps of 5 hp capacity for drainage of water shall be provided by the Contractor.

xi. Pipe drains shall be connected through manholes at an interval of max. 30m.

xii. If the invert level of outfall point is above the last drain point in the substation boundary, sump of suitable size has to be constructed with in the substation boundary.

xiii. The drainage scheme and associated drawings shall be got approved from Employer before commencement of construction.

7. ROADS

7.1 All the roads as shown in the General Arrangement drawing for the substation issued along with the tender documents are in the present scope. Adequate turning space for vehicles shall be provided and bend radii shall be set accordingly. Road to the Transformer /Reactor shall be as short and straight as possible.

7.2 All concrete roads within substation boundary wall shall be with 3.75 m RCC concrete pavement of suitable thickness and 1.3 m wide earthen shoulder on either side of the road. Below RCC concrete pavement, water bound macadam of adequate thickness as per design (WBM) shall be laid.

7.3 All black top (Bituminous/Asphalt) roads within substation boundary wall if any shall be with 3.75 m asphaltic pavement of suitable thickness and 1.3 m wide earthen shoulder on either side of the road. Below black top pavement, water bound macadam of adequate thickness as per design (WBM) shall be laid.

7.4 Strengthening of existing roads as applicable (as shown in General Arrangement Drawing) shall be carried out with 2.5 cm thick premix carpet and 100 mm thick compacted layer of

WBM (Water Bound Macadum) after filling the pot holes of existing roads with WBM material.

7.5 All roads shall be designed as per relevant British standard codes (B S Codes)/ equivalent International Standards. All drawings of road and culverts shall be prepared by the contractor.

7.6 All the culverts and allied structures (required for road/rail, drain, trench crossings etc.) shall be designed as per relevant British standard codes (B S Codes)/ equivalent International Standards.

8. TRANSFORMERS FOUNDATION, RAIL TRACK/ RAIL CUM ROAD TRACK

8.1 The Contractor shall design, prepare drawing and provide a RCC Rail cum road system integrated with the Transformer foundation to enable installation and the replacement of any failed unit. The transfer track system shall be suitable to permit the movement of any failed unit fully assembled (including OLTC, bushings) with oil. This system shall enable the removal of any failed unit from its foundation to the nearest road. If trench/drain crossings are required then suitable R.C.C. culverts shall be provided in accordance with relevant BS.

8.2 The Contractor shall provide a pylon support system for supporting the fire fighting system.

8.3 Each Transformer including oil conservator tank and cooler banks etc. shall be placed in a self-sufficient pit surrounded by retaining walls (Pit walls). The clear distance of the retaining wall of the pit from the Transformer shall be 20% of the Transformer height or 0.8m whichever is more. The oil collection pit thus formed shall have a void volume equal to 200% volume for 220 kV & above and 130% for 132 kV & below of total oil in the Transformer. The minimum height of the retaining walls shall be 15 cm above the finished level of the ground to avoid outside water pouring inside the pit. The bottom of the pit shall have a uniform slope towards the sump pit. While designing the oil collection pit, the movement of the Transformer must be taken into account.

8.4 The grating shall be made of MS flat of size 40mmx 5mm placed at 30mm center to center and 25mmx5mm MS flat at spacing of 150mm at right angle to each other. Maximum length of grating shall be 2000mm and width shall not be more than 500mm. The gratings, supported on ISMB 150mm, shall be placed at the formation level and will be covered with 100mm thick layer of broken/crushed/non-crushed stone having size 40mm to 60mm which acts as an extinguisher for flaming oil. All steel works used for grating and support in transformer foundation shall be painted with Zinc phosphate primer (two packs) conforming to relevant British standard codes (BS Codes)/ IS/ equivalent International Standards.

8.5 Each oil collection pit shall be drained towards a sump pit within the collection pit whose role is to drain water and oil due to leakage within the collection pit so that collection pit remains dry.

8.6 MATERIALS

Complete foundation shall be made of reinforced cement concrete and shall be designed as per guidelines for design of foundations.

8.7 DRAINAGE

One 0.5 H.P pump for each pit shall be supplied and installed by the Contractor to evacuate the firefighting & rain water from the sump pit in to the nearest drain.

9. FIRE PROTECTION WALLS

9.1 GENERAL

Fire protection walls shall be provided, if required, in accordance with Local Advisory Committee (LAC) recommendations. The scope of works covers design, preparation of drawing and construction of RCC fire protection walls. While designing the wall, following points may be taken care of:

9.1.1 FIRE RESISTANCE

The firewall shall have a minimum fire resistance of 3 hours. The partitions, which are made to reduce the noise level, shall have the same fire resistance. The walls of the building, which are used as firewalls, shall also have a minimum fire resistance of 3 hours.

The firewall shall be designed to protect against the effect of radiant heat and flying debris from an adjacent fire.

9.1.2 DIMENSIONS

The firewall shall extend 600 mm on each side of the Transformer and 600 mm above the conservator tank or safety vent.

These dimensions might be reduced in special cases, as per the approval of employer where there is lack of space. A minimum of 2.0-meter clearance shall be provided between the equipment e.g., Transformer and firewalls.

The building walls, which act as firewalls, shall extend at least 1 m above the roof in order to protect it.

9.1.3 MATERIALS

The firewall will be made of reinforced cement concrete as per the relevant British standard codes (B S Codes)/ IS/equivalent International Standards.

10. CABLE TRENCHES AND CABLE TRENCH CROSSINGS

10.1 The work covered under this clause comprises of design, drawing and construction of cable trenches and cable trench crossings. While designing, following points may be taken care of:

10.2 The cable trenches and pre-cast removable RCC cover (with lifting arrangement) shall be constructed using RCC of M25 (Minimum) grade as per relevant British standard codes (B S Codes)/ equivalent International Standards.

10.3 The cable trench walls shall be designed for the following loads.

i. Dead load of 155 kg/m length of cable support + 75 Kg on one tier at the outer edge of tier.

ii. Earth pressure + uniform surcharge pressure of 2T/m2.

10.4 Cable trench covers shall be designed for self-weight of top slab + concentrated load of 150 kg at centre of span on each panel.

10.5 Necessary sumps shall be provided and each sump shall be provided with pumps of 5 HP capacity shall be supplied for pumping out water collected in cable trench. Cable trenches shall not be used as storm water drains.

10.6 The top of trenches shall be kept at least 100 mm above the finished ground level. The top of cable trench shall be such that the surface rainwater do not enter the trench.

10.7 All metal parts inside the trench shall be connected to the earthing system.

10.8 Trench wall shall not foul with the foundation. Suitable clear gap shall be provided.

10.9 The trench bed shall have a slope of 1/500 along the run & 1/250 perpendicular to the run.

10.10 Cable trenches shall be blocked at the ends if required with brick masonry in cement sand mortar 1:6 and plaster with 12mm thick 1:6 cement sand mortar.

10.11 Cable trench crossings shall be designed for critical load likely to be passed over the crossing. The cable trench crossing may be of either RCC box culvert type or RCC hume pipes embedded in plain concrete as per design of contractor.

11. FOUNDATION / RCC CONSTRUCTION

11.1 GENERAL

11.1.1 Work covered under this Clause of the Specification comprises the design, drawing and construction of foundations and other RCC constructions for switchyard equipment supports, cable trenches, Transformer, jacking pad, pulling blocks, fire protection walls, auxiliary equipments, Control Room Cum Administrative building, GIS hall, Panel room, RCC retaining wall, or for any other equipment or service and any other foundation required to complete the work. This clause is as well applicable to the other RCC constructions.

11.1.2 Concrete shall conform to the requirements mentioned in relevant British standard codes (B S Codes)/IS/ equivalent International Standards and all the tests shall be conducted as per relevant British standard codes (B S Codes)/IS/ equivalent International Standards. However, a minimum grade of M25 (design Mix) concrete shall be used for all foundations and structural/load bearing members as per relevant British standard codes (B S Codes)/IS/ equivalent International Standards.

11.1.3 If the site is sloppy, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.

11.1.4 The switchyard foundation's plinths and building plinths shall be minimum 300mm and 500 mm above finished ground level respectively.

11.1.5 Minimum 75mm thick lean concrete (1:3:6) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction.

11.1.6 Concrete made with Portland slag cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.

11.1.7 The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof. The Spread footings foundation or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided.

11.1.8 If pile foundations are adopted, the same shall be cast-in-situ driven/bored or pre-cast or under reamed type as per relevant parts of relevant British standard codes (B S Codes)/IS/ equivalent International Standards. Only RCC piles shall be provided. Suitability of the adopted pile foundations shall be justified by way of full design calculations. Detailed design calculations shall be submitted by the contractor showing complete details of piles/pile groups proposed to be used. Necessary initial load test shall also be carried out by the bidder at their cost to establish the piles design capacity. Only after the design capacity of piles has been established, the Contractor shall take up the job of piling. Routine tests for the piles shall also be conducted. All the work (design & testing) shall be planned in such a way that these shall not cause any delay in project completion.

11.2 DESIGN

While designing foundations, following may be taken care of:

11.2.1 All foundations shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per relevant BS/IS and minimum grade of concrete shall be M-25 (design Mix). Higher grade of concrete than specified above may be used at the discretion of Contractor without any additional financial implication to the Owner.

11.2.2 Limit state method or any other method as per relevant British standard codes (BS Codes)/IS/equivalent International Standards of design shall be adopted unless specified otherwise in the specification.

11.2.3 For detailing of reinforcement relevant BS followed. Cold twisted deformed bars conforming to relevant British standard codes (BS Codes)/IS/ equivalent International Standards. Two layers of reinforcement (on inner and outer face) shall be provided for wall & slab sections having thickness of 150 mm and above. Clear cover to reinforcement shall be as per relevant British standard codes (BS Codes)/IS/ equivalent International Standards.

11.2.4 RCC water retaining structures like storage tanks, etc. shall be designed as uncracked section in accordance with relevant British standard codes (B S Codes)/ equivalent International Standards. However, water channels shall be designed as cracked section with limited steel stresses as per relevant BS/IS.

11.2.5 The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and/or superstructure and other conditions which produces the maximum stresses in the foundation or the foundation component and as per the relevant British standard codes (BS Codes)/IS/ equivalent International Standards of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.

11.2.6 Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.

11.2.7 Necessary protection to the foundation work, if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental/harmful to the concrete foundations.

11.2.8 RCC columns shall be provided with rigid connection at the base.

11.2.9 All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be taken as mentioned in relevant British standard codes (BS Codes)/IS/ equivalent International Standards or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.

11.2.10 Earth pressure for all underground structures shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.

11.2.11 In addition to earth pressure and ground water pressure etc., a surcharge load of 2T/Sq.m shall also be considered for the design of all underground structures including channels, sumps, tanks, trenches, substructure of any underground hollow enclosure etc., for the vehicular traffic in the vicinity of the structure.

11.2.12 Following conditions shall be considered for the design of channels, sumps, trenches and other underground structures:

i. Full water pressure from inside and no earth pressure & ground water pressure & surcharge pressure from outside (application only to structures which are liable to be filled up with water or any other liquid).

ii. Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

iii. Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.

11.2.13 Base slab of any underground enclosure shall also be designed for empty condition during construction and maintenance stages with maximum ground water table (GWT). Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the super-imposed loadings.

11.2.14 Base slab of any underground enclosure like water storage tank shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum GWT. Intermediate dividing piers of such enclosures shall be designed considering water in one pump sump only and the other pumps sump being empty for maintenance.

11.2.15 The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.

11.2.16 The foundations of transformer and circuit breaker shall be of lock type foundation. Minimum reinforcement shall be governed by relevant British standard codes (BS Codes)/IS/ equivalent International Standards.

11.2.17 The equipment foundations shall be checked for a factor of safety as per relevant British standard codes (BS Codes)/IS/ equivalent International Standards for two conditions i.e. Normal condition and short circuit condition against sliding, overturning and pullout. The same factors shall be used as partial safety factor over loads in limit state design also.

11.3 ADMIXTURES & ADDITIVES

11.3.1 Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification.

11.3.2 Admixtures in concrete shall conform to relevant British standard codes (BS Codes)/IS/ equivalent International Standards. The water proofing cement additives shall conform to relevant BS/IS. Concrete Admixtures/ Additives shall be approved by Owner.

11.3.3 The Contractor may propose and the Employer may approve the use of a water-reducing set-retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.

11.3.4 The water-reducing setting-retarding admixture shall be an approved brand as per relevant British standard codes (BS Codes)/IS/ equivalent International Standards.

11.3.5 The water proofing cement additives shall be used as required/advised by Owner.

12. BUILDINGS – GENERAL REQUIREMENTS

12.1 GENERAL

12.1.1 The scope includes the design, drawing, engineering and construction including anti-termite treatment, plinth protection, DPC, Peripheral drain, sanitary, water supply, electrification, false ceiling etc. as applicable for complete of control room building (CRB) & GIS Building.

12.1.2 The GIS building shall be of pre-engineered steel structure. Control room building shall be reinforced concrete framed structure. The Control room building shall be attached to GIS Building with internal access to the GIS hall from control room building provided.

12.1.3 The contractor shall appoint a reputed architect (To be approved by Owner) for design of architecturally pleasing building.

12.2 AREA REQUIREMENT

12.2.1 Dimensions of the GIS and CRB building shall be decided by the bidder depending upon requirement. A corridor having minimum width of 1500 mm shall be provided all around the GIS to facilitate maintenance of equipment. Pre-engineered steel structure GIS building consists of GIS hall, provision of service (maintenance) bay and future bay. The room for control, protection & communication panels and AHU room shall also be included on either CRB or GIS building as permitted by space and with approval from the

Owner. Similarly, a store room of suitable size for storing all the spared to be supplied as detailed in annexure I of section Project. The size and layout of the store room shall be finalized by the bidder so as to ensure proper storage of all spares in line with the storage instructions of respective manufactures. The finish schedule of the store room shall be same as that of GIS hall.

12.2.2 The GIS building shall be of pre-engineered steel structure. Internal access to the GIS hall from control room building shall be provided.

12.2.3 Material specification and other details for construction of Pre-engineered steel building shall be as described in subsequent paragraphs. The base plate of steel columns shall be mounted on the RCC foundation by means of hot dip galvanised foundation bolts (Galvanisation of 610 gms/Sq. M).

12.2.4 In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. The built-up frame shall be applied with a prime coat of red oxide zinc chromate primmer before taken out of the workshop. Separate fire escape doors shall also be provided in the GIS Building. Panels shall be kept in an air-conditioned enclosure preferably within the GIS hall. A glazed partition made of aluminium frame and 5.5mm thick glass shall be provided between GIS hall and panel room. The glazing shall be kept at a sill level of 0.9 m above floor level. The height of glazing shall be minimum 2.1 m above sill level.

12.2.5 Walkway of width not less than 1.0m shall be provided at gantry girder level on the two longer side of GIS hall along with climbing arrangement to facilitate maintenance of crane. All steel work shall be painted with one coat of steel primer and two coats of synthetic enamel paint after erection.

12.2.6 All the material required for Pre-engineered (steel) building shall be from reputed manufacturer for which prior approval shall be obtained from Owner. Manufacturing of various parts of the building shall start only after approval of "Manufacturing Quality Plan". Complete material shall be offered for inspection by Owner before dispatch. Inspection shall be carried out based on assembly (fabrication) drawings approved by Employer and "BILL OF MATERIAL" & Shop drawing prepared by the Manufacturer and certified by the Contractor for its correctness. Approval of BOM and shop drawing from employer is not required.

12.3 DESIGN

12.3.1 The building shall be designed:

i. to the requirements of the National Building Code of Nepal, and the standards quoted therein.

ii. for the specified climatic & loading conditions.

iii. to adequately suit the requirements of the equipment and apparatus contained in the buildings and in all respects to be compatible with the intended use and occupancy.

iv. with functional and economical space requirement.

v. for a life expectancy of structure, systems and components not less than that of the equipment, which is contained in the building, provided regular maintenance is carried out.

vi. to be aesthetically pleasing. Different buildings shall show a uniformity and consistency in architectural design.

vii. to allow for easy access to equipment and maintenance of the equipment.

viii. with, wherever required, fire retarding materials for walls, ceilings and door, which would prevent supporting or spreading of fire.

ix. with materials preventing dust accumulation.

x. All structures shall be designed for the worst combination of dead loads, live loads, wind loads as per IS-875, seismic forces as per IS1893.

xi. The design of steel structures for the GIS building shall be done in accordance with IS:800.

xii. The design of RCC structures for the GIS building and Control Room Building shall be done in accordance with IS: 456.

xiii. Permissible stresses for different load combinations shall be taken as per relevant IS Codes.

12.3.2 Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns.

12.3.3 Individual members of the building frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion etc.

12.3.4 Permissible stresses for different load combinations shall be taken as per relevant IS Codes.

12.3.5 The building lighting shall be designed in accordance with the requirements of relevant section.

12.3.6 The building auxiliary services like air conditioning and ventilation systems, fire protection and detection systems and all other miscellaneous services shall be designed in accordance with the requirements specified in relevant section or elsewhere in this Specification.

12.3.7 Chequred plate walkway shall be provided at crane girder level with suitable access ladders.

12.4 DESIGN LOADS

12.4.1 Building structures shall be designed for the most critical combinations of dead loads, super-imposed loads, equipment loads, crane load (if any) wind load and seismic loads.

12.4.2 Dead loads shall include the weight of structures complete with finishes, fixtures and partitions and should be taken as per IS: 1911.

12.4.3 Super-imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks/hangers and erection, operation and maintenance loads wherever these loads are expected. Equipment loads shall constitute, if applicable, all load of equipment to be supported on the building frame.

12.4.4 For crane loads an impact factor of 30% and lateral crane surge of 10% (lifted weight + trolley) shall be considered in the analysis of frame according of IS:875. The horizontal surge shall be 5% of the static wheel load.

12.4.5 The wind loads shall be computed as per IS875-1987, Seismic Coefficient method/Response Spectrum method shall be used for the seismic analysis as per IS 1893 with importance factor 1.5.

12.4.6 Wind and Seismic forces shall not be considered to act simultaneously.

12.4.7 Floors/slabs shall be designed to carry loads imposed by equipment, cables and other loads associated with building. Floors shall be designed for live load as per relevant IS. Cable load shall also be considered additionally for floors where these loads are expected.

12.4.8 In addition, beams shall be designed for any incidental point loads to be applied at any point along the beams. The floor loads shall be subject to Owner's approval.

12.4.9 For consideration of loads on structures, IS:875 -1987, the following minimum superimposed live loads shall, however, be considered for the design.

a. Roof	1.5 kN/m^2	for accessible roofs
	0.75 kN/m^2	for in-accessible roofs
b. RCC-Floor	5 kN/m^2	for offices
	10 kN/m^2	for equipment floors or actual requirement, if higher than 10kN/m^2 based on equipment weight and layout plans.
c. Stairs & Balconies		5 kN/m^2
d. Toilet Rooms		2 kN/m^2
e. Chequered Plate floor		4 kN/m^2
f. Walkways		3 kN/m^2

12.4.10 Any additional load coming in the structure shall be calculated as per IS:875-1987.

12.5 SUBMISSION

12.5.1 The following information shall be submitted for review and approval to the Owner:

i. Soft as well as hard copies of structural design calculations and drawing (including construction/ fabrication) for all reinforced concrete and structural steel structures.

ii. Fully dimensioned concept plan including floor plans, cross sections, longitudinal sections, elevations and perspective view of each building. These drawings shall be drawn at a scale not smaller than 1:50 and shall identify the major building components.

iii. Fully dimensioned drawings showing details and sections drawn to scales of sufficient size to clearly show sizes and configuration of the building components and the relationship between them.

iv. Product information of building components and materials, including wall partitions, flooring, ceiling, roofing, door and windows and building finishes.

v. A detailed schedule of building finishes including colour schemes.

vi. A door & window schedule showing door types and locations, door lock sets and latch sets and other door hardware.

vii. Approval of the above information shall be obtained before ordering.

12.6 MATERIAL SPECIFICATION:

12.6.1 Primary members fabricated from plates and sections with minimum yield strength of 345 MPa or to suit design by continuous welding.

12.6.2 Secondary members for Purlins and Grits shall conform to the physical specification of ASTM A570 (Grade 50) or equivalent IS standards having a minimum yield strength of 345 MPa. The minimum thickness of secondary members shall be 2.5mm.

12.6.3 Rod / ANGLE bracing shall conform to the physical specification of IS 2062 of minimum 245 MPa Yield Strength.

12.6.4 All hot rolled sections shall conform to the physical specifications IS 2062. All other miscellaneous secondary members shall have minimum yield strength of 250 MPa.

12.7 DESCRIPTION

12.7.1 Primary Members

Primary structural framing shall include the transverse rigid frames, columns, corner columns, end wall wind column and crane gantry girders and Frames at Door openings.

12.7.2 Secondary Members

Secondary structural framing shall include the purlins, girts, eave struts, wind bracing, flange bracing, base angles, clips, flashing and other miscellaneous structural parts. Suitable wind bracings sag rods to be reckoned while designing the structure.

12.7.3 Purlins

Purlins should be of Pre Galvanised steel of 345 MPa having a coating thickness of 275 gms/sq. M inclusive of both sides.

12.7.4 Roof Sheeting

50mm thick puff (density 40kg/cu.m.) sandwiched panels shall be provided. These panels shall be made of puff insulation sandwiched between two number SMP coated galvalume steel sheets. These steel sheets shall be made out of 0.5 mm thick high tensile steel having minimum yield strength of 345 MPa conforming to ASTM- A446. Galvalume sheets shall conform to AZ 150 of AS 1397 or ASTM 792 with hot dip metallic coating of 55% Al and 45% Zn alloy having total coating mass of minimum 150 gms/sq.m inclusive of both sides. Total coat thickness (TCT) of sheets shall be minimum 0.55 mm with base metal thickness.

12.7.5 Wall Panels

Wall panel material specifications shall be same as roof panels.

12.7.6 Sheeting Fasteners

Standard fasteners shall be self-tapping zinc plated metal screws with EPDM bonded zinc plated washers. All screws shall be colour coated to match roof and wall sheeting.

12.7.7 Sealer

This is to be applied at all side laps and end laps of roof panels and around self-flashing windows. Sealer shall be pressure sensitive elastomeric Butyl tapes. The sealer shall be non-asphaltic, non-shrinking and nontoxic and shall be superior adhesive metals, plastics and painted at temperatures from 51°C to +104°C.

12.7.8 Closures

Solid or closed cell closures matching the profiles of the panel shall be installed along the eaves, rake and other locations specified on drawings.

12.7.9 Flashing and Trim

Flashing and / or trim shall be furnished at the rake, corners, eaves, and framed openings and wherever necessary to provide weather tightness and finished appearance. Colour shall be matching with the colour of wall. Material shall be 26-gauge thick conforming to the physical specifications of sheeting.

12.7.10 Wall Lights

For day lighting purpose of GIS hall, minimum 2 mm thick approved translucent polycarbonate sheet shall be provided for wall lighting in addition to windows for at least 10% of wall area on upper portion of both long walls. The polycarbonate sheet shall be fixed with necessary EPDM, rubber gasket, Silicon Sealant, cold forged fastener, aluminum profile etc. including MS supporting structural steel (conforming to relevant BS/equivalent International Standards) frame to ensure watertight arrangement.

12.7.11 Gutters and Down Spouts

Gutters and down spouts shall be adequately designed to ensure proper roof drainage system. Material shall be same as that of sheeting with matching colour.

12.7.12 Painting of Built-Up steel frames, Crane Gantry Girders, Frames at Door Openings, Walkway steel and Ladder

The built up frame, Crane gantry girders, frames for door openings and steel for walk way shall be applied with a priming coat of standard steel primmer followed by one coat coating of epoxy paint and final coating of PU (Minimum 100 Micron) . The steel work for aforesaid members shall be provided with suitable treatment of shot blasting before application of steel primer. The steel material of ladder shall be galvanized.

12.7.13 Colour Scheme

Colour Scheme matching with local aesthetic and best industry practices shall be submitted by vendors for approval of Owner. Three alternatives of coloured isometric views with colour codes shall be submitted for approval. The monotony of external colour of sheet shall be avoided by providing vertical bands of different coloured sheet. The colour of roof sheet shall be light coloured to minimize heat absorption. External and internal masonry walls shall be painted with suitable colour matching with colour of steel sheet.

12.8 CONNECTIONS:

12.8.1 SITE CONNECTIONS

i. All primary bolted connections shall be provided with galvanized high strength bolts, washers, nuts conforming to specifications of grade 8.8 of IS 1367 or equivalent international standard.

ii. All secondary bolted connections shall be furnished with bolts, nuts, washers conforming to the specifications of grade 4.6 of IS 1367 or ASTM-A307.

12.8.2 SHOP CONNECTIONS

All shop connections shall be welded with appropriate arc welding process and welding shall be in accordance with IS 816, IS 819, IS 1024, IS 1261, IS 1323, IS 9595, AWSD 1.1. as appropriate. The Webs should be welded on to the flanges at both the faces at top and bottom for columns, beams, and crane girders. Weld material should have strength more than the parent metal.

12.8.3 ROOF & WALL BRACINGS

Roof and wall bracings shall have minimum yield strength of 250 MPa and shall conform to the specifications of IS 2062.

12.8.4 FLOORING

Flooring in various rooms of Control Room Building and GIS Building shall be as per detailed schedule given in Table -1.

12.8.5 WALLS

All walls of control room building shall be non-load bearing walls. Min. thickness of walls shall be 230 mm (one brick) with 1:6 cement sand mortar. Partition walls (115mm thick) in toilets and pantry can be half brick walls with 1:4 cement sand mortar and two nos. 6mm dia MS bars at every third course.

In GIS building 230mm thick brick wall shall be provided up to first floor level of control building. 50mm thick puff sandwiched panels as described above shall be provided above brick wall.

12.8.6 ROOF

Roofing Panel for GIS hall: 50mm thick puff (density 40kg/cu.m.) sandwiched panels shall be provided as described in previous clauses. RCC roofing shall be provided for control building.

12.9 PLASTERING

All internal walls shall have minimum 12.5 mm thick 1:4 cement sand plaster. The ceiling shall have 12.5 mm thick 1:4 cement sand plaster.

12.10 CABLE TRENCH IN GIS & CONTROL ROOM BUILDING

All cable trenches in GIS hall and Control Room Building shall be covered with minimum 6 mm thick steel chequered plate with suitable stiffeners. Chequered plate shall be painted with two or more coats of Epoxy paint as per relevant standards.

12.11 EXTERNAL PLASTER AND PAINTING

External plaster 20 mm thick shall be of 1:4 cement sand plaster in two layers. External surface of the control room building, and GIS building (brick wall portion) shall be painted with Premium acrylic smooth exterior paint with silicon additives over and including priming coat of exterior primer as per relevant standards.

12.12 INTERNAL FINISH SCHEDULE

The finishing schedule is given in subsequent clauses and Table -1. Areas not specified shall be provided with vitrified tile flooring, and Premium Acrylic emulsion paint oil bound washable distemper over two mm thick putty. Paints used in the work shall be of best quality. Internal finish schedule for GIS building and Control Room Building are given in Table -1 below:

INTERNAL FINISH SCHEDULE (Table -1)

	Location	Flooring & Skirting 150 mm High	Wall (Internal)	Ceiling	Door, Windows & Ventilator
1.	Control Room	Vitrified tiles 8mm thick size 600 x 600mm	Non VOC acrylic emulsion paint over two or more coats of putty upto false ceiling over approved primer coat	False ceiling painted with Non VOC acrylic emulsion paint to give an even shade	Windows shall be of UPVC frames with 5mm thick glass by using suitable patch fittings/spider fittings. Doors shall be Salwood Chaukhat with ready made seasoned wood shutter with 3mm thick plywood cover and finished with 1mm thick laminate on both sides.
2.	Conference Room	Vitrified tiles 8mm size 600 x 600mm	Non VOC acrylic emulsion paint over two or more coats of putty upto false ceiling over approved primer coat	False ceiling painted with Non VOC acrylic emulsion paint to give an even shade	Windows shall be of UPVC frames with 5mm thick glass by using suitable patch fittings/spider fittings. Doors shall be Salwood Chaukhat with ready made seasoned wood shutter with 3mm thick plywood cover and finished with 1mm thick laminate on both sides.
3.	(S/S) In-charge Room	Vitrified tiles 8 mm size 600 x 600mm	Non VOC acrylic emulsion paint over two or more coats of putty upto false ceiling over approved primer coat	False ceiling painted with Non VOC acrylic emulsion paint to give an even shade	Windows shall be of UPVC frames with 5mm thick glass by using suitable patch fittings/spider fittings. Doors shall be Salwood Chaukhat with ready made seasoned wood shutter with 3mm thick plywood cover and finished with 1mm thick laminate on both sides.
4	Other Office Rooms	Vitrified tiles 8 mm size 600 x 600mm	Non VOC acrylic emulsion paint over two or more coats of putty upto false ceiling over approved primer coat	False ceiling painted with Non VOC acrylic emulsion paint to give an even shade	Windows shall be of UPVC frames with 5mm thick glass by using suitable patch fittings/spider fittings. Doors shall be Salwood Chaukhat with ready made seasoned wood shutter with 3mm thick plywood cover and finished with 1mm thick laminate on both sides.
5.	ACDB & DCDB Room	62mm thick cement concrete flooring with hardener	Non VOC acrylic emulsion paint over two or more coats of putty upto false ceiling over approved primer coat	False ceiling painted with Non VOC acrylic emulsion paint to give an even shade	Windows shall be of UPVC frames with 5mm thick glass by using suitable patch fittings/spider fittings. Doors shall be Salwood Chaukhat with ready made seasoned wood shutter with 3mm thick plywood cover and finished with 1mm

	Location	Flooring & Skirting 150 mm High	Wall (Internal)	Ceiling	Door, Windows & Ventilator
					thick laminate on both sides.
6.	Battery room	Acid resistant non-skid tiles on flooring and upto 2100 mm height on wall.	Acid alkali resistant painting above 2100 mm height.	False ceiling and White wash above False Ceiling	Windows shall be of UPVC frames with 5mm thick glass by using suitable patch fittings/spider fittings. Doors shall be Salwood Chaukhat with ready made seasoned wood shutter with 3mm thick plywood cover and finished with 1mm thick laminate on both sides.
7.	Staircase	16 mm thick Rajasthani white or equivalent marble flooring		Plastered ceiling painted with Non VOC acrylic emulsion paint to give an even shade	
8.	Corridor	Vitrified tiles 8 mm size 600 x 600mm	Non VOC acrylic emulsion paint over two or more coats of putty upto ceiling over approved primer coat	Plastered ceiling painted with Non VOC acrylic emulsion paint to give an even shade	Windows shall be of UPVC frames with 5mm thick glass by using suitable patch fittings/spider fittings. Doors shall be Salwood Chaukhat with ready made seasoned wood shutter with 3mm thick plywood cover and finished with 1mm thick laminate on both sides.
9.	Store/Kitchen	Vitrified tiles 8 mm size 600 x 600mm	Non VOC acrylic emulsion paint over two or more coats of putty upto ceiling over approved primer coat	Non VOC Acrylic emulsion paint over a approved primer coat	Windows shall be of UPVC frames with 5mm thick glass by using suitable patch fittings/spider fittings. Doors shall be Salwood Chaukhat with ready made seasoned wood shutter with 3mm thick plywood cover and finished with 1mm thick laminate on both sides.
10.	Toilet	Ceramic tiles	DADO glazed tile 2100mm high, above that non VOC acrylic emulsion paint over two or more coats of putty along with primer coat.	Non VOC Acrylic emulsion paint over a approved primer coat	Windows/Ventilators shall be of UPVC frames with 5mm thick glass by using suitable patch fittings/spider fittings. Doors shall be Salwood Chaukhat with ready made seasoned wood shutter with 3mm thick plywood cover and finished with 1mm thick laminate on both sides.

	Location	Flooring & Skirting 150 mm High	Wall (Internal)	Ceiling	Door, Windows & Ventilator
11.	GIS Hall	62mm thick cement concrete flooring with hardener. Two coats of PU coating over the floor shall be provided. The final coat of PU shall be applied after installation of equipment. Total thickness of PU coats shall be minimum 300 microns.	Premium Acrylic emulsion paint having Volatile Organic Compound (VOC) content less than 50 gms per liter of approved brand and manufacturer on smooth surface applied with two or more coats of putty over approved primer coat.	In case of RCC roof, ceiling shall be finished with non VOC Acrylic emulsion paint approved primer coat	Windows/Ventilators shall be of UPVC frames with 5mm thick glass by using suitable patch fittings/spider fittings. Doors shall be Salwood Chaukhat with ready made seasoned wood shutter with 3mm thick plywood cover and finished with 1mm thick laminate on both sides.
14.	Panel/Relay Room/Switchgear Room	Vitrified tiles 8mm thick size 600 x 600mm	Premium Acrylic emulsion paint on smooth surface applied with two or more coats of putty	False ceiling and White wash above False Ceiling	Windows shall be of UPVC frames with 5mm thick glass by using suitable patch fittings/spider fittings. Doors shall be Salwood Chaukhat with ready made seasoned wood shutter with 3mm thick plywood cover and finished with 1mm thick laminate on both sides.
15.	AHU Room	62mm thick cement concrete flooring with metallic hardener topping	Premium Acrylic emulsion paint on smooth surface applied with two or more coats of putty	False ceiling and White wash above False Ceiling	Windows/Ventilators shall be of UPVC frames with 5mm thick glass by using suitable patch fittings/spider fittings. Doors shall be Salwood Chaukhat with ready made seasoned wood shutter with 3mm thick plywood cover and finished with 1mm thick laminate on both sides.
16	RCC Roof	38mm screeding with 1:2:4 cement sand mortar with 3 to 5 mm 1:1 c/c punning			

12.13 Staircase shall be provided with stainless steel railing and 16mm thick marble slab in risers and treads.

12.14 DOORS AND WINDOWS

The details of doors and windows of the GIS and control room building shall be as per finish schedule Table-1 conforming to relevant BS/IS/ equivalent International Standards. Rolling steel shutters and rolling steel grills shall be provided as per layout and requirement of buildings.

12.15 PARTITION ON GIS BUILDING

Partitions, if required, shall be made of powder coated aluminum frame provided with 5.5 mm thick clear glass or pre- laminated board depending upon the location of partition.

12.16 FALSE CEILING

Providing and fixing 16 mm thick approximately 600x600 mm Mineral fiber board panel false ceiling and making cut-outs for electrical fixtures, AC diffusers, openable access etc. complete with silhouette profile system with 15 mm wide flange incorporating 6mm central recess white/black main runners at 1200 mm center - center and not greater than 600 mm from the adjacent wall. The cross tees shall be provided to make a module of approximately 600 mm x 600 mm by fitting 600 mm long cross tees centrally placed between 1200 mm long cross tees. Cross tees also have 15 mm wide flange incorporating 6 mm central recess white/black. The module formed above shall be anchored to the slab with channels or angles, suspenders as per manufacturer's specifications.

12.17 PLUMBING & SANITATION

12.17.1 All plumbing and sanitation works shall be executed to comply with the requirements of the appropriate bye-laws, rules and regulations of the Local Authority having jurisdiction over such matters. The Contractor shall arrange for all necessary formalities to be met with regards to inspection, testing, obtaining approval and giving notices etc.

12.17.2 "SINTEX" or an equivalent make PVC Roof water tanks with metal stand of adequate capacity depending on the number of users for 24 hours storage shall be provided. However, Minimum 1 Nos. 1500 liter capacity shall be provided.

12.17.3 Chlorinated Polyvinyl chloride (CPVC) pipes having thermal stability for hot and cold water supply including all CPVC plain and brass threading conforming to relevant British standard codes (BS Codes)/IS/equivalent International Standards shall be used for internal piping works for water supply.

12.17.4 For internal soil, waste and vent pipe Unplasticised rigid PVC pipes of 75 mm for waste & 110 mm dia for soil shall be provided conforming to IS 13592 type B and all its fittings like bends, sockets, door bend, Y-tee etc. as per requirement with seal ring conforming to IS 5382 including jointing with cement solvent conforms to IS 14182. All underground or under floor pipes shall be encased with 1:4:8 concrete. Minimum concrete cover shall be 75 mm thick.

12.17.5 Each toilet shall have the following minimum fittings.

i. WC (Western type) 390 mm high with toilet paper roll holder and all fittings in toilets attached to conference and sub-station in charge office and WC (Indian Type) Orissa Pattern (580 x 440 mm) with all fittings shall be provided in common toilets.

ii. Urinal (430 x 260 x 350 mm size) with all fittings.

iii. Wash basin (550 x 400 mm) with all fittings.

iv. Bathroom mirror (600 x 450 x 6 mm thick) hard board backing

v. CP brass towel rail (600 x 20 mm) with C.P. brass brackets

vi. CP Soap holder and CP liquid soap dispenser.

vii. All urinals and washbasins shall be provided with built in sensors.

viii. Automatic Hand Dryer

12.17.6 Water cooler for drinking water with adequate water storage facility shall be provided and located near pantry and away from the toilet block.

12.17.7 1 no. stainless steel kitchen sink with Drain board (510 x 1040 x 178 mm bowl depth) for pantry shall be provided.

12.17.8 All fittings, fastener, grating shall be chromium plated.

12.17.9 All sanitary fixtures and fittings shall be of approved quality and type manufactured by well-known manufacturers. All items brought to site must bear identification marks of the type of the Manufacturer.

12.17.10 Contractor shall provide septic tank and soak pit of adequate capacity to treat the sewage / sullage from the building.

12.17.11 Contractor shall undertake all other activities required to complete and commission the building.

13. EXTERNAL PAINTING

External surfaces of the GIS & Control Room Building shall be painted with acrylic exterior flat paint as per manufacturer's specification and approval of Owner.

14. DOORS, WINDOWS AND VENTILATORS

The schedule of doors, windows and ventilators of the GIS and Control Room Building shall be as per the detailed finish schedule given in Table -1 (Detailed Finish Schedule) and shall conform to the relevant British Standard codes (BS Codes)/IS/ equivalent International Standards. Rolling Steel shutters shall be provided as per the layout and requirements of the building.

15. PLINTH PROTECTION

750 mm wide plinth protection around all the buildings shall be provided. Plinth protection shall comprise of 50 mm thick plain cement concrete laid over 75 mm thick well compacted stone aggregates with interstices filled with local sand.

16. BUILDING STORM WATER DRAINAGE

16.1 The building design shall provide for the collection of storm water from the roof. This water shall be drained to the main drainage system of the Sub-station.

16.2 UPVC Rainwater down comer pipes conforming to relevant International standards/ British Standards with water tight lead joints conforming to relevant British Standard Codes (BS Codes)/ IS Code/ Equivalent International Standards.

16.3 All drains around the buildings shall have minimum 40 mm thick grating covers, and in areas where heavy equipment loads are envisaged, Pre-Cast RCC covers shall be provided in place of steel grating.

16.4 Suitable arrangements for draining out water collected from equipment blowdowns, leakages, floor washings, firefighting etc. shall be provided for each floor.

17. SUBMISSIONS

17.1 The following information/documents/ drawings shall be submitted for review and approval:

i. Structural design calculations, Structural drawings (including construction/ fabrication), both in hard and soft copies, for all reinforced concrete and structural steel structures.

ii. Fully dimensioned and detailed floor plans, cross sections, longitudinal sections and elevations identifying the major building components.

iii. Product information of building components and materials, including walls, partitions, flooring, ceilings, roofing, doors, wall paneling and windows and building finishes along with BOQ.

iv. A detailed schedule of building finishes including colors schemes along with item description.

v. A door & window schedule showing door & window types and locations, lock sets and latch sets and other door hardware along with item details.

vi. Approval of the above information shall be obtained before ordering materials or starting construction/ fabrication, as applicable.

18. UNDERDECK INSULATION

18.1 The method of fixing shall consist of slotted MS angles of appropriate size (minimum 65x50x2 mm) fixed to soffit of RCC roof slab at 600 mm centers in both directions by Rawl plugs of adequate strength. The slots shall have 14g G.I. tie wire drawn through them.

18.2 50mm thick insulation mat Fiberglass Crown – 100 or equivalent shall be made out of fiberglass or approved equivalent conforming to relevant international standard, backed with 34g aluminum foil and 22g x 12 mm mesh wire netting. The net shall be stretched tightly across the slotted angles or slotted plates holding it in place by means of wires. The joints of the wire netting shall be butted and tightly laced down with 14g G.I. wire. The system shall be approved from Owner.

19. ELECTRIFICATION

All electrification shall be executed as per details specified elsewhere in the technical specification. All details shall be as per relevant British standard codes (BS Codes)/IS/ equivalent International Standards

20. WATER PROOFING TREATMENT FOR RCC ROOF/TERRACE

Roof of the Building shall of Cast-in-Situ RCC slab treated with water proofing system conforming to relevant British standard codes (BS Codes)/IS/ equivalent international standard. The water proofing system to be implemented shall be provided in detail with material and methodology to the Owner. The material procurement and the water proofing work shall only be started after approval has been obtained from the Owner.

21. WATER SUPPLY

i. Water shall be made available by Employer at any feasible point within substation boundary at single point to the contractor. Contractor shall state the total water requirement both in terms of quantity and head to Owner.

ii. The contractor shall carry out all the plumbing/erection works required for supply of water in control room and GIS building beyond the single point as at (i) above.

iii. The details of tanks, pipes, fittings, fixtures etc. for water supply are given elsewhere in the specification under respective sections.

iv. A scheme shall be prepared by the contractor indicating the layout and details of water supply which shall be got approved by Employer before actual start of work including all other incidental items not shown or specified but as may be required for complete performance of the works. All drawings shall be prepared by the contractor for approval of Employer.

v. Bore wells and pumps for water supply is not in the scope of contractor.

22. SEWERAGE SYSTEM

22.1 Sewerage system shall be provided for all GIS building and control room building.

22.2 The Contractor shall construct septic tank and soak pit suitable for required numbers of user but minimum of 50 users. If septic and soak pit system is not acceptable by local Nepal Authority, contractor will have to install suitable sewerage system as per local statutory requirement.

22.3 The system shall be designed as per relevant British standard codes (B S Codes)/ IS code/ equivalent International Standards. All drawings shall be prepared by the contractor for approval of Owner.

23. MODE OF MEASUREMENT

23.1 Geotechnical investigation

This shall include carrying out field tests, laboratory tests, compilation of results and preparation of soil report with recommendations for type of foundations shallow or pile type, suitability of soil for construction of substation etc. The geotechnical investigation work shall be measured on lump sum basis.

23.2 Site clearing, Contour survey and site leveling

23.2.1 The site clearing work and contour survey work shall not be measured and paid separately and shall be deemed to be included in the item of site leveling work.

23.2.2 Measurement of Earth work in all kind of soil including soft/disintegrated rock in the item of cutting and filling and item of earth work in the filling with borrowed earth shall be made in Cubic meters. No void deduction for 95% compaction.

23.3 Earthwork

This shall include excavation in all kinds of soil including rock, all leads and lifts including back filling with suitable earth, compacting, dewatering (if required) and disposal of surplus earth or rock to a suitable location within a lead up to 2 km. The surplus earth if disposed within substation boundary shall be spread in uniform layers each compacted with two passes of suitable compacting equipment. The quantity of excavation for foundations of towers, equipment support structures, all transformers/Reactors, DG Set, firewall, cable trenches, fire fighting water tank, buildings and underground water tanks, covered car parking, External lighting poles, control cubicles, marshalling box shall only be measured. The quantity of excavation for roads, rail cum road, drains, culverts, rainwater harvesting, septic tank, soak pit, external water supply system, site surfacing, chain link fencing (including gate) shall not be measured separately and shall be deemed to be included in the composite rates quoted by the bidder for the respective works. All other excavation required for the completion of the work including plinth protection, flooring, sewerage system, manholes, pipes, earth mat etc. shall also not be paid for. The measurement of excavation of all concrete works shall be made considering dimension of the pit leaving 150mm gap around the base pad (lean concrete) or actually excavated pit, whichever is less. The quantity shall be measured in cubic metres.

23.4 PCC

23.4.1 Providing and laying Plain Cement Concrete of all types and at all locations including all leads and lifts. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings.

23.4.2 PCC 1:2:4 (1 cement : 2 sand : 4 coarse aggregate 20 mm nominal size) shall be measured in flooring of buildings, plinth protection, fencing, transformer/reactor foundation, rail track, drain, culverts, septic tank, chain link fencing, fencing gate ,external lighting poles etc. as indicated in the approved drawings.

23.4.3 PCC 1:3:6 (1 cement : 3 coarse sand : 6 stone aggregate, 40mm nominal size) shall be measured below all foundations of towers, equipment support structures, buildings, firefighting water tanks, covered car parking, cable trench, roads, under flooring, rail-cum-road, transformer foundation, reactor foundation, drain, cable trench crossings, culverts, fence, gate etc. as indicated in the approved drawings.

23.4.4 PCC 1:5:10 (1 Cement: 5 sand: 10 Stone aggregate, 40mm nominal size) shall be provided for site surfacing in switchyard, roof water proofing etc.

23.4.5 All other PCC required for the completion of the work including hold fasts of doors/windows/rolling shutters, fixing of plumbing pipes, bedding concrete for sewer lines, embedment of electrical conduits etc. shall not be measured and deemed included in the composite rates quoted by the bidder for respective works. Water proofing compound wherever specified shall be added without any extra cost.

23.5 RCC

Measurement of reinforced cement concrete at all locations shall be made and shall include all leads, lifts, grouting of pockets and underpinning, (but shall exclude reinforcement, formwork & miscellaneous structural steel like inserts etc.), of M25 design mix (Minimum). This shall also include pre-cast RCC work, and addition of water proofing compound wherever required for which no additional payment shall be made. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings having cross-sectional area up to 0.1 Sq.m.

23.6 Formwork

Measurement of formwork for reinforced cement concrete at all locations shall be measured in square meters as per lines and levels indicated in the drawings. No deduction shall be made for openings having cross-sectional area up to 0.1 Sq.m.

23.7 Steel Reinforcement

Reinforcement steel shall be measured in length (actual or theoretical as per drawing whichever is less) including hooks, if any, separately for different diameters as actually used in RCC work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in metric tonnes on the basis of sectional weights as adopted by British Standards/Indian Standards/equivalent International standards. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

23.8 Stone filling over grating in Transformer foundation

Measurement of stone (40mm nominal size) filling over gratings of transformer/reactor foundations shall be made as per theoretical volume of the space to be filled in the transformer foundation as per approved drawings. This shall be measured in Cu.M.

23.9 Miscellaneous structural steel

Measurement for Supply, fabrication, transportation and erection of all miscellaneous structural steel work for rails along with rail fixing details and gratings with supports for transformers/reactors, Cable trenches with covers (Chequered plate covers, cable supports, earthing cleats and edge protection angles etc.), all other steel fittings and fixtures, inserts and embedment in concrete of transformer/reactor foundation and cable trenches shall be made as per approved drawings. The unit rate for this item shall be inclusive of cutting, grinding, drilling, bolting, welding, pre- heating of the welded joints, applying a priming coat of steel primer and anti-corrosive bitumastic paint/ synthetic enamel paint in general but with Zinc Phosphate Primer (Two packs) for grating and support for grating in Transformer foundation. (Wherever specified), setting of all types of embedment in concrete, etc. Steel required for foundation bolts, nuts and bolt, doors, windows, ventilators, louvers, rolling shutters, chain link fencing, gratings in drains, soil pipes, plumbing pipes, floor traps, embedment's required for rainwater harvesting, septic tank, soak pit, roof truss and purlins required for fire water tank, etc. shall not be considered for payment and measurements. Quantity shall be measured in metric tonnes.

23.10 Roads

23.10.1 The measurement for the concrete road shall be made on the basis of area in square meter (M^2) of top concrete completed surface of the road and shall be deemed to include all items such as excavation, compaction, rolling, watering, WBM, shoulder, etc. complete as per approved drawing but excluding concreting and reinforcement which shall be paid separately under respective items of BPS.

23.10.2 The measurement of bituminous road shall be made on the basis of area in square meter (M^2), of the top bituminous completed surface of the road and shall include all items such as excavation, compaction, rolling, watering, sub base course, WBM, shoulder, premix carpet etc. complete as per approved drawing.

23.10.3 The measurement of strengthening of existing road (bituminous road) shall be made on the basis of area in square meter (M^2), of the top bituminous completed surface of the road including premix carpet etc. but excluding item of granular sub base course which shall be paid separately under respective item of BPS.

23.11 Anti-weed Treatment and Stone Spreading

The measurement shall be done for the actual area in square metres of stone spreading provided in the switchyard. It includes providing and spreading of 100mm thickness of uncrushed/crushed/broken stone of 40mm nominal size as per relevant BS codes/equivalent International standards for the specified area. Application of anti-weed treatment including material shall not be measured separately and item would be deemed to be included in the quoted rate of stone spreading in switchyard.

23.12 Chain Link Fencing and gate

The measurement shall be made in running metres of the fence provided as per approved drawing. The rate shall be including the post, fencing, MS Flat, painting, brick work and plaster of toe wall etc. complete but excluding the concrete. The switch yard gate shall be measured in numbers.

23.13 Cable Trenches and Cable trench Crossings

Earthwork, PCC, RCC, reinforcement steel, RCC hume pipes and miscellaneous steel required for construction of Cable Trenches and cable trench crossings shall be measured under respective items of Bid price schedule (BPS). No additional payment for brick work, plaster and PVC pipes used for cable trench crossings and sealing of trench mouth shall be admissible.

23.14 Drains & Culverts

PCC (1:2:4 and 1:4:8) for drains and culverts shall be measured under respective items of Bid price schedule (BPS) as described in clauses of aforesaid paragraphs. All other items like excavation, brick work, plaster and stone pitching except RCC hume pipes required for completion of drains and culverts shall be deemed to be included in the quoted rate of drain. The quantity for each type of drain section shall be measured in running meters. However, RCC hume pipes used in culverts shall be measured under under respective item of Bid price schedule (BPS) as described in clause of hume pipes.

23.15 External Finishing of RCC Framed Buildings/structures:

The item shall be measured per square meter area basis. Contractor has to assess the quantity as per requirement of Control room cum administrative building, Fire Fighting Pump House, firefighting water tank, switchyard panel room, residential and

nonresidential buildings, covered car parking and quote for the same separately. This shall include following items.

i. External plastering/cement wash : 20mm Cement plaster in two coats under layer 12 mm thick cement plaster 1:5 (1 cement: 5 coarse Sand) finished with a top layer of 8 mm thick cement plaster 1:4 (1 cement: 4 fine Sand) for all buildings and fire fighting water tank.

ii. Providing and applying two or more coats of Acrylic smooth exterior paint over an under coat of suitable primer on new cement plaster surfaces of the control room building, auxiliary building, firefighting pump house building, firefighting water tank, panel room , residential and nonresidential buildings and covered car parking. It shall be inclusive of required tools, scaffolding, materials and other painting accessories etc. as per recommendations of manufacturer.

23.16 Hume Pipe

Hume pipe shall be measured diameter-wise and laid as per approved drawings and shall be measured in running meters. The item shall be inclusive of excavation, laying, back filling, jointing etc. but excluding concrete and reinforcement (if any).

23.17 GIS Steel Building

Payment for all civil works of this item shall be made on lump sum basis including internal foundations, cable trenches, internal and external finishes as well as internal firefighting works etc. complete in all respect. However, the quantity of excavation, concrete, reinforcement, formwork shall be measured in respective items of BPS and described in above paras. The structural steel used for cable tray support, earthing cleat, chequered plates for internal cable trenches of building and panel room shall be measured and paid under miscellaneous steel item of BPS. The rest of the entire work required to complete the building in all respect as per drawings prepared by contractor and approved by Owner shall be deemed to be included in this rate.

23.18 Building

The measurement of all items except excavation, concrete, reinforcement steel, formwork of each type of buildings shall be made on lump sum basis. However, the quantity of excavation, concrete, reinforcement and formwork shall be measured in respective items of BPS. The structural steel used for cable tray support, earthing cleat, chequered plates for internal cable trenches of building and panel room wherever applicable shall be measured and paid under miscellaneous steel item of BPS and described above paras. The structural steel and foundation bolts for fixing equipments with foundations/raft within buildings shall not be measured separately which shall be deemed to be included in the quoted rates per square meter of buildings. External Finishing shall be measured and paid in respective items of BPS and described in above paras. The rest of the entire work required to complete the building in all respect as per drawings prepared by contractor and approved by Employer shall be deemed to be included in this item rate per square meter area basis.

23.19 Rain Water Harvesting

This is a lump sum item. The contractor shall be required to complete the work in all respect as per drawings prepared by contractor and approved by Employer. All the items

including excavation, miscellaneous steel, brick work, fillings of boulders, gravel, sand, pipes etc. shall be deemed to be included in this lump sum rate. However, the concrete (all types) and the reinforcement shall be measured and paid under respective item of BPS and described in above paras.

23.20 Rail cum Road

The measurement for the rail cum road shall be made in square metres of top concrete completed surface of the rail cum road and shall include all items such as excavation, compaction, rolling, watering, WBM etc. complete as per approved drawing but excluding concrete, reinforcement, structural steel and rails with rail fixing details which shall be measured separately under respective item of BPS and described in above paragraphs.

23.21 Septic Tank and Soak Pit

This is a lump sum item. The contractor shall be required to complete the work in all respect as per drawings furnished by the contractor and approved by Employer. All the items including excavation, masonry work, all types of fillings, all types of pipes including plumbing and vent pipes, all type of fittings etc. shall be deemed to be included in this lump sum rate. However, the concrete (all types) and the reinforcement shall be measured and paid under the respective item mentioned above.

23.22 Firewater Tank

This is a lump sum item. The contractor shall be required to complete the work in all respect as per approved drawings. The items including brick work if any, and miscellaneous steel including steel embedment Rungs, roof truss, corrugated AC Sheet roofing, door, pipe sleeves, internal finish, etc. shall be deemed to be included in this lump sum cost. However, the items like excavation, concrete (all types), reinforcement steel, external finish shall be measured and paid under the respective item of BPS and described in above paras.

23.23 External water supply from Bore-well/ other source of water supply arrangement to Fire water tank, Control Room building ,Residential and nonresidential buildings

23.24 The external water supply from Bore-well shall be measured in lump-sum basis. It shall include all the items such as excavation, piping, pipe fittings, painting, brickwork, sand filling, concrete, valves, chambers cutting chases in walls, openings in RCC and repairs, etc. required to complete the job.

23.25 External Sewage System of Control Room Building and other Buildings of Township.

It shall be measured in lump-sum. It shall include all the items such as excavation, piping, pipe fittings, manholes, gully trap, gully chamber casing in concrete and repairs etc. required to complete the job. Any modification in the existing sewage system, if required, shall be done by the Contractor without any extra cost implicated to Employer.

24. MISCELLANEOUS GENERAL REQUIREMENTS

24.1 Dense concrete with controlled water cement ratio as per BS-code shall be used for all underground concrete structures such as pump-house, tanks, water retaining structures, cable and pipe trenches etc. for achieving water-tightness.

24.2 All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230 mm.

24.3 All steel sections and fabricated structures which are required to be transported on sea shall be provided with anti-corrosive paint to take care of sea worthiness.

24.4 All mild steel parts used in the water retaining structures shall be hot-double dip galvanised. The minimum coating of the zinc shall be 750 gm/sq. m. for galvanised structures and shall comply with relevant BS. Galvanizing shall be checked and tested in accordance with relevant BS. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS: 3416.

24.5 A screed concrete layer not less than 100 mm thick and of grade not weaker than M10 conforming to relevant BS shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structures.

24.6 Bricks having minimum 75 kg/cm2 compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 75 kg/cm2 compressive strength before submitting his offer. The contractor may use concrete blocks of equivalent compressive strength in place of brick work.

24.7 Doors and windows on external walls of the buildings (other than areas provided, with insulated metal claddings) shall be provided with RCC sun-shade over the openings with 300 mm projection on either side of the openings. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings.

24.8 All stairs shall have maximum riser height of 150 mm and a minimum tread width of 300 mm. Minimum width of stairs shall be 1500 mm. Service ladder shall be provided for access to all roofs. RCC fire escape staircase if required as per local bye laws, shall be provided in GIS Building.

24.9 Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of manhole precast cover and any other place where breakage of corners of concrete is expected.

24.10 Anti-termite chemical treatment for buildings shall be given to all column pits, wall trenches, foundations, filling below the floors etc. as per relevant International/BS.

24.11 Hand-railing minimum 900mm high shall be provided around all floor/roof openings, projections/balconies, walk ways, platforms, steel stairs etc. All handrails and ladder pipes shall be 32 mm nominal bore MS pipes (medium class) and shall be galvanised (medium-class as per relevant BS). All rungs for ladder shall also be galvanised as per relevant BS.

24.12 For RCC stairs, hand railing with 20 mm square MS bars, balustrades with suitable MS flats & aluminium handrails shall be provided.

24.13 For all civil works covered under this specification, design Mix of Minimum M25 grade as per relevant International /BS/ IS shall be used. Reinforcement steel shall be of minimum Fe 500 grade.

24.14 The material specification, workmanship and acceptance criteria shall be as per relevant clauses of applicable International/BS standard.

24.15 Items/components of buildings not explicitly covered in the specification and BPS but required for completion of the project shall be deemed to be included in the scope.

24.16 Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the International/BS Standards based on the findings of the detailed soil investigation to be carried out by the Bidder.

24.17 Foundation system adopted by Bidder shall ensure that relative settlement and other criteria shall be as per provision in relevant BS and other International Standards.

24.18 Construction joints shall be as per International/BS standard.

24.19 All building/construction materials shall conform to the best quality specified in relevant International /BS standard.

25. INTERFACING

The proper coordination & execution of all interfacing civil works activities like fixing of conduits in roofs/walls/floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/embedment's, provision of cut outs etc. shall be the sole responsibility of the Contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc. is reduced to minimum.

26. STATUTORY RULES

26.1 Contractor shall comply with all the applicable statutory rules pertaining to relevant acts of GoN.

26.2 Provisions for fireproof doors, no. of staircases, fire escape stairs, fire separation wall, plastering on structural members (in fire prone areas) etc. shall be made according to the recommendations of Local Advisory Committee.

26.3 Statutory clearance and norms of Local Pollution Control Board shall be followed as per Water Resources Act for effluent quality from plant.

27. FIELD QUALITY PLAN

All tests as required in accordance to BS codes or equivalent International standards have to be carried out. The contractor shall prepare field quality plan for civil works as per relevant /BS codes/equivalent International Standards during detailed engineering stage and submit to Owner for approval within ONE month after award of work.

28. BRITISH STANDARD CODES

Major British standard Codes for civil work have been given in the following list. This list is illustrative but not exhaustive. However, for design and engineering relevant BS codes

or equivalent International standards shall be referred by the contractor. Relevant portion of BS codes or equivalent international standards referred by the contractor for the design shall be made available to Owner if necessary, during detailed engineering stage.

SN.	Standard No.	Title	Year
1	BS 41	Structural steel sections. Specification for hotrolled sections	2005
2	BS 13771	Methods of test for soils for civil engineering purposes. General requirements and sample preparation	1990
3	BS 4449	Steel for the reinforcement of concrete. Weldable reinforcing steel. Bar, coil and decoiled product. Specification (with A2:2009)	2005
4	BS 4482	Steel fabric for the reinforcement of concrete. Specification	2005
5	BS 4483	Steel fabric for the reinforcement of concrete. Specification	2005
6	BS EN 102102	Hot finished structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties	2006
7	BS EN 100561	Specification for structural steel equal and unequal angles. Dimensions	1999
8	BS EN ISO 800001	Quantities and units. General	2013
9	BS 5930	Code of practice for site investigations (with A2:2010)	1999
10	BS EN 199311	Eurocode 3. Design of steel structures. General rules and rules for buildings	2005
11	NA to BS EN 199311	UK National Annex to Eurocode 3. Design of steel structures. General rules and rules for buildings	2008
12	BS EN 199315	Eurocode 3. Design of steel structures. Plated structural elements	2006
13	NA to BS EN 199315	UK National Annex to Eurocode 3. Design of steel structures. Plated structural elements	2008
14	BS EN 199318	Eurocode 3. Design of steel structures. Design of joints	2005
15	NA to BS EN 199318	UK National Annex to Eurocode 3. Design of steel structures. Design of joints	2008
16	BS 60732	Precast concrete masonry units. Guide for specifying precast concrete masonry units	2008
17	BS 7668	Weldable structural steels. Hot finished structural hollow sections in weather resistant steels. Specification	2004
18	BS EN 19971	Eurocode 7. Geotechnical design. General rules	2004
19	NA to BS EN 19971	UK National Annex to Eurocode 7. Geotechnical design. General rules	2007
20	BS EN 19923	Eurocode 2. Design of concrete structures. Liquid retaining and containing structures	2006
21	BS EN 199211	Eurocode 2. Design of concrete structures. General rules and rules for buildings	2004
22	NA to BS EN 199211	UK National Annex to Eurocode 2. Design of concrete structures. General rules and rules for buil	2005

SN.	Standard No.	Title	Year
		dings	
23	BS 75334	Pavements constructed with clay, natural stone or concrete pavers. Code of practice for the construction of pavements of precast concrete flags or natural stone slabs	2006
24	BS EN 1971	Cement. Composition, specifications and conformity criteria for common cements	2011
25	BS 743	Specification for materials for dampproof courses	1970
26	BS 8122	Testing aggregates. Methods for determination of density	1995
27	BS 952-1	Glass for glazing. Classification	1995
28	BS 952-2	Glass for glazing. Terminology for work on glass	1980
29	BS EN 12620	Aggregates for concrete	2013
30	BS 1125	Specification for WC flushing cisterns (including dual flush cisterns and flush pipes)	1987
31	BS 1188	Specification for ceramic wash basins and pedestals	1974
32	BS 1199 and 1200	Specifications for building sands from natural sources	1976
33	BS EN 13310	Kitchen sinks. Functional requirements and test methods	2003
34	BS 1245	Pedestrian doorsets and door frames made from steel sheet. Specification	2012
35	BS 1254	Specification for WC seats (plastics)	1981
36	BS 1370	Specification for low heat Portland cement	1979
37	BS EN 1008	Mixing water for concrete. Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete	2002
38	BS 3505	Specification for unplasticized polyvinyl chloride (PVCU) pressure pipes for cold potable water	1986
39	BS EN 15743	Supersulfated cement. Composition, specifications and conformity criteria	2010
40	BS EN ISO 3766	Construction drawings. Simplified representation of concrete reinforcement	2003
41	BS 8666	Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete. Specification	2005
42	BS 4514	Unplasticized PVC soil and ventilating pipes of 82.4 mm minimum mean outside diameter, and fittings and accessories of 82.4 mm and of other sizes. Specification	2001
43	BS 4551	Mortar. Methods of test for mortar and screed. Chemical analysis and physical testing (with A2:2013)	2005
44	BS EN 122001	Plastics rainwater piping systems for above ground external use. Unplasticized poly (vinyl chloride) (PVC-U). Specifications for pipes, fittings and the system	2000

SN.	Standard No.	Title	Year
45	BS EN 1462	Brackets for eaves gutters. Requirements and test ing	2004
46	BS EN 607	Eaves gutters and fittings made of PVCU. Definit ions, requirements and testing	2004
47	BS 6262	Code of practice for glazing for buildings	1982
48	BS EN 14411	Ceramic tiles. Definitions, classification, charact eristics, evalua tion of conformity and marking	2012
49	BS 6510	Steelframed windows and glazed doors. Specific ation	2010
50	BS EN 636	Plywood. Specifications	2012
51	NA to BS EN 19923	UK National Annex to Eurocode 2. Design of co ncrete structures. Liquid retaining and containme nt structures	2007
52	BS EN 1339	Concrete paving flags. Requirements and test me thods	2003
53	BS EN 1340	Concrete kerb units. Requirements and test meth ods	2003

CHAPTER 19

CONTROL RELAY AND PROTECTION PANELS

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CHAPTER 19: CONTROL, RELAY & PROTECTION PANELS

1. TYPE OF PANELS

1.1 Simplex Panel

Simplex panel shall consist of a vertical front panel with equipment mounted thereon and having wiring access from rear for control panels & front for relay/protection panels. In case of panel having width more than 800mm, double leaf-doors shall be provided. Doors shall have handles with either built-in locking facility or will be provided with pad-lock.

1.2 Duplex Panel

Duplex panel shall be walk-in tunnel type comprising two vertical front and rear panel sections connected back-on-back by formed sheet steel roof tie members and a central corridor in between. The corridor shall facilitate access to internal wiring and external cable connections. In case of number of duplex panels located in a row side by side, the central corridor shall be aligned to form a continuous passage. Both ends of the corridor shall be provided with double leaf doors with lift off hinges. Doors shall have handles either with built-in locking facility or shall be provided with pad-locks. Separate cable entries shall be provided for the front and rear panels. However, inter-connections between front and back panels shall be by means of inter panel wiring at the top of the panel.

2. CONSTRUCTIONAL FEATURES

2.1 Control and Relay Board shall be of panels of simplex or duplex type (Finalise during detail engineering design). It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes be properly accommodated in the panels without congestion and if necessary, either add a greater number of panels or provide panels with larger dimensions. No price increase at a later date on this account shall be allowed. However, the width of panels that are being offered to be placed in existing switchyard control rooms, should be in conformity with the space availability in the control room.

2.2 Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-31 in accordance with IEC 60529 (Part-1).

2.3 Panels shall be free standing, floor mounting type and shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.

2.4 All doors, removable covers of panels shall be gasketed all around with synthetic gaskets Neoprene/EPDM. However, XLPE gaskets can also be used for fixing protective glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

2.5 Design, materials selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt head apparent from outside, with all exterior surfaces tune and smooth.

2.6 Panels shall have base frame with smooth bearing surface, which shall be fixed on the embedded foundation channels/insert plates. Anti-vibration strips made of shock absorbing materials that shall be supplied by the contractor, which shall be placed between panel & base frame.

2.7 Cable entries to the panels shall be from the bottom. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor rigidly.

2.8 Relay/protection panels of modern modular construction would also be acceptable.

3. MOUNTING

3.1 All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush.

3.2 Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.

3.3 The Contractor shall carry out cut out, mounting and wiring of the free issue items supplied by others which are to be mounted in his panel in accordance with the corresponding equipment manufacturer's drawings. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.

3.4 The centre lines of switches, push buttons and indicating lamps shall not be less than 750mm from the bottom of the panel. The centre lines of relays, meters and recorders shall not be less than 450mm from the bottom of the panel.

3.5 The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise, the top lines of all meters, relays and recorders etc. shall be matched.

3.6 No equipment shall be mounted on the doors.

4. PANEL INTERNAL WIRING

4.1 Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be carried out internally.

4.2 All wiring shall be carried out with 650V grade, single core, stranded copper conductor wires with PVC insulation. The minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows:

i. All circuits except current transformer circuits and voltage transfer circuits meant for energy metering - one 1.5mm sq. per lead.

ii. All current transformer circuits - one 2.5 sq.mm per lead.

iii. Voltage transformer circuit (for energy meters): Two 2.5 mm sq. per lead.

4.3 All internal wiring including FO patch cords shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & troughs shall be used for this purpose.

4.4 Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels.

4.5 Wire termination shall be made with solderless crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule.

4.6 Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires.

4.7 Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipment.

5. TERMINAL BLOCKS

5.1 All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 650 V grade and have 10 Amps. continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.

5.2 Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

5.3 At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

5.4 Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side

i. All CT & PT circuits: minimum of two of 2.5mm Sq. copper.

ii. AC/DC Power Supply Circuits: One of 16mm Sq. Copper.

iii. All other circuits: minimum of one of 2.5mm Sq. Copper.

5.5 There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel side wall. Also, the clearance between two rows of terminal blocks edges shall be minimum of 150mm.

5.6 Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring-duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

5.7 The number and sizes of the Owner's multi core incoming external cables will be furnished to the Contractor after placement of the order. All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be included in the scope of supply. Termination blocks provided on interface panel used for external wiring from switchyard shall be provided with necessary surge protection device to safeguard IEDs from transient voltage surges, spikes.

6. PAINTING

The painting shall be carried out as detailed in Chapter 2–GTR.

7. MIMIC DIAGRAM

7.1 Coloured mimic diagram and symbols showing the exact representation of the system shall be provided in the front of control panels.

7.2 Mimic diagram shall be made preferably of anodised aluminium or plastic of approved fast colour material, which shall be screwed on to the panel and can be easily cleaned. The mimic bus shall be 2mm thick. The width of the mimic bus shall be 10mm for bus bars and 7mm for other connections. Painted overlaid mimic is also acceptable.

7.3 Mimic bus colour will be decided during detailed Engineering.

7.4 When semaphore indicators are used for equipment position, they shall be so mounted in the mimic that the equipment in close position shall complete the continuity of mimic.

7.5 Indicating lamp, one for each phase, for each bus shall be provided on the mimic to indicate bus charged condition.

8. NAME PLATES AND MARKINGS

8.1 All equipment mounted on front and rear side as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved. Also, on the top of each panel on front as well as rear side, large and bold nameplates shall be provided for circuit/feeder designation.

8.2 All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.

8.3 Each instrument and meter shall be prominently marked with the quantity measured e.g. kV, A, MW, etc. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

8.4 Name Plates shall be made of non-rusting metal. Name plates shall be black with white engraving lettering.

8.5 Each switch shall bear clear inscription identifying its function e.g. 'BREAKER' '52A', "SYNCHRONISING" etc. Similar inscription shall also be provided on each device whose function is not other-wise identified. If any switch device does not bear this inscription separate name plate giving its function shall be provided for it. Switch shall also have clear inscription for each position indication e.g. "Trip- Neutral-Close", "ON-OFF", "R-Y-B-OFF" etc.

8.6 All the panels shall be provided with name plate mounted inside the panel bearing LOA No & Date, Name of the Substation & feeder and reference drawing number.

9. MISCELLANEOUS ACCESSORIES

9.1 Plug Point:

230V, Single phase 50Hz, AC socket with switch suitable to accept 5 Amps and 15 Amps pin round standard plug, shall be provided in the interior of each cubicle with ON-OFF switch.

9.2 Interior Lighting:

Each panel shall be provided with LED type (Min 7 watt) lighting fixture rated for 230 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch. Adequate lighting shall be provided inside the panel.

9.3 Switches and Fuses:

Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with Fuses. Selection of the main and sub-circuit Fuses rating shall be such as to ensure selective clearance of sub-circuit faults. Voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC cartridge type conforming to relevant international standard. The short time fuse rating of Fuses shall be not less than 9 KA. Fuse carrier base shall have imprints of the fuse 'rating' and 'voltage'. MCB's shall also accepted for protecting the relaying and metering circuits instead of HRC fuse.

9.4 Space Heater:

Each panel shall be provided with a thermostatically connected space heater rated for 230V, single phase, 50 Hz AC supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit.

10. EARTHING

10.1 All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference from earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least 25 X 6 sq.mm copper with threaded holes at a gap of 50 mm with provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of

supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

10.2 Provision shall be made on each bus bar of the end panels for connecting Substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope of supply of Contractor.

10.3 All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than 2.5 sq. mm. The colour code of earthing wires shall be green.

10.4 Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. However, looping of earth connections between equipment to provide alternative paths to earth bus shall be provided.

10.5 VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

10.6 An electrostatic discharge arrangement shall be provided in each panel so as to discharge human body before he handles the equipment inside the panels.

11. INDICATING INSTRUMENTS & TRANSDUCERS FOR CONTROL PANEL:

All instruments, meters and transducers shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. All Megawatt, MegaVAR, Bus voltage and frequency indicating instruments shall be provided with individual transducers and these shall be calibrated along with transducers to read directly the primary quantities. They shall be accurately adjusted and calibrated at works and shall have means of calibration check and adjustment at site. The supplier shall submit calibration certificates at the time of delivery. However, no separate transducers are envisaged for digital bus voltmeters and digital frequency meters and the indicating meters provided in the synchronising equipment.

11.1 Indicating Instruments

i. Unless otherwise specified, all electrical indicating instruments shall be of digital type suitable for flush mounting.

ii. Instruments shall have 4-digit display; display height being not less than 25 mm

iii. Instrument shall confirm to relevant IEC and shall have an accuracy class of 1.5 or better. Watt and Var meters shall have an indication of (+) and (-) to indicate EXPORT and IMPORT respectively.

iv. Digital voltage and frequency meters shall be of class: 0.5 and shall have digital display of 5 and 4 digits respectively, with display size, not less than 25mm (height).

11.2 Transducers

i. Transducers (for use with Indicating Instruments and Telemetry/Data

Communication application) shall in general confirm to IEC:688-1

ii. The transducers shall be suitable for measurement of active power, reactive power, voltage, current and frequency in three phase four wire unbalanced system.

iii. The input to the transducers will be from sub-station current & potential transformers. The output shall be in milli-ampere D.C. proportional to the input & it shall be possible to feed the output current directly to the telemetry terminal or indicating instruments.

iv. The transducer characteristic shall be linear throughout the measuring range.

v. The transducer output shall be load independent.

vi. The input & output of the transducer shall be galvanically isolated.

vii. Each transducer shall be housed in a separate compact case and have suitable terminals for inputs & outputs.

viii. The transducers shall be suitably protected against transient high peaks of voltage & current.

ix. The transducer shall withstand indefinitely without damage and work satisfactorily at 120% of the rated voltage and 120% of the rated input current as applicable.

x. All the transducers shall have an output of 4-20 mA.

xi. The response time of the transducers shall be less than 1 second.

xii. The accuracy class of transducers shall be 1.0 or better for voltage/current transducer, 0.5 or better for watt/VAR transducer and 0.2 or better for frequency transducer.

xiii. The transducers shall have a low AC ripple on output less than 1%.

xiv. The transducer shall have dual output.

12. ANNUNCIATION SYSTEM FOR CONTROL PANEL

12.1 Alarm annunciation system shall be provided in the control board by means of visual and audible alarm in order to draw the attention of the operator to the abnormal operating conditions or the operation of some protective devices. The annunciation equipment shall be suitable for operation on the voltages specified in this specification.

12.2 The visual annunciation shall be provided by annunciation facia, mounted flush on the top of the control panels.

12.3 The annunciation facia shall be provided with translucent plastic window for alarm point with approximate size of 35mm x 50mm. The facia plates shall be engraved in black lettering with respective inscriptions. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall not be less than 5 mm.

12.4 Each annunciation window shall be provided with two white lamps in parallel to provide safety against lamp failure. Long life lamps shall be used. The transparency of cover plates and wattage of the lamps provided in the facia windows shall be adequate to ensure

clear visibility of the inscriptions in the control room having high illumination intensity (350 Lux), from the location of the operator's desk.

12.5 All Trip facia shall have red colour and all non-trip facia shall have white colour.

12.6 The audible alarm shall be provided by Buzzer/ Hooter /Bell having different sounds and shall be used as follows.

i. Hooter Alarm Annunciation

ii. Bell Annunciation DC failure

iii. Buzzer AC supply failure

12.7 Sequence of operation of the annunciator shall be as follows:

SN	Alarm Condition	Fault Contact	Visual Annunciation	Audible Annunciation
1.	Normal	Open	OFF	OFF
2.	Abnormal	Close	Flashing	ON
3.	Accept Push Button Pressed	Close Open	Steady On Steady On	OFF OFF
4.	Reset Push Button Pressed	Close Open	On Off	OFF OFF
5.	Lamp Test Push Button Pressed	Open	Steady On	OFF

12.8 Audible annunciation for the failure of DC supply to the annunciation system shall be provided and this annunciation shall operate on 230 Volts AC supply. On failure of the DC to the annunciation system for more than 2 or 3 seconds (adjustable setting), a bell shall sound. A separate push button shall be provided for the cancellation of this audible alarm alone but the facia window shall remain steadily lighted till the supply to annunciation system is restored.

12.9 A separate voltage check relay shall be provided to monitor the failure of supply (230V AC) to the scheme mentioned in Clause above. If the failure of supply exists for more than 2 to 3 seconds, this relay shall initiate visual and audible annunciation. Visual and audible annunciation for the failure of AC supply to the annunciation system shall be provided and this annunciation shall operate on Annunciation DC and buzzer shall sound.

12.10 The annunciation system described above shall meet the following additional requirements:

12.10.1 The annunciation system shall be capable of catering to at least 20 simultaneous signals at a time.

12.10.2 One set of the following push buttons shall be provided on each control panel:

i. Reset push button for annunciation system

ii. Accept push button for annunciation system

iii. Lamp test push button for testing the facia windows

12.10.3 One set of the following items shall be provided common for all the control panel:

i. Flasher relay for annunciation system

ii. Push button for Flasher test

iii. Three Push buttons for test of all audible alarm systems

12.10.4 These testing circuits shall be so connected that while testing is being done, it shall not prevent the registering of any new annunciation that may land during the test.

12.10.5 The annunciation shall be repetitive type and shall be capable of registering the fleeting signal. Minimum duration of the fleeting signal registered by the system shall be 15 milli seconds.

12.10.6 In case of static annunciator scheme, special precaution shall be taken to ensure that spurious alarm condition does not appear due to influence of external electromagnetic/ electrostatic interference on the annunciator wiring and switching disturbances from the neighbouring circuits within the panels and the static annunciator shall meet the high voltage susceptibility test , impulse voltage withstand test , high frequency disturbance test– class III and fast transient disturbance test –level III as per IEC 60255.

12.11 For the control panel with BCU, only common alarm lamp shall be provided for each control panel. Each BCU of the control panel shall energize this common alarm lamp on occurrence of alarms/trips. All alarms shall be available in the BCU mimic/HMI.

12.12 Following may add regarding busbar connection in existing substation/CRP (Check) :

The annunciation system to be supplied for existing sub-stations shall be engineered as an extension to the existing scheme.

13. SWITCHES

13.1 Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out.

13.2 The selection of operating handles for the different types of switches shall be as follows:

Breaker, Isolator control switches	Pistol grip, black
Synchronising switches	Oval, Black, Keyed handle (one common removable handle for a group of switches or locking facility having common key)
synchronising Selector switches	Oval or knob, black
Instrument switches	Round, knurled, black
Protection Transfer witch, Local/Remote selector switch	Pistol grip, lockable and black.

13.3 The control switch of breaker and isolator shall be of spring return to neutral type. The switch shall have spring return from close and trip positions to "after close" and "after trip" positions respectively.

13.4 Instrument selection switches shall be of maintained contact (stay put) type. Ammeter selection switches shall have make-before-break type contacts so as to prevent open circuiting of CT secondary when changing the position of the switch. Voltmeter transfer

switches for AC shall be suitable for reading all line- to-line and line-to-neutral voltages for non- effectively earthed systems and for reading all line-to-line voltages for effectively earthed systems.

13.5 Synchronizing switches shall be of maintained contact (stay put) type having a common removable handle for a group of switches. The handle shall be removable only in the OFF position and it shall be coordinated to fit into all the synchronizing switches. These switches shall be arranged to connect the synchronizing equipment when turned to the 'ON' position. One contact of each switch shall be connected in the closing circuit of the respective breaker so that the breaker cannot be closed until the switch is turned to the 'ON' position.

13.6 Lockable type of switches which can be locked in particular positions shall be provided when specified. The key locks shall be fitted on the operating handles.

13.7 The contacts of all switches shall preferably open and close with snap action to minimize arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy. Springs shall not be used as current carrying parts.

13.8 The contact combination and their operation shall be such as to give completeness to the interlock and function of the scheme.

13.9 The contact rating of the switches shall be as follows:

SN	Description	Contact rating in Amps		
		220 V DC	48 V DC	230 V AC
1	Make and carry continuously	10	10	10
2	Make and carry for 0.5 Seconds	30	30	30
3	Break for resistive loads	3	20	7
	Break for Inductive load with L/R=40 mS	0.2	-	-

14. INDICATING LAMPS

14.1 Indicating lamps shall be of cluster LED type suitable for panel mounting with rear terminal connections. Lamps shall be provided with series connected resistors preferably built in the lamp assembly. Lamps shall have translucent lamp covers to diffuse lights coloured red, green, amber, clear white or blue as specified. The lamp cover shall be preferably of screwed type, unbreakable and moulded from heat resisting material.

14.2 The lamps shall be provided with suitable resistors.

14.3 Lamps and lenses shall be interchangeable and easily replaceable from the front of the panel. Tools, if required for replacing the bulbs and lenses shall also be included in the scope of the supply.

14.4 The indicating lamps with resistors shall withstand 120% of rated voltage on a continuous basis.

15. POSITION INDICATORS (AS APPLICABLE)

15.1 Position indicators of "SEMAPHORE" type shall be provided when specified as part of the mimic diagrams on panels for indicating the position of circuit breakers, isolating/earthing switches etc. The indicator shall be suitable for semi-flush mounting with only the front disc projecting out and with terminal connection from the rear. Their strips shall be of the same colour as the associated mimic.

15.2 Position indicator shall be suitable for DC Voltage as specified. When the supervised object is in the closed position, the pointer of the indicator shall take up a position in line with the mimic bus bars, and at right angles to them when the object is in the open position. When the supply failure to the indicator occurs, the pointer shall take up an intermediate position to indicate the supply failure by changing the appropriate colour.

15.3 The rating of the indicator shall not exceed 2.5 W.

15.4 The position indicators shall withstand 120% of rated voltage on a continuous basis.

16. RELAYS

16.1 All relays shall conform to the requirements of IS: 3231/IEC-60255/IEC 61000 or other applicable standards. Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear.

16.2 All protective relays shall be of numerical type and communication protocol shall be as per IEC 61850. Further, the test levels of EMI as indicated in IEC 61850 shall be applicable to these relays.

16.3 All protective relays shall be in draw out or plug-in type/modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractor's scope of supply.

16.4 All AC operated relays shall be suitable for operation at 50 Hz. AC Voltage operated relays shall be suitable for 110 Volts VT secondary and current operated relays for 1 amp CT secondary. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

16.5 The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme; contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay coils and contacts, including spare contacts.

16.6 Timers shall be of solid-state type. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not preferred and shall be avoided.

16.7 No control relay, which shall trip the power circuit breaker when the relay is de-energised, shall be employed in the circuits.

16.8 Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.

16.9 Auxiliary seal-in-units provided on the protective relays shall preferably be of shunt reinforcement type. If series relays are used the following shall be strictly ensured:

i. The operating time of the series seal-in-unit shall be sufficiently shorter than that of the trip coil or trip relay in series with which it operates to ensure definite operation of the flag indicator of the relay.

ii. Seal-in-unit shall obtain adequate current for operation when one or more relays operate simultaneously.

iii. Impedance of the seal-in-unit shall be small enough to permit satisfactory operation of the trip coil on trip relays when the D.C. Supply Voltage is minimum.

iv. Trip-circuit seal-in is required for all trip outputs, irrespective of the magnitude of the interrupted current. The trip-circuit seal-in logic shall not only seal-in the trip output(s), but also the relevant initiation signals to other scheme functions, (e.g., initiate signals to the circuit-breaker failure function, reclosing function etc.), and the alarm output signals.

v. Two methods of seal-in are required, one based on the measurement of AC current, catering for those circumstances for which the interrupted current is above a set threshold, and one based on a fixed time duration, catering for those circumstances for which the interrupted current is small (below the set threshold).

vi. For the current seal-in method, the seal-in shall be maintained until the circuit-breaker opens, at which time the seal-in shall reset and the seal-in method shall not now revert to the fixed time duration method. For this seal-in method, the seal-in shall be maintained for the set time duration. For the line protection schemes, this time duration shall be independently settable for single- and three-pole tripping.

vii. Seal-in by way of current or by way of the fixed duration timer shall occur irrespective of whether the trip command originates from within the main protection device itself (from any of the internal protection functions), or from an external device with its trip output routed through the main protection device for tripping. Trip-circuit seal-in shall not take place under sub-harmonic conditions.

16.10 The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.

16.11 Any alternative/additional protections or relays considered necessary for providing complete effective and reliable protection shall also be offered separately. The acceptance of this alternative/ additional equipment shall lie with the Employer.

16.12 All relays and their drawings shall have phase indications as R-Red, Y-yellow, B-blue

16.13 For numerical relays, the scope shall include the following:

i. Necessary software and hardware to up/down load the data to/from the relay

from/to the personal computer installed in the substation. However, the supply of PC is not covered under this clause.

ii. The relay shall have suitable communication facility for future connectivity to SCADA. The relay shall be capable of supporting IEC 61850 protocol.

iii. In case of line bay protection and transformer, the features like fault recorder and event logging function as available including available as optional feature in these relays shall be supplied and activated at no extra cost to the owner. Also, necessary software/ hardware for automatic uploading to station HMI/DR work station (as applicable) shall be supplied. It is to be clearly understood that these shall be in addition to Fault recorder function as specified at clause no. 28.

17. TRANSMISSION LINE PROTECTION

The protection of Suichatar-Balaju line not included on the present scope of work but after the completion of the present scope of work, the contractor shall do the necessary work for shifting, erection and integrating of existing line control/protection panel of Suichatar – Balaju feeder to new control building.

18. CIRCUIT BREAKER PROTECTION:

This shall include following functions:

i. Numerical AUTO RECLOSING function shall

ii. have single phase reclosing facilities

iii. have a continuously variable single phase dead time range of 0.1-2 seconds

iv. have a continuously variable reclaim time range of 5-300 seconds

v. Incorporate a **two-position** selector switch, from which single-phase auto-reclosure and non-auto reclosure mode can be selected. Alternatively, the mode of auto reclosing can be selected through programming.

vi. be of single shot type

vii. However, Auto-reclose as in-built function of bay controller unit (BCU) (if supplied) provided for sub-station automation system is also acceptable.

18.1 LOCAL BREAKER BACK-UP PROTECTION SCHEME shall

i. be triple pole type

ii. have an operating time of less than 15 milli seconds

iii. have a resetting time of less than 15 milli seconds

iv. have three over current elements

v. be arranged to get individual initiation from the corresponding phase of main protections of line for each over current element. However, common three phase initiation is acceptable for other protections and equipment protections

vi. have a setting range of 20-80% of rated current

vii. have a continuous thermal withstand two times rated current irrespective of the setting

viii. have a timer with continuously adjustable setting range of 0.1-1 seconds

ix. have necessary auxiliary relays to make a comprehensive scheme

19. TRANSFORMER PROTECTION

19.1 All transformer protection functions shall be grouped into Group-I and Group-II protections in the following manner:

19.2 Group-I Protection: Following protection functions shall be provided in Group-I Transformer protection relay:

i. Differential Protection

ii. Over fluxing Protection for HV side

iii. Direction Over current and earth fault protection for HV side

iv. Over Load Protection

19.3 Group-II Protection: Following protection functions may be provided in Group-II Transformer protection relay:

i. REF Protection

ii. Over fluxing Protection for HV/LV side 2

iii. Directional Over current and earth fault protection for HV/LV side

19.4 Transformer differential protection scheme shall

i. be triple pole type, with faulty phase identification/ indication

ii. have an operating time not greater than 30 milli seconds at 5 times the rated current

iii. have three instantaneous high set over-current units

iv. have an adjustable bias setting range of 20-50%

v. be suitable for rated current of 1 Amp.

vi. have second harmonic or other inrush proof features and also should be stable under normal over fluxing conditions. Magnetising inrush proof feature shall not be achieved through any intentional time delay e.g. use of timers to block relay operation or using disc operated relays

vii. have an operating current setting of 15% or less

viii. include necessary separate interposing current transformers for angle and ratio correction or have internal feature in the relay to take care of the angle & ratio correction

ix. have a fault recording feature to record graphic form of instantaneous values of following analogue channels during faults and disturbances for the pre fault and post fault period:

19.5 Current in all three windings in six analogue channels and Voltage in one channel.

19.6 The disturbance recorder function built in the differential protection IED shall have the facility to record following external digital channel signals associated with transformer, which shall be wired to differential relay apart from, the digital signals pertaining to differential relay.

i. REF protection operated

ii. HV Breaker status (Main)

iii. LV Breaker status (Main)

iv. Bucholz relay/OLTC/WTI/OTI alarm,

v. Bhuhholz relay/ PRD/SPR/Trip,

vi. Group-A,Group-B lockout relay trip.

19.7 Necessary hardware and software, for automatic up-loading the data captured by disturbance recorder to the personal computer available in the substation, shall be included in the scope.

19.8 Over Fluxing Protection Relays shall

i. operate on the principle of Voltage to frequency ratio and shall be phase to phase connected

ii. have inverse time characteristics, matching with transformer over fluxing withstand capability curve

iii. provide an independent 'alarm' with the time delay continuously adjustable between 0.1 to 6.0 seconds at values of 'v/f' between 100% to 130% of rated values

iv. tripping time shall be governed by 'v/f' Vs. time characteristics of the relay

v. have a set of characteristics for Various time multiplier settings. The maximum operating time of the relay shall not exceed 3 seconds and 1.5 seconds at 'v/f' values of 1.4 and 1.5 times, the rated values, respectively.

vi. have an accuracy of operating time, better than ±10%

vii. have a resetting ratio of 95 % or better

19.9 Restricted Earth Fault Protection shall

i. be single pole type

ii. be of current/voltage operated type

iii. have a current setting range of 5-50% of 1 Amp./ have a suitable voltage setting range

iv. be tuned to the system frequency

19.10 Back-up Over Current and Earth fault protection scheme with high set feature

i. Shall have three over current and one earth fault element(s) which shall be either independent or composite unit(s).

ii. The scheme shall include necessary VT fuse failure relays for alarm purposes

19.10.1 Over current relay shall

iii. have directional IDMT characteristic with a definite minimum time of 1.0 seconds at 10 times setting and have a variable setting range of 25-200% of rated current

iv. have low transient, over reach high set instantaneous unit of continuously variable setting range 500-2000 % of rated current

v. have a characteristic angle of 30/45 degree lead

vi. include hand reset flag indicators or LEDs.

19.10.2 Earth fault relay shall

i. have directional IDMT characteristic with a definite minimum time of 1.0 seconds at 10 times setting and have a variable setting range of 10-80% of rated current

ii. have low transient, over reach high set instantaneous unit of continuously variable setting range 100-800 % of rated current

iii. have a characteristic angle of 45/60 degree lag

iv. include hand reset flag indicators or LEDs

v. include necessary separate interposing voltage transformers or have internal feature in the relay for open delta voltage to the relay

19.11 Transformer Overload Protection Relay shall

i. be of single pole type

ii. be of definite time over-current type

iii. have one set of over-current relay element, with continuously adjustable setting range of 20-200% of rated current

iv. have one adjustable time delay relay for alarm having setting range of 1 to 10.0 seconds, continuously

v. have a drop-off/pick-up ratio greater than 95%.

19.12 Further, Transformer auxiliary protections contacts (Buchholz, PRV, Oil Temperature, Winding Temperature, OLTC Buchholz etc.) can be wired suitably in above protections or provide separate Flag relays/Auxiliary relays as per scheme requirements.

20. TRIP CIRCUIT SUPERVISION RELAY

i. The relay shall be capable of monitoring the healthiness of each 'phase' trip-coil and associated circuit of circuit breaker during 'ON' and 'OFF' conditions.

ii. The relay shall have adequate contacts for providing connection to alarm and event logger.

iii. The relay shall have time delay on drop-off of not less than 200 milli seconds and be provided with operation indications for each phase

21. DC SUPPLY SUPERVISION RELAY

iv. The relay shall be capable of monitoring the failure of D.C. supply to which, it is connected.

v. It shall have adequate potential free contacts to meet the scheme requirement.

vi. The relay shall have a 'time delay on drop-off' of not less than 100 milli seconds and be provided with operation indicator/flag.

22. BUS BAR PROTECTION

22.1 Redundant (1+1) bus bar protection scheme shall be provided for Bus 1 and Bus 2 (as applicable) for 132 kV Voltage levels.

22.2 Each Bus Bar protection scheme shall

i. have maximum operating time up to trip impulse to trip relay for all types of faults of 25 milli seconds at 5 times setting value and operate selectively for each bus bar.

ii. give hundred percent security up to 40 KA for 132 kV system,

iii. incorporate continuous supervision for CT secondary against any possible open circuit and if it occurs, shall render the relevant zone of protection inoperative and initiate an alarm,

iv. not give false operation during normal load flow in bus bars

v. incorporate clear zone indication

vi. be of phase segregated and triple pole type

vii. provide independent zones of protection. If the bus section is provided, then each side of bus section shall have separate set of bus bar protection schemes

viii. include individual high speed electrically reset tripping relays for each feeder. However, in case of distributed Bus bar protection, individual trip relay shall not be required if bay unit is having trip duty contacts for breaker tripping.

ix. be transient free in operation

x. include continuous D.C. supplies supervision

xi. not cause tripping for the differential current below the load current of heaviest loaded feeder. Contractor shall submit application check for the same.

xii. shall include necessary C.T. switching relays wherever C.T. switching is involved and have 'CT' selection incomplete alarm

xiii. include protection 'IN/OUT' switch for each zone

xiv. shall include trip relays, CT switching relays (if applicable), auxiliary CTs (as applicable) as well as additional power supply modules, input modules etc. as may be required to provide a Bus-bar protection scheme for the complete bus arrangement i.e. for all the bays or breakers including future bays as per the Single line diagram for new substations. However, for extension of bus bar protection scheme in existing substations, scope shall be limited to the bay or breakers covered under this specification. Suitable panels (if required) to

mount these are also included in the scope of the work.

22.3 Built-in Local Breaker Backup protection feature as a part of bus bar protection scheme shall also be acceptable.

22.4 The test terminal blocks (TTB) to be provided shall be fully enclosed with removable covers and made of moulded, non-inflammable plastic material with boxes and barriers moulded integrally. All terminals shall be clearly marked with identification numbers or letters to facilitate connection to external wiring. Terminal block shall have shorting, disconnecting and testing facilities for CT circuits.

23. RELAY TEST KIT

One relay test kit shall comprise of the following equipment as detailed here under

i. 3 sets -Relay tools kits

ii. 2 nos. -Test plugs **for TTB**

iii. **2** nos. -Test plugs for using with modular type relays (if applicable)

24. TYPE TESTS

24.1 The reports for following type tests shall be submitted during detailed engineering for the Protective relays, Fault Recorder, Fault locator and Disturbance recorder:

iv. Insulation tests as per IEC 60255-5

v. DC Voltage dips and interruptions/Variation as per IEC 6100-4-29.

vi. High frequency disturbance test as per IEC 61000-4 16, Class IV (Not applicable for electromechanical relays)

vii. Electrostatic discharges as per IEC 61000-4-2, level; 4 (not applicable for Electromechanical relays)

viii. Fast transient test as per IEC 61000, Level **IV** (Not applicable for electromechanical relays)

ix. Relay characteristics, performance and accuracy test as per IEC 60255

- Steady state Characteristics and operating time
- Dynamic Characteristics and operating time for distance protection relays and current differential protection relays
- Conformance test as per IEC 61850-10.

x. For Fault recorder, Disturbance recorder; only performance tests are intended under this item.

- Tests for thermal and mechanical requirements as per IEC 60255-6
- Tests for rated burden as per IEC 60255-6
- Contact performance test as per IEC 60255-0-20 (not applicable for Distance to fault locator and Disturbance recorder)

In case there is a change either in version or in model (Except firmware) of the relay, the contractor has to submit the type test reports for the offered revision/model.

24.2 Steady state & Dynamic characteristics test reports on the distance protection relays, as type test, shall be based on test programme specified in Appendix A on simulator/network analyser/PTL. Alternatively, the files generated using Electromagnetic transient Programme (EMTP) can also be used for carrying out the above tests. Single source dynamic tests on transformer differential relay shall be/ should have been conducted based on general guidelines specified in CIGRE committee 34 report on Evaluation of characteristics and performance of Power system protection relays and protective systems.

25. CONFIGURATION OF RELAY AND PROTECTION PANELS

The following is the general criteria for the selection of the equipment to be provided in each type of panel. However, contractor can optimise the requirement of panels by suitably clubbing the feeder protection and CB relay panels.

25.1 CONTROL PANEL

The Various types of control panels supplied under the package shall consist of the following

SN	Particular	detail
1	Ammeter	3 set for each Line, BC, TBC, Bus section, Transformer
2	Wattmeter with transducer	1 set for each line, transformer
3	VAR meter with transducer	1 set for each line, transformer
4	CB Control switch	1 no. for each Circuit breaker
5	Isolator Control switch	1 no. for each isolator
6	Semaphore	1 no. for each earth switch
7	Red indicating lamp	1 no. for each Circuit breaker
8	Red indicating lamp	1 no. for each Isolator
9	Green indicating lamp	1 no. for each Isolator
10	White indicating lamp (DC healthy lamp)	2 nos for each feeder
11	Annunciation windows with associated annunciation relays	24 nos for each transformer
12	Push button for alarm Accept/reset/lamp test	3 nos for each control panel
13	Synchronising Socket	1 no. for each Circuit Breaker if required

SN	Particular	detail
14	Synchronising selector Switch	1 no. for each Circuit Breaker switch if required
15	Protection Transfer Switch	1 no. for each breaker in case of DMT/DM*/SMT scheme (Except TBC and BC Breaker)-*with Bypass ISO
16	Mimic to represent SLD	Lot in all control panels
17	Voltmeter with selector	1 no for each line, transformer
18	Cut out, mounting and wiring for RWTI and selector switch	Lot for transformers

Notes:

i. For transformer feeders, all equipment of control panel shall be provided separately for HV and MV sides.

ii. The above list of equipment mentioned for control panel is generally applicable unless it is defined elsewhere and in case of bay extension in existing substations, necessary equipment for matching the existing control panel shall be supplied.

iii. Each line /HV side of transformer/MV/LV side of transformer / TBC /BC/ Bus Section shall be considered as one feeder for above purpose.

25.2 132/11 kV TRANSFORMER CONTROL & RELAY PANEL

SN	**Description**	**HV side**	**MV/LV side**
1.	Transformer Differential Protection scheme	1 Nos.	Nil
2.	Restricted Earth fault protection scheme	1 no.	1 no
3.	Directional back up O/C and E/F relay with non-directional high set feature *Non-Directional back up O/C and E/F relay with high set feature*	1 set	1 set
4.	Over Fluxing Protection scheme	--	1 no.
5.	Overload protection scheme	1 nos.	NIL
6.	Three phase trip relays	2 nos.	2 nos.
7.	CVT selection relays as per scheme requirement	Lot	Lot
8.	Cut-out and wiring with TTB for supplied energy meter	1 set	1 set
9.	Trip supervision relay	2No.	2No.
10.	Flag Relays/Aux. Relays for wiring Transformer auxiliary protection contacts such as Buchholz, Oil Temperature, Winding Temperature, PRV, OLTC Buchholz etc. as per scheme requirements	As required	

11.	Revenue Energy meter (As per T.S. Chapter-1)	1 No.

The above protection schemes may be clubbed in Group-I/II as per clause no. 21 of technical specification.

25.3 OTHER ADDITIONAL FEATURE OF RELAY PANEL (132kV)

The breaker relay panel shall comprise of the following:

SN	Description	With A/R	Without A/R
1.	Breaker failure Protection Scheme	1 No.	1 No.
2.	DC supply Supervision relay	2 Nos.	2 Nos.
3.	Trip Circuit supervision relays#	6 Nos.	6 Nos.
4.	Auto-reclose scheme (if standalone)	1 Nos.	NIL
5.	Flag relays, aux relays, timers, trip relays as per scheme requirements	As required	As required

Trip supervision relays shall be 2 or 6 numbers as per no. of trip coils for each 132KV Circuit breaker

Note: Equipment/relays to be provided under CB Relay Panel may be accommodated in the Protection Panels to be provided for Transmission Line/Transformer

26. ERECTION AND MAINTENANCE TOOL EQUIPMENT

All special testing equipment required for the installation and maintenance of the apparatus, instruments devices shall be furnished in relevant schedule.

27. TROPICALIZATION

Control room will be normally air-cooled/air- conditioned. All equipment shall however be suitable for installation in a tropical monsoon area having hot, humid climate and dry and dusty seasons with ambient conditions specified in the specification. All control wiring, equipment and accessories shall be protected against fungus growth, condensation, vermin and other harmful effects due to tropical environment.

CHAPTER 20

SUBSTATION AUTOMATION SYSTEM

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CHAPTER 20: SUBSTATION AUTOMATION SYSTEM

1. GENERAL

1.1 The substation automation system shall be offered from a manufacturer who must have designed, manufactured, tested, installed and commissioned substation automation system which must be in satisfactory operation on 132kV system or higher for at least 5(Five) years as on the date of bid opening.

1.2 All the IEDs shall be integrated to the existing Substation Automation System (SAS), control and monitor of all the sub-station equipment from Master Control System (MCC) and Load Dispatched Centre (LDC) as well as from local control station.

1.3 The SAS shall contain the following main functional parts:

i. Bay control Intelligence Electronic Devices (IEDs) for control and monitoring.

ii. Redundant managed switched Ethernet Local Area Network communication infrastructure with hot standby.

iii. Integration of all IEDs present in the present scope to the existing substation Automation system of Balaju Substation.

iv. Data communication through existing gateway for remote control via industrial grade hardware (to Master Control Centre (MCC) and Load Dispatch Centre (LDC) through IEC60870-5-101 protocol).

v. Existing Gateway for remote supervisory control (to MCC and LDC), the gateway should be able to communicate with MCC and LDC on IEC 60870-5-101 protocol. It shall be the bidder's responsibility to integrate his offered system with existing MCC and LDC system for exchange of desired data. The requirement of IO point shall be worked out by the bidder and approved by the employer for data exchange with MCC and LDCs.

1.4 The existing communication gateway shall facilitate the information flow with MMC and LDCs. The bay level intelligent electronic devices (IED) for protection and control shall provide the direct connection to the switchgear without the need of interposing components and perform control, protection, and monitoring functions.

2. SYSTEM DESIGN

2.1 General system design

2.1.1 The components of Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation vai existing substation automation system including future extensions as given in Chapter 2 - GTR.

2.1.2 The systems components shall be of the state-of-the art suitable for operation under electrical environment present in high voltage substations, follow the latest engineering practice, ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff.

2.1.3 Bidder shall offer the Bay level unit (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer), bay mimic along with relay and protection panels housed in air-conditioned Switchyard Panel Room suitably located in switchyard. All the equipment within the substation shall be control and monitor from the existing HMI.

2.2 System architecture

2.2.1 The SAS shall be based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence.

2.2.2 Functions shall be decentralized, object-oriented and located as close as possible to the process.

2.2.3 The main process information of the station shall be stored in distributed databases. The typical SAS architecture shall be structured in two levels, i.e., in a station and a bay level.

2.2.4 At bay level, the IEDs shall provide all bay level functions regarding control, monitoring and protection, inputs for status indication and outputs for commands. The IEDs should be directly connected to the switchgear without any need for additional interposition or transducers.

2.2.5 Each bay control IED shall be independent from each other and its functioning shall not be affected by any fault occurring in any of the other bay control units of the station.

2.2.6 The data exchange between the electronic devices on bay and station level shall take place via the communication infrastructure. This shall be realized using fibre-optic cables/Ethernet Cables, thereby guaranteeing disturbance free communication. The communication cables shall be run in GI conduit pipes/HDEP conduits. Data exchange is to be realised using IEC 61850 protocol with a redundant managed switched Ethernet communication infrastructure.

2.2.7 The communication shall be made through star tropology in redundant mode, excluding the links between individual bay IEDs to switch wherein the redundant connections are not envisaged, such that failure of one set of cable shall not affect the normal operation of the SAS. However, failure of cable shall be alarmed in SAS. Each cable shall have four (4) spare cores.

2.2.8 At station level, the entire station shall be controlled and supervised from the existing station HMI. It shall also be possible to control and monitor the bay from the bay level equipment at all times.

2.2.9 Clear control priorities shall prevent operation of a single switch at the same time from more than one of the various control levels, i.e., RCC, MCC, station HMI, bay level or apparatus level. The priority shall always be on the lowest enabled control level.

2.2.10 The station level contains the station-oriented functions, which cannot be realised at bay level, e.g., alarm list or event list related to the entire substation, gateway for the communication with remote control centres.

2.2.11 The existing GPS time synchronising signal (as specified in the section relay & protection) for the synchronization of the entire system shall be provided.

3. FUNCTIONAL REQUIREMENTS

3.1 The high-voltage apparatus within the station shall be operated from different places:

i. Master Control Centre (MCC)

ii. Load Dispatch Centre (LDC)

iii. Station HMI.

iv. Local Bay controller IED (in the bays)

3.2 Operation shall be possible by only one operator at a time.

3.3 The operation shall depend on the conditions of other functions, such as interlocking, synchro check, etc. (see description in "Bay level control functions").

3.4 Select-before-execute

For security reasons the command is always to be given in two stages: selection of the object and command for operation under all mode of operation except emergency operation. Final execution shall take place only when selection and command are actuated.

3.5 Command supervision

3.5.1 Bay/station interlocking and blocking

Software Interlocking is to be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accidents in case of false operation does not take place.

In addition to software interlocking hardwired interlocking are to be provided for:

i. Bus Earth switch Interlocking

ii. Transfer Bus interlocking (if applicable)

It shall be a simple layout, easy to test and simple to handle when upgrading the station with future bays. For software interlocking the bidder shall describe the scenario while an IED of another bay is switched off or fails.

A software interlock override function shall be provided which can be enabled to bypass the interlocking function.

3.5.2 Run Time Command cancellation

Command execution timer (configurable) must be available for each control level connection. If the control action is not completed within a specified time, the command should get cancelled.

3.5.3 Self-supervision

Continuous self-supervision function with self-diagnostic feature shall be included.

3.5.4 User configuration

The monitoring, controlling and configuration of all input and output logical signals and binary inputs and relay outputs for all built-in functions and signals shall be possible both locally and remotely.

It shall also be possible to interconnect and derive input and output signals, logic functions, using built-In functions, complex voltage and currents, additional logics (AND-gates, OR gates and timers). (Multi-activation of these additional functions should be possible).

The Functional requirement shall be divided into following levels:

i. Bay (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer) Level Functions

ii. System Level Functions

3.6 Bay level functions

In a decentralized architecture the functionality shall be as close to the process as possible. In this respect, the following functions can be allocated at bay level:

i. Bay control functions including data collection functionality in bay control/protection unit.

ii. Bay protection functions

Separate IEDs shall be provided for bay control function and bay protection function.

3.7 Bay control functions

i. Control mode selection

ii. Select-before-execute principle

iii. Command supervision:

- Interlocking and blocking
- Double command

iv. Synchrocheck, voltage selection

v. Run Time Command cancellation

vi. Transformer tap changer control (Raise and lower of tap) (for power transformer bays)

vii. Operation counters for circuit breakers

viii. Air compressor runtime supervision

ix. Operating pressure supervision through digital contacts only

x. Breaker position indication per phase

xi. Alarm annunciation

xii. Measurement display

xiii. Local HMI (local guided, emergency mode)

xiv. Data storage for at least 200 events

xv. Extension possibilities with additional I/O's inside the unit or via fibre-optic communication and process bus.

3.8 Control mode selection

3.8.1 Bay level Operation:

As soon as the operator receives the operation access at bay level the operation is normally performed via bay control IED. During normal operation bay control unit allows the safe operation of all switching devices via the bay control IED.

3.8.2 Emergency Operation

It shall be possible to close or open the selected Circuit Breaker with ON or OFF push buttons even during the outage of bay IED**.**

3.8.3 Remote mode

Control authority in this mode is given to a higher level (LDC and MCC) and the installation can be controlled only remotely. Control operation from lower levels shall not be possible in this operating mode.

3.9 Synchronism and energizing check

The synchronism and energizing check functions shall be bay-oriented and distributed to the bay control and/or protection devices. These features are:

i. Settable voltage, phase angle, and frequency difference.

ii. Energizing for dead line - live bus, live line - dead bus or dead line – dead bus with no synchro-check function.

iii. Synchronising between live line and live bus with synchro-check function

3.9.1 Voltage selection

The voltages relevant for the Synchro check functions are dependent on the station topology, i.e., on the positions of the circuit breakers and/or the isolators. The correct voltage for synchronizing and energizing is derived from the auxiliary switches of the circuit breakers, the isolator, and earthing switch and shall be selected automatically by the bay control and protection IEDs.

3.10 Transformer tap changer control

Raise and lower operation of OLTC taps of transformer shall be facilitated through Bay controller IED.

4. BAY PROTECTION FUNCTIONS

4.1 General

The protection functions are independent of bay control function. The protection shall be provided by separate protection IEDs (numerical relays) and other protection devices as per section Relay & Protection.

IEDs, shall be connected to the communication infrastructure for data sharing and meet the real-time communication requirements for automatic functions. The data presentation and the configuration of the various IEDs shall be compatible with the overall system communication and data exchange requirements.

4.2 Event and disturbance recording function

Each IED should contain an event recorder capable of storing at least 200 time-tagged events. The disturbance recorder function shall be as per detailed in Chapter Control, Relay & Protection Panels.

4.3 Bay Monitoring Function:

Analogue inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) without intermediate transducers. The values of active power (W), reactive power (VAR), frequency (Hz), and

the rms values for voltage (U) and current (I) shall be calculated in the Bay control/protection unit.

5. SYSTEM LEVEL FUNCTIONS

5.1 Status supervision

5.1.1 The position of each switchgear, e.g., circuit breaker, isolator, earthing switch, transformer tap changer etc., shall be supervised continuously. Every detected change of position shall be immediately displayed in the single-line diagram on the station HMI screen, recorded in the event list, and a hard copy printout shall be produced. Alarms shall be initiated in the case of spontaneous position changes.

5.1.2 The switchgear positions shall be indicated by two auxiliary switches, normally closed (NC) and normally open (NO), which shall give ambivalent signals. An alarm shall be initiated if these position indications are inconsistent or if the time required for operating mechanism to change position exceeds a predefined limit.

5.1.3 The status and control of auxiliaries shall be done through separate one or more IED and all alarm and analogue values shall be monitored and recoded through this IED.

5.1.4 Measurements

The analogue values acquired/calculated in bay control/protection unit shall be displayed locally on the station HMI and in the control centres. The abnormal values must be discarded. The analogue values shall be updated every 2 seconds. Threshold limit values shall be selectable for alarm indications.

5.1.5 Event and alarm handling

Events and alarms are generated either by the switchgear, by the control IEDs, or by the station level unit. They shall be recorded in an event list in the station HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All, or a freely selectable group of events and alarms shall also be printed out on an event printer. The alarms and events shall be time-tagged with a time resolution of 1 ms. The tentative list for various feeders and systems are enclosed as **Annexure-I**

6. STATION HMI

6.1 Substation HMI Operation:(the existing Station HMI used as HMI for the present scope)

6.1.1 On the HMI the object has to be selected first. In case of a blocking or interlocking conditions are not met; the selection shall not be possible and an appropriate alarm annunciation shall occur. If a selection is valid the position indication will show the possible direction, and the appropriate control execution button shall be pressed in order to close or open the corresponding object.

6.1.2 Control operation from other places (e.g. REMOTE) shall not be possible in this operating mode.

6.2 Presentation and dialogues

6.2.1 The existing operator station HMI have a redundant with hot standby and shall provide basic functions for supervision and control of the substation. The operator shall give commands to the switchgear on the screen via mouse clicks.

6.2.2 The HMI shall give the operator access to alarms and events displayed on the screen. Aside from these lists on the screen, there shall be a printout of alarms or events in an event log.

6.2.3 An acoustic alarm shall indicate abnormalities, and all unacknowledged alarms shall be accessible from any screen selected by the operator.

6.2.4 The following standard pictures shall be available from the HMI:

i. Single-line diagram showing the switchgear status and measured values

ii. Control dialogues with interlocking or blocking information details. This control dialogue shall tell the operator whether the device operation is permitted or blocked.

iii. Measurement dialogues

iv. Alarm list, station / bay-oriented

v. Event list, station / bay-oriented

vi. System status

6.3 HMI design/Integration principles

Consistent design principles shall be adopted with the HMI concerning labels, colours, dialogues and fonts. Non-valid selections shall be dimmed out.

The object status shall be indicated using different status colours for:

i. Selected object under command

ii. Selected on the screen

iii. Not updated, obsolete values, not in use or not sampled

iv. Alarm or faulty state

v. Warning or blocked

vi. Update blocked or manually updated

vii. Control blocked

viii. Normal state

6.4 Process status displays and command procedures

6.4.1 The process status of the substation in terms of actual values of currents, voltages, frequency, active and reactive powers as well as the positions of circuit breakers, isolators and transformer tap-changers shall be displayed in the station single-line diagram.

6.4.2 In order to ensure a high degree of security against undesired operation, a "select-before-execute" command procedure shall be provided. After the "selection" of a switch, the operator shall be able to recognize the selected device on the screen, and all other switchgear shall be blocked. As communication between control centre and device to be controlled is established, the operator shall be prompted to confirm the control action and only then final execute command shall be accepted. After the “execution” of the command the operated switching symbol shall flash until the switch has reached its new position.

6.4.3 The operator shall be in a position to execute a command only, if the switch is not blocked and if no interlocking condition is going to be violated. The interlocking statements shall be checked by the interlocking scheme implemented at bay and station level.

6.4.4 After command execution the operator shall receive a confirmation that the new switching position has been reached or an indication that the switching procedure was unsuccessful with the indication of the reason for non-functioning.

6.5 System supervision & display

The SAS system shall be comprehensively self-monitoring such that faults are immediately indicated to the operator, possibly before they develop into serious situations. Such faults are recorded as a faulty status in a system supervision display. This display shall cover the status of the entire substation including all switchgear, IEDs, communication infrastructure and remote communication links, and printers at the station level, etc.

6.6 Event list

The event list shall contain events that are important for the control and monitoring of the substation.

The event and associated time (with1 ms resolution) of its occurrence has to be displayed for each event.

The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or sections of it.

A printout of each display shall be possible on the hard copy printer.

The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It shall be possible to store all events in the computer for at least one month. The information shall be obtainable also from a printed event log.

The chronological event list shall contain:

i. Position changes of circuit breakers, isolators and earthing devices

ii. Indication of protective relay operations

iii. Fault signals from the switchgear

iv. Indication when analogue measured values exceed upper and lower limits. Suitable provision shall be made in the system to define two level of alarm on either side of the value or which shall be user defined for each measurands.

v. Loss of communication.

vi. Filters for selection of a certain type or group of events shall be available. The filters shall be designed to enable viewing of events grouped per:

- Date and time
- Bay
- Device
- Function e.g., trips, protection operations etc.

- Alarm class

6.7 Alarm list

6.7.1 Faults and errors occurring in the substation shall be listed in an alarm list and shall be immediately transmitted to the control centre. The alarm list shall substitute a conventional alarm tableau, and shall constitute an evaluation of all station alarms. It shall contain unacknowledged alarms and persisting faults. The date and time of occurrence shall be indicated.

6.7.2 The alarm list shall consist of a summary display of the present alarm situation. Each alarm shall be reported on one line that contains:

i. The date and time of the alarm

ii. The name of the alarming object

iii. A descriptive text

iv. The acknowledgement state.

6.7.3 Whenever an alarm condition occurs, the alarm condition must be shown on the alarm list and must be displayed in a flashing state along with an audible alarm. After acknowledgement of the alarm, it should appear in a steady (i.e. not flashing) state and the audible alarm shall stop. The alarm should disappear only if the alarm condition has physically cleared and the operator has reset the alarm with a reset command. The state of the alarms shall be shown in the alarm list (Unacknowledged and persistent, Unacknowledged and cleared, Acknowledged and persistent).

6.7.4 Filters for selection of a certain type or group of alarms shall be available as for events.

6.8 Object picture

When selecting an object such as a circuit breaker or isolator in the single-line diagram, the associated bay picture shall be presented first. In the selected object picture, all attributes like

i. Type of blocking

ii. Authority

iii. Local / remote control

iv. LDC/MCC/ SAS control

v. Errors

vi. etc.,

Shall be displayed.

6.9 Control dialogues

The operator shall give commands to the system by means of mouse click located on the single-line diagram. Data entry is performed with the keyboard. Dedicated control dialogues for controlling at least the following devices shall be available:

i. Breaker and disconnector

ii. Transformer tap-changer

6.10 User-authority levels

a. It shall be possible to restrict activation of the process pictures of each object (bays, apparatus...) within a certain user authorisation group. Each user shall then be given access rights to each group of objects, e.g.:

i. Display only

ii. Normal operation (e.g., open/close of switchgear)

iii. Restricted operation (e.g., by-passed interlocking)

iv. System administrator

For maintenance and engineering purposes of the station HMI, the following authorisation levels shall be available:

i. No engineering allowed

ii. Engineering/configuration allowed

iii. Entire system management allowed

The access rights shall be defined by passwords assigned during the log-in procedure. Only the system administrator shall be able to add/remove users and change access rights.

6.11 Reports

The reports shall provide time-related follow-ups of measured and calculated values. The data displayed shall comprise:

6.11.1 Trend reports:

i. Day (mean, peak)

ii. Month (mean, peak)

iii. Semi-annual (mean, peak)

iv. Year (mean, peak)

6.11.2 Historical reports of selected analogue Values:

i. Day (at 15 minutes interval)

ii. Week

iii. Month

iv. Year

6.11.3 It shall be possible to select displayed values from the database in the process display on-line. Scrolling between e.g., days shall be possible. Unsure values shall be indicated. It shall be possible to select the time period for which the specific data are kept in the memory.

6.11.4 Following printouts shall be available from the printer and shall be printed on demand:

i. Daily voltage and frequency curves depicting time on X-axis and the appropriate parameters on the Y-axis. The time duration of the curve is 24 hours.

ii. Weekly trend curves for real and derived analogue values.

iii. Printouts of the maximum and minimum values and frequency of occurrence and duration of maximum and minimum values for each analogue parameter for each circuit in 24 hr period.

iv. Provision shall be made for logging information about breaker status like number of operations with date and time indications along with the current value it interrupts (in both conditions i.e., manual opening and fault tripping)

v. Equipment operation details shift wise and during 24 hours.

vi. Printout on adjustable time period as well as on demand for MW, MVAR, Current, Voltage on each feeder and transformer as well as Tap Positions, temperature and status of pumps and fans for transformers.

vii. Printout on adjustable time period as well as on demand system frequency and average frequency.

viii. Reports in specified formats which shall be handed over to successful bidder. The bidder has to develop these reports. The reports are limited to the formats for which data is available in the SAS database.

6.11.5 Trend display (historical data)

It shall be possible to illustrate all types of process data as trends - input and output data, binary and analogue data. The trends shall be displayed in graphical form as column or curve diagrams with a maximum of 10 trends per screen. Adjustable time span and scaling ranges must be provided.

It shall be possible to change the type of value logging (direct, mean, sum, or difference) on-line in the window. It shall also be possible to change the update intervals on-line in the picture as well as the selection of threshold values for alarming purposes.

6.11.6 Automatic disturbance file transfer

All recorded data from the IEDs with integrated disturbance recorder as well as dedicated disturbance recording systems shall be automatically uploaded (event triggered or once per day) to a dedicated computer and be stored on the hard disc.

6.11.7 Disturbance analysis

The PC-based work station shall have necessary software to evaluate all the required information for proper fault analysis.

6.11.8 IED parameter setting

It shall be possible to access all protection and control IEDs for reading the parameters (settings) from the station HMI or from a dedicated monitoring computer. The setting of parameters or the activation of parameter sets shall only be allowed after entering a password.

6.11.9 Automatic sequences

The available automatic sequences in the system should be listed and described, (e.g. sequences related to the bus transfer). It must be possible to initiate pre-defined automatic sequences by the operator and also define new automatic sequences.

7. SYSTEM HARDWARE

7.1 Switched Ethernet Communication Infrastructure:

The bidder shall provide the redundant switched optical Ethernet communication infrastructure for SAS. One switch shall be provided to connect all IEDs for two bays of yard to communication infrastructure. Each switch shall have at least two spare ports for connecting bay level IEDs and one spare port for connecting station bus.

7.2 Bay level unit

7.2.1 The bay unit shall use industrial grade components. The bay level unit, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals. They shall incorporate select-before-operate control principles as safety measures for operation via the HMI. They shall perform all bay related functions, such as control commands, bay interlocking, data acquisition, data storage, event recording and shall provide inputs for status indication and outputs for commands. They shall be directly connected to the switchgear. The bay unit shall acquire and process all data for the bay (Equipment status, fault indications, measured values, alarms etc.) and transmit these to the other devices in sub-station automation system. In addition, this shall receive the operation commands from station HMI and control center. The bay unit shall have the capability to store all the data for at least 24 hours.

7.2.2 One number Bay level unit shall be provided for supervision and control of each bay (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer). The Bay level unit shall be equipped with analogue and binary inputs/outputs for handling the control, status monitoring and analogue measurement functions. All bay level interlocks are to be incorporated in the Bay level unit so as to permit control from the Bay level unit/ local bay mimic panel, with all bay interlocks in place, during maintenance and commissioning or in case of contingencies when the Station HMI is out of service.

7.2.3 The bay control unit to be provided for the bays shall be preferably installed in the CB relay panel/feeder protection panel for respective bay.

7.2.4 The bay control unit for future bay (if required as per Chapter – Project Specification Requirement) shall be installed in a separate panel.

7.2.5 The Bay level unit shall meet the requirements for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

7.3 Input/Output (I/O) modules

The I/O modules shall form a part of the bay level unit and shall provide coupling to the substation equipment. The I/O modules shall acquire all switchgear information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear. The measured values of voltage and current shall be from the secondaries of instrument transformers. The digital inputs shall be acquired by exception with 1 ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state

7.4 Switchyard Panel Room:

The switchyard panel room shall be constructed to house Bay level units, bay mimic, relay and protection panels, etc. The layout of equipment/panel shall be subject to Employer's approval. The switchyard panel room shall be provided with necessary illuminations, fire alarm system with at least two detectors with necessary power supply if required and it shall be wired to SAS equipment. The detailed constructional requirement of switchyard panel room is detailed in chapter civil of technical specification and air conditioning requirement of switchyard panel room shall be as detailed in chapter Air conditioning system of technical specification. The air conditioner provided in switchyard panel room shall be monitored from substation automation system.

7.5 Station level software

7.5.1 Human-machine interface (HMI)

Contractor shall integrate the present scope of work with the existing HMI.

7.6 Bay level software

7.6.1 System software

The system software shall be structured in various levels through existing system. Contractor shall be responsible for the required software adjustment and integration work by the approval of employer.

7.6.2 Application software

Any additional software arrangement shall be made by the contractor for the functional integration of present scope to existing system.

7.6.3 Network Management System (NMS):

Any additional software arrangement shall be made by the contractor for the Network Management System of present scope to existing system. Following works shall be executed by the contractor.

i. Configuration Management

ii. Fault Management

iii. Performance Monitoring

This system shall be used for management of communication devices and other IEDs in the system. This NMS can be loaded in DR work-station and shall be easy to use, user friendly and menu based. The NMS shall monitor all the devices in the SAS and report if there is any fault in the monitored devices. The NMS shall

i. Maintain performance, resource usage, and error statistics for all managed links and devices and present this information via displays, periodic reports and on demand reports.

ii. Maintain a graphical display of SAS connectivity and device status.

iii. Issue alarms when error conditions occur

iv. Provide facility to add and delete addresses and links

8. TESTS

The substation automation system components offered by the bidder shall be subjected to following tests to establish compliance with IEC 61850 for EHV sub-station equipment installed in sheltered area in the outdoor switchyard and specified ambient conditions:

8.1 Type Tests:

8.1.1 Control IEDs and Communication Equipment:

8.1.1.1 Power Input:

i. Auxiliary Voltage

ii. Current Circuits

iii. Voltage Circuits

iv. Indications

8.1.1.2 Accuracy Tests:

i. Operational Measured Values

ii. Currents

iii. Voltages

iv. Time resolution

8.1.1.3 Insulation Tests:

i. Dielectric Tests

ii. Impulse Voltage withstand Test

8.1.1.4 Influencing Quantities

i. Limits of operation

ii. Permissible ripples

iii. Interruption of input voltage

8.1.1.5 Electromagnetic Compatibility Test:

i. 1 MHZ. burst disturbance test

ii. Electrostatic Discharge Test

iii. Radiated Electromagnetic Field Disturbance Test

iv. Electrical Fast transient Disturbance Test

v. Conducted Disturbances Tests induced by Radio Frequency Field

vi. Magnetic Field Test

vii. Emission (Radio interference level) Test.

viii. Conducted Interference Test

8.1.1.6 Function Tests:

i. Indication

ii. Commands

iii. Measured value Acquisition

iv. Display Indications

8.1.1.7 Environmental tests:

i. Cold Temperature

ii. Dry Heat

iii. Wet heat

iv. Humidity (Damp heat Cycle)

v. Vibration

vi. Bump

vii. Shock

8.2 Factory Acceptance Tests:

8.2.1 The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system equipment for approval. For the individual bay level IED's applicable type test certificates shall be submitted.

8.2.2 The manufacturing and configuration phase of the equipment shall be concluded by the factory acceptance test (FAT). The purpose is to ensure that the Contractor has interpreted the specified requirements correctly and that the FAT includes checking to the degree required by the user. The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified performance has been verified, as far as site conditions can be simulated in a test lab. During FAT the entire Sub-station Automation System including complete control and protection system to be supplied under present scope shall be tested for complete functionality and configuration in factory itself. The extensive testing shall be carried out during FAT. The purpose of Factory Acceptance Testing is to ensure trouble free installation at site. No major configuration setting of system is envisaged at site.

8.2.3 If the complete system consists of parts from various suppliers or some parts are already installed on site, the FAT shall be limited to sub-system tests. In such a case, the complete system test shall be performed on site together with the site acceptance test (SAT).

8.3 Hardware Integration Tests:

The hardware integration test shall be performed on the specified systems to be used for Factory tests when the hardware has been installed in the factory. The operation of each item shall be verified as an integral part of system. Applicable hardware diagnostics shall be used to verify that each hardware component is completely operational and assembled into a configuration capable of supporting software integration and factory testing of the system. The equipment expansion capability shall also be verified during the hardware integration tests. The vendor specifically demonstrates how to add a device in future in SAS during FAT. The device shall be from a different manufacturer than the SAS supplier.

8.4 Integrated System Tests:

Integrated system tests shall verify the stability of the hardware and the required software. During the tests all functions shall run concurrently and all equipment shall operate a continuous 100 Hours period. The integrated system test shall ensure the SAS is free of

improper interactions between software and hardware while the system is operating as a whole.

8.5 Site Acceptance Tests:

The site acceptance tests (SAT) shall completely verify all the features of SAS hardware and software (if required). The bidder shall submit the detailed SAT procedure and SAT procedure shall be read in conjunction with the specification.

9. SYSTEM OPERATION

9.1 Substation Operation

9.1.1 NORMAL OPERATION

Operation of the system by the operator from the remote LDC/MCC or at the substation shall take place via existing industry standard HMI (Human Machine interface) subsystem consisting of graphic colour VDU, a standard keyboard and a cursor positioning device (mouse). Integration work shall be done by the contractor by doing the following manner.

The coloured screen shall be divided into 3 fields:

i. Message field with display of present time and date

ii. Display field for single line diagrams

iii. Navigation bar with alarm/condition indication

9.1.2 For display of alarm annunciation, lists of events etc.

All operations shall be performed with mouse and/or a minimum number of function keys and cursor keys. The function keys shall have different meanings depending on the operation. The operator shall see the relevant meanings as function tests displayed in the command field (i.e., operator prompting). For control actions, the switchgear (i.e. circuit breaker etc.) requested shall be selectable on the display by means of the cursor keys. The switching element selected shall then appear on the background that shall be flashing in a different color. The operator prompting shall distinguish between: -

i. Prompting of indications e.g., fault indications in the switchgear, and

ii. Prompting of operational sequences e.g., execution of switching operations

9.1.3 The summary information displayed in the message field shall give a rapid display of alarm/message of the system in which a fault has occurred and alarm annunciation lists in which the fault is described more fully.

9.1.4 Each operational sequence shall be divided into single operation steps which are initiated by means of the function keys/WINDOW command by mouse. Operator prompting shall be designed in such a manner that only the permissible keys are available in the command field related to the specific operation step. Only those switching elements shall be accessed for which control actions are possible. If the operation step is rejected by the system, the operator prompting shall be supported by additional comments in the message field. The operation status shall be reset to the corresponding preceding step in the operation sequence by pressing one of the function keys. All operations shall be verified. Incorrect operations shall be indicated by comments in the message field and must not be executed.

9.2 The offer shall include a comprehensive description of the system. The above operation shall also be possible via WINDOWS based system by mouse.

10. POWER SUPPLY

Power for the substation automation system shall be derived from substation 220 V DC system. 48 V supply will be provided by the employer.

11. DOCUMENTATION

11.1 The following documents shall be submitted for employer's approval during detailed engineering:

i. System Architecture Drawing

ii. Hardware Specification

iii. Functional Design Document

iv. Clear procedure describing how to add an IED/bay/diameter in future covering all major supplier

11.2 The following documentation to be provided for the system in the course of the project shall be consistent, CAD supported, and of similar look/feel. All CAD drawings to be provide in "dxf" format.

v. List of Drawings

vi. Substation automation system architecture

vii. Block Diagram

viii. Guaranteed technical parameters, Functional Design Specification and Guaranteed availability and reliability

ix. Calculation for power supply dimensioning

x. I/O Signal lists

xi. Schematic diagrams

xii. List of Apparatus

xiii. List of Labels

xiv. Logic Diagram (hardware & software)

xv. Switchgear Panel Room layout drawing

xvi. Control Room Lay-out

xvii. Test Specification for Factory Acceptance Test (FAT)

xviii. Product Manuals

xix. Assembly Drawing

xx. Operator's Manual

xxi. Complete documentation of implemented protocols between various elements

xxii. Listing of software and loadable in CD ROM (If required)

xxiii. Other documents as may be required during detailed engineering

11.3 Two sets of hard copy and four sets of CD ROM containing all the as built documents/drawings shall be provided.

12. TRAINING, SUPPORT SERVICES, MAINTENANCE AND SPARES

12.1 Training

Contractor personnel who are experienced instructors and who speak understandable English shall conduct training. The contractor shall arrange on its own cost all hardware training platform required for successful training and understanding in Nepal. The Contractor shall provide all necessary training material. Each trainee shall receive individual copies of all technical manuals and all other documents used for training. These materials shall be sent to Employer at least two months before the scheduled commencement of the particular training course. Class materials, including the documents sent before the training courses as well as class handouts, shall become the property of Employer. Employer reserves the right to copy such materials, but for in-house training and use only. Hands-on training shall utilize equipment identical to that being supplied to Employer.

The Contractor shall quote training prices as indicated in BPS.

The schedule, location, and detailed contents of each course will be finalized during Employer and Contractor discussions.

12.2 Computer System Hardware Course (as required)

A computer system hardware course shall be offered, but at the system level only. The training course shall be designed to give Employer hardware personnel sufficient knowledge of the overall design and operation of the system so that they can correct obvious problems, configure the hardware, perform preventive maintenance, run diagnostic programs, and communicate with contract maintenance personnel. The following subjects shall be covered:

i. System Hardware Overview: Configuration of the system hardware.

ii. Equipment Maintenance: Basic theory of operation, maintenance techniques and diagnostic procedures for each element of the computer system, e.g., processors, auxiliary memories, LANs, routers and printers. Configuration of all the hardware equipment.

iii. System Expansion: Techniques and procedures to expand and add equipment such as loggers, monitors, and communication channels.

iv. System Maintenance: Theory of operation and maintenance of the redundant hardware configuration, failover hardware, configuration control panels, and failover switches. Maintenance of protective devices and power supplies.

v. Subsystem Maintenance: Theory of design and operation, maintenance techniques and practices, diagnostic procedures, and (where applicable) expansion techniques and procedures. Classes shall include hands-on training for the specific subsystems that are part of Employer's equipment or part of similarly designed and configured subsystems. All interfaces to the computing equipment shall be taught in detail.

vi. Operational Training: Practical training on preventive and corrective maintenance of all equipment, including use of special tools and instruments. This training shall be provided on Employer equipment, or on similarly configured systems.

12.3 Computer System Software Course (as required)

The Contractor shall provide a computer system software course that covers the following subjects:

i. System Programming: Including all applicable programming languages and all stand-alone service and utility packages provided with the system. An introduction to software architecture, Effect of tuning parameters (OS software, Network software, database software etc.) on the performance of the system.

ii. Operating System: Including the user aspects of the operating system, such as program loading and integrating procedures; scheduling, management, service, and utility functions; and system expansion techniques and procedures

iii. System Initialization and Failover: Including design, theory of operation, and practice

iv. Diagnostics: Including the execution of diagnostic procedures and the interpretation of diagnostic outputs,

v. Software Documentation: Orientation in the organization and use of system software documentation.

vi. Hands-on Training: One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

12.4 Application Software Course (as required)

The Contractor shall provide a comprehensive application software course covering all applications including the database and display building course. The training shall include:

i. Overview: Block diagrams of the application software and data flows. Programming standards and program interface conventions.

ii. Application Functions: Functional capabilities, design, and major algorithms. Associated maintenance and expansion techniques.

iii. Software Development: Techniques and conventions to be used for the preparation and integration of new software functions.

iv. Software Generation: Generation of application software from source code and associated software configuration control procedures.

v. Software Documentation: Orientation in the organization and use of functional and detailed design documentation and of programmer and user manuals.

vi. Hands-on Training: One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor

available for assistance as necessary.

12.5 Requirement of training:

The contractor shall provide training for EMPLOYER'S personnel comprehensively covering following courses.

SN	Name of Course
1	Computer System Hardware
2	Computer System Software
3	Application Software

12.6 MAINTENANCE

12.6.1 Maintenance Responsibility during the Guaranteed Availability Period.

During **Guaranteed Availability Period**, the Contractor shall take continual actions to ensure the guaranteed availability and shall make available all the necessary resources such as specialist personnel, spare parts, tools, test devices etc. for replacement or repair of all defective parts and shall have prime responsibility for keeping the system operational. During guarantee period as specified in tender document, contractor shall arrange bi-monthly visit of their representative to site to review the performance of system and in case any defect/shortcoming etc. is observed during the period, the same shall be set right by the contractor within 15 days.

13. RELIABILITY AND AVAILABILITY

The SAS shall be designed so that the failure of any single component, processor, or device shall not render the system unavailable. The SAS shall be designed to satisfy the very high demands for reliability and availability concerning:

i. Mechanical and electrical design

ii. Security against electromagnetic interference (EMI)

iii. High quality components and boards

iv. Modular, well-tested hardware

v. Thoroughly developed and tested modular software

vi. Easy-to-understand programming language for application programming

vii. Detailed graphical documentation and application software

viii. Built-in supervision and diagnostic functions

ix. Security

- Experience of security requirements
- Process know-how
- Select before execute at operation
- Process status representation as double indications

x. Distributed solution

xi. Independent units connected to the local area network

xii. Back-up functions

xiii. Panel design appropriate to the harsh electrical environment and ambient conditions

xiv. Panel grounding immune against transient ground potential rise

13.1 Outage terms

13.1.1 Outage

In the event, the employer has taken any equipment/ system other than Sub-station Automation System for schedule/forced maintenance, the consequent outage to SAS shall not be considered as outage for the purpose of availability.

13.1.2 Actual outage duration (AOD)

The time elapsed in hours between the start and the end of an outage. The time shall be counted to the nearest $1/4^{th}$ of an hour. Time less than $1/4^{th}$ of an hour shall be counted as having duration of $1/4^{th}$ of an hour.

13.1.3 Period Hours (PH)

The number of hours in the reporting period. In a full year the period hour are 8760h (8784h for a leap year).

13.1.4 Actual Outage hours (AOH)

The sum of actual outage duration within the reporting period

$AOH = \sum AOD$

13.1.5 Availability:

Each SAS shall have a total availability of 99.98 % i.e., the ratio of total time duration minus the actual outage duration to total time duration.

13.2 Guarantees Required

13.2.1 The availability for the complete SAS equipment shall be guaranteed by the Contractor. Bidder shall include in their offer the detailed calculation for the availability. The contractor shall demonstrate their availability guaranteed by conducting the availability test on the total sub-station automation system as a whole after commissioning of total Sub-station Automation system. The test shall verify the reliability and integrity of all sub-systems. Under these conditions the test shall establish an overall availability of 99.98%. After the lapse of 1000 Hours of cumulative test time, test records shall be examined to determine the conformance with availability criterion. In case of any outage during the availability test, the contractor shall rectify the problem and after rectification, the 1000 Hours period start after such rectification. If test object has not been met the test shall continue until the specified availability is achieved.

13.2.2 The contractor has to establish the availability in a maximum period of three months from the date of commencement of the availability test.

13.2.3 After the satisfactory conclusion of test both contractor and employer shall mutually agree to the test results and if these results satisfy the availability criterion, the test is considered to be completed successfully. After that the system shall be taken over by the employer and then the guarantee period shall start.

14. SPARES

14.1 Consumables:

All consumables such as paper, cartridges shall be supplied by the contractor till the SAS is taken over by the employer.

14.2 Availability Spares:

In addition to mandatory spares as listed in section project for SAS, the bidder is required to list the spares, which may be required for ensuring the guaranteed availability during the guaranteed availability period. The final list of spares shall form part of scope of supply and accordingly the price thereof shall be quoted by the bidder and shall be considered in the evaluation of the bids. During the guaranteed availability period, the spare parts supplied by the Contractor shall be made available to the Contractor for usage subject to replenishment at the earliest. Thus, at the end of availability period the inventory of spares with the Employer shall be fully replenished by the Contractor. However, any additional spares required to meet the availability of the system (which are not a part of the above spares supplied by the Contractor) would have to be supplied immediately by the Contractor free of cost to the Employer.

15. LIST OF EQUIPMENT

Quantity of equipment shall be decided by bidder in order to achieve guaranteed reliability and availability as declared by bidder.

i. Bay level units along with bay mimic as detailed in Project Specification Requirement.

ii. Bay Level Unit for Auxiliary system (as per requirement)

iii. Disturbance Recorder Work Station

iv. All interface equipment for gateway to LDC and MCC

v. Communication infrastructure between Bay level units, Station HMI, Printers, gateways, redundant LAN etc. as required

vi. Modems as per requirement.

vii. Any other equipment as necessary.

ANNEXURE 1

16. LIST OF ANALOGUE AND DIGITAL INPUTS

16.1 Basic Monitoring requirements are:

i. Switchgear status indication

ii. Measurements (U, I, P, Q, f)

iii. Event

iv. Alarm

v. Winding temperature of transformers & reactors

vi. ambient temperature

vii. Status and display of 400 V LT system, 220 V & 48 V DC system

viii. Status of display of Fire protection system and Air conditioning system.

ix. Acquisition of alarm and fault record from protection relays

x. Disturbance records

xi. Monitoring the state of batteries by displaying DC voltage, charging current and load current etc.

xii. Tap-position of Transformer

16.2 List of Inputs

The list of input for typical bays is as below: -

16.2.1 Analogue inputs

i) For line
Current R phase
Y phase
B phase
Voltage R-Y phase
Y-B phase
B-R phase

ii) For transformer/reactor
Current R phase
Y phase
B phase
WTI (for transformer)
Tap position (for transformer only)

iii) For TBC and bus coupler

Current R phase
Y phase
B phase

iv) Common

a) Voltage for Bus-I and Bus-II wherever applicable

Voltage R-Y phase
Y-B phase
B-R phase

b) Frequency for Bus-I and Bus-II

c) Ambient temperature (switchyard)
d) Switchyard Panel Room Temperature.
e) LT system
   i) Voltage R-Y, Y-B, B-R of Main Switch Board section-I
   ii) Voltage R-Y, Y-B, B-R of Main Switch Board section-II
   iii) Voltage R-Y, Y-B, B-R of UPS
   iv) Current from LT transformer-I
   v) Voltage of 220V DCDB-I
   vi) Voltage of 220V DCDB-II
   vii) Current from 2200V Battery set-I
   viii) Current from 220V Battery set-II
   ix) Current from 220V Battery charger-I
   x) Current from 220V Battery charger-I

16.2.2 Digital Inputs

The list of input for various bays/SYSTEM is as follows:

i. Line bays
ii. Status of each pole of CB.
iii. Status of Isolator, Earth switch
iv. CB trouble
v. CB operation/closing lockout
vi. Pole discrepancy optd
vii. Trip coil faulty
viii. LBB optd
ix. Bus bar protection trip relay operated
x. Main breaker auto recloser operated
xi. Tie/transfer auto recloser operated
xii. A/r lockout
xiii. Tie/transfer bkr a/r lockout
xiv. Direct trip-I/II sent
xv. Direct trip-I/II received
xvi. Main I/II blocking
xvii. Main I/II-Inter trip send
xviii. Main I/II-Inter trip received
xix. O/V STAGE – I operated

xx. O/V STAGE – II operated

xxi. FAULT LOCATOR FAULTY

xxii. Back-up e/f optd

xxiii. 220V DC-I/II source fail

xxiv. Other requirement finalized during detail engineering.

16.3 Transformer bays

i. Status of each pole of CB, Isolator, Earth switch

ii. CB trouble

iii. CB operation/closing lockout

iv. Pole discrepancy optd

v. Trip coil faulty

vi. LBB optd

vii. Bus bar protn trip relay optd

viii. REF OPTD

ix. DIF OPTD

x. OVERFLUX ALARM (MV)

xi. OVERFLUX TRIP (MV)

xii. OVERFLUX ALARM (HV)

xiii. OVERFLUX TRIP (HV)

xiv. HV BUS CVT ½ FUSE FAIL

xv. MV BUS CVT ½ FUSE FAIL

xvi. OTI ALARM/TRIP

xvii. PRD OPTD

xviii. OVERLOAD ALARM

xix. BUCHOLZ TRIP

xx. BUCHOLZ ALARM

xxi. OLTC BUCHOLZ ALARM

xxii. OLTC BUCHOLZ TRIP

xxiii. OIL LOW ALARM

xxiv. back-up o/c (HV) optd

xxv. back-up e/f (HV)optd

xxvi. 220v DC-I/II source fail

xxvii. TAP MISMATCH

xxviii. GR-A PROTN OPTD

xxix. GR-B PROTN OPTD

xxx. back-up o/c (MV) optd

xxxi. back-up e/f (MV)optd

16.4 Bus bar Protection

i. Bus bar main-I trip

ii. Bus bar main-II trip

iii. Bus bar zone-I CT open

iv. Bus bar zone-II CT open

v. Bus transfer CT sup. Optd

vi. Bus transfer bus bar protn optd

vii. Bus protection relay fail

16.5 Auxiliary system

i. Incomer-I On/Off

ii. Incomer-II On/Off

iii. 400 V Bus-I/II U/V

iv. 400 V bus coupler breaker on/off

v. LT transformer-I WTI Alarm & trip

vi. LT transformer-II WTI Alarm & trip

vii. LT transformer-I OTI Alarm & trip

viii. LT transformer-II OTI Alarm & trip

ix. Alarm/trip signals as listed in Section: Battery and Battery charger

x. 220 V DC-I earth fault

xi. 2200 V DC-II earth fault

xii. Alarm/trip signals as listed in Section: Fire protection system

16.6 Switchyard Panel Room:

i. AC Compressor 1 ON/OFF

ii. AC Compressor 2 ON/OFF

iii. Fire Detection 1 ON/OFF

iv. Fire Detection 2 On/OFF

v. Switchyard Panel Room Temperature High Alarm

The exact number and description of digital inputs shall be as per detailed engineering requirement Apart from the above-mentioned digital inputs, minimum of 200 inputs shall be kept for future use.

APPENDIX -I

17. LIST OF IO POINTS TO BE TRANSMITTED TO MCC

i. MW and MVAr for all lines, transformers.

ii. Voltage of all buses

iii. Frequency of 132 kV Bus

iv. All Breakers Status

v. All isolators Status

vi. Tap Position for all transformers

vii. Master protection signal for all feeders, transformers Units and Bus Bar

viii. Loss of Voltage signal for Bus bar

ix. All the points identified in point (a), (b) and (c) above as GPS Time stamped.

x. Temperature value per substation.

xi. Any other point decided during detailed engineering

CHAPTER 21

TECHNICAL DATA SHEETS

Table of Contents

CHAPTER 21: TECHNICAL DATASHEET

1. 132 KV GAS INSULATED SWITCHGEAR (GIS)

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 1: 132 kV GIS				
SN	***DESCRIPTION***	***UNIT***	***REQ***	***DATA to be Filled***
132 kV CIRCUIT BREAKER				
1	Manufacturer and Country of Origin			
2	Year of manufacturing experience	Years	10	
3	Manufacturing's Designation as per submitted catalogue			
4	Applicable standard		IEC	
5	Type		GIS	
6	Poles		Three pole	
7	Rated Voltage	kV	132	
8	Rated current			
8.1	Continuous at 50 degree ambient	A	1250,2000 (B/C),As per PSR	
8.2	Short time for 1 sec at max. kV	kA	40	
9	Frequency	Hz	50	
10	Temperature rise above 45 degree C ambient		As per IEC	
10.1	Contacts	°C	65	
10.2	Terminals	°C	65	
11	Rated short circuit breaking current	kA	40	
12	Rated short circuit making current			
12.1	Peak	kA	80	
13	Interrupting time at 100% capacity			
13.1	Maximum opening time	ms	<40	
13.2	Total interrupting time	ms		
14	Closing time	ms	<35	
15	Maximum capacitive current breaking capacity (rms)	A		
16	Insulation level			
16.1	Impulse withstand voltage (crest)	kV	650	

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 1: 132 kV GIS				
SN	***DESCRIPTION***	***UNIT***	***REQ***	***DATA to be Filled***
16.2	Power frequency withstand voltage	kV	275	
17	Operating mechanism			
17	Type		Spring operated	
17.1	Number of mechanism per breaker		1	
17.2	Single/three phase auto-reclosure		3	
18	Operating voltage of closing and tripping coil	V DC	220	
18.1	Operating voltage range	% of rated voltage		
	-Closing		85-110%	
	-Tripping		70-110%	
18.2	Closing and tripping current	A		
19	Spring charging motor rating			
	-Capacity	kW		
	-Rated voltage	V	220V DC	
20	Anti-pumping device provided	Yes/No	Yes	
21	Trip-free feature provided	Yes/No	Yes	
22	Number of N.C. contacts	No.	8	
23	Number of N.O. contacts	No.	8	
132 kV DISCONNECTING SWITCH & EARTH SWITCH				
A	**Disconnecting Switch**			
1	Applicable standard		IEC	
2	Type		3 pole group operated	
3	Rated Voltage			
3.1	Nominal	kV	132	
3.2	Maximum	kV	145	
4	Rated current			
4.1	Continuous at 50°C ambient	A	1250 / 2000 (As per PSR)	
4.2	Short time for 1 sec at max. kV	kA	40	
5	Temperature rise above 45 degree C		As per IEC	

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)

ITEM NO. 1: 132 kV GIS

SN	*DESCRIPTION*	*UNIT*	*REQ*	*DATA to be Filled*
	ambient at normal rated current			
5.1	Contacts	°C		
5.2	Current carrying parts	°C		
6	Insulation level			
6.1	Impulse withstand voltage(peak)	kV	650	
6.2	Power frequency withstand voltage (1min, rms)	kV	275	
7	Main contacts			
	- Material of fixed contacts		Provide	
	- Material of moving contacts		Provide	
	- Material of the contacts of the earthing switch		Provide	
8	Auxiliary power supply			
8.1	Control circuit	V, DC	220V DC	
8.2	Operating motor	V, phase	220V DC	
9	Number of N.C. contacts	No.	4 minimum	
10	Number of N.O. contacts	No.	4 minimum	
11	Operating mechanism		Motor & Manual Operated	
12	Operating motor	W		
13	Types of interlocks furnished		Electrical and manual	
B	**Earthing Switch**			
2	Operating motor	W		
3	Type of Interlocks		Electrical and manual	
4	Number of N.C. contacts	No.	4	
5	Number of N.O. contacts	No.	4	
132 kV Current Transformer				
1	Type		Indoor, Metal enclosed	
2	Number of cores in each CT	NO.	5	

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)

ITEM NO. 1: 132 kV GIS

SN	*DESCRIPTION*	*UNIT*	*REQ*	*DATA to be Filled*
3	Rated Primary Voltage			
3.1	Nominal	kV	132	
3.2	Maximum	kV	145	
4	Insulation level			
4.1	Impulse withstand voltage(peak)	kV	650	
4.2	Power frequency withstand voltage (1min, rms)	kV	275	
5	Short time thermal rating	kA	40	
6	Rated Peak Short Circuit Current	kA	80	
7	Rated VA burden for each core	VA	20	
8	Accuracy class		PS for protection 0.2 for metering PS for diff / Bus	
9	Current Ratio	A	As per Technical Data in specification	
10	Overvoltage factor		1.1	
11	Rated continuous thermal current		1.2x	
132 kV VOLTAGE TRANSFORMER				
1	Applicable standard		IEC	
2	Type		Indoor Metal enclosed	
3	Rated primary voltage			
	a) Nominal	kV	132/√3	
	b) Maximum voltage	kV	145/√3	
4	Insulation level			
	a) Impulse withstand voltage (primary)	kV	650	
	b) Power frequency withstand (1 min. rms) (primary)	kV	275	
5	Rating			
	a) Voltage ratio	kV	132/√3:0.11/√3	
	b) Rated burden	VA	50	
	c) Accuracy class		3P & 0.2 for metering	

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)

ITEM NO. 1: 132 kV GIS

SN	*DESCRIPTION*	*UNIT*	*REQ*	*DATA to be Filled*
	d) Overvoltage factor			
	- Continuous		1.1	
	- 30 seconds		1.5	
	e) Number of secondary windings		As per Technical Data in specification	
132 kV SURGE ARRESTOR				
1	Type		Indoor Metal enclosed	
2	Voltage rating of L.A	kV	120	
3	Nominal discharge current	kA	10	
4	Surge counter with insulating base furnished	Yes/No	Yes	
5	Insulation level			
	a) Impulse withstand voltage(peak)	kV	650	
	b) Power frequency withstand voltage (1min, rms)	kV	275	
GAS INSULATED BUS				
1	Bus arrangement formation		Horizontal	
2	Bus Duct Proposed	1 or 3 Phase		
GENERAL				
1	Gas density detector provided	Yes/No	Yes	
2	Operation counter provided (Breaker)	Yes/No	Yes	
3	Space heater provided for cubicle	Yes/No	Yes	
4	Enclosure Protection		IP55W	
5	Number of possible operations without maintenance under (CB):			
	i. Rated short circuit breaking current	No	40kA	
6	ii. Rated normal current	No	2000	
6	Rated SF6 pressure	kgf/cm2		
7	Guaranteed SF6 losses/year	kg	0.5% per Annum	

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)

ITEM NO. 1: 132 kV GIS

SN	*DESCRIPTION*	*UNIT*	*REQ*	*DATA to be Filled*
8	Padlocking provision for local cubicle	Yes/No	Yes	
9	UHF sensors for PD detection	Yes/No	Yes	
10	Numbers of sensors			
11	Total weight of the circuit breaker	Kg		
12	Mechanical dimension(LXWXH) (Whole GIS)	mm x mm x mm		
13	Delivery of equipment in months following award of contract	(Allowing time for approval of drawing)		
14	Is the manufacturer an ISO 9001 holder?	Yes/No	Yes	
15	Type test certificate submitted?	Yes/No	Yes	
16	Has manufacturer exported units?	Yes/No	Yes	
17	Technical literature / drawings submitted?	Yes/No	Yes	

Signed _____
As representative for _____
Address_____
Date_____

2. OUTDOOR EQUIPMENT

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 2: 132 kV LIGHTNING ARRESTOR				
	DESCRIPTION	UNIT	Requirement	DATA to be Filled
1	Manufacturer and Country of Origin			
2	Year of manufacturing experience	Years	10	
3	Manufacturing's Designation as per submitted catalogue			
4	Applicable standard		IEC	
5	Type		Outdoor, gapless, Zinc- Oxide	
6	Voltage rating of LA	kV	120	
7	Nominal discharge current	kA	10	
8	Surge counter with insulating base furnished	Yes/No	Yes	
9	Minimum power frequency sparkover voltage	kV		
10	Maximum 1/50 impulse sparkover voltage	kV		
11	Maximum front wave sparkover voltage	kV		
12	Maximum switching surge sparkover voltage	kV		
13	Number of section per Pole		1	
14	Insulation level			
14.1	a)Impulse withstand voltage(peak)	kV	650	
14.2	b)Power frequency withstand voltage (1min, rms)	kV	275	
15	Porcelain creepage distance	mm	3300	
16	Earth terminal with accessories provided	Yes/No	Yes	
17	Delivery of equipment in months following award of contract (Allowing time for approval of drawing)	month		
18	Is manufacturer is ISO 9001 holder?	Yes/No	Yes	
19	Has manufacturer exported units?	Yes/No	Yes	
20	Technical literature/drawings submitted?	Yes/No	Yes	

Signed _____
As representative for _____
Address _____
Date_____

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)
ITEM NO. 3 : 9 kV LIGHTNING ARRESTOR

	DESCRIPTION	UNIT	Requirement	DATA to be Filled
1	Manufacturer and Country of Origin			
2	Year of manufacturing experience	Years	10	
3	Manufacturing's Designation as per submitted catalogue			
4	Applicable standard		IEC	
5	Type		Outdoor, gapless, Zinc- Oxide	
6	Voltage rating of LA	kV	9	
7	Nominal discharge current	kA	10	
8	Surge counter with insulating base furnished	Yes/No	Yes	
9	Minimum power frequency sparkover voltage	kV		
10	Maximum 1/50 impulse sparkover voltage	kV		
11	Maximum front wave sparkover voltage	kV		
12	Maximum switching surge sparkover voltage	kV		
13	Number of section per Pole		1	
14	Insulation level			
14.1	a)Impulse withstand voltage(peak)	kV	28	
14.2	b)Power frequency withstand voltage (1min, rms)	kV	75	
15	creepage distance	mm	25mm/kV	
16	Earth terminal with accessories provided	Yes/No	Yes	
17	Delivery of equipment in months following award of contract (Allowing time for approval of drawing)	month		
18	Is manufacturer is ISO 9001 holder?	Yes/No	Yes	
19	Has manufacturer exported units?	Yes/No	Yes	
20	Technical literature/drawings submitted?	Yes/No	Yes	

Signed _____
As representative for _____
Address _____
Date_____

3. 132 KV CLASS TRANSFORMER

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)
ITEM NO. 3 : 132 /11 kV, 45 MVA Transformer

	DESCRIPTION	UNIT	Requirement	DATA to be Filled
1	Manufacturer and Country of Origin			
2	Year of manufacturing experience	Years	10	
3	Manufacturing's Designation as per submitted catalogue			
4	Applicable standard		IEC	
5	Type		Outdoor, oil immersed, Core Type	
6	Winding		Two	
7	Cooling		ONAN / ONAF	
8	Ratings			
8.1	Rated MVA			
8.1.1	ONAN	MVA	31.5	
8.1.2	ONAF	MVA	45	
8.2	Rated Voltage			
8.2.1	Primary	kV	132	
8.2.2	Secondary	kV	11	
8.3	Maximum Voltage			
8.3.1	Primary	kV	145	
8.3.2	Secondary	kV	12	
8.4	Number of Phases		Three	
8.5	Rated Frequency	Hz	50	
9	Noise Level			
	On ONAN Rating	dB	As per NEMA Standard	
	On ONAF Rating Rated Voltage	dB	As per NEMA Standard	
10	Temperature Rise			
10.1	Temperature Rise above 40^0C ambient			
	- In Oil by Thermometer	^{0}C	50	
	- In Winding by Resistance	^{0}C	55	
10.2	Hottest Spot Temperature in Winding	^{0}C	55	
	Limited to			
10.3	Temperature Indicators			
	Make			
11	Connection			
11.1	High Voltage		Star	
11.2	Low Voltage		Star	
11.3	Vector Group Ref in accordance with IEC 60076		YNyn0	
12	Taps			
12.1	Type of Tap changer		OLTC	
12.2	Tap Step		1.25%	
12.3	Tap Range		±10%	

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)
ITEM NO. 3 : 132 /11 kV, 45 MVA Transformer

	DESCRIPTION	UNIT	Requirement	DATA to be Filled
12.4	Nos. of Tap		17	
13	Cooling Equipment (For ONAF)			
13.1	Manufacturer/ Type			
13.2	Number of Fans Connected	Nos		
13.3	Rated Operating Voltage, Vac	Vac	230/400 50Hz	
13.4	Rated Control Voltage, V	Vdc	220	
13.5	Rated Power	KW		
14	**OLTC Gear**			
14.1	Manufacturer / Type		MR, Germany ABB, Sweden or equivalent	
14.2	Rating			
	- Rated Voltage	kV	132	
	- Rated Current	A		
	- Step Voltage	V		
	- Numbers of Steps	Nos	17	
14.3	Control Suitable for			
	- Remote / Local Operation		Remote / Local	
	- Auto / Manual Operation		Auto / Manual	
	- Parallel Operation	Yes/No	Yes	
	- Master Slave Operation	Yes/No	Yes	
14.4	Rated voltage of Drive Motor	Vac	230/400 50Hz	
15	Guaranteed losses			
15.1	No Load Losses at Rated Voltage and Frequency on Max. MVA Base.	kW		
15.2	Load Losses at rated Current and at 75^0C on max. MVA base	kW		
15.3	Cooler Losses for full load operation on max. MVA base	kW		
16	**Impedance at Rated Current and Frequency at 75^0C Winding Temperatures on ONAF, MVA Base.**	%		
16.1	Positive Sequence Impedance at nameplate Normal tap	%	> 12	
16.2	Positive Sequence at Maximum Voltage	%		
	Tap (Tap 17)			
16.3	Positive Sequence at Minimum Voltage	%		
	Tap (Tap 1)			
16.4	Zero Sequence at Nameplate Tap			
17	Reactance at rated current and Frequency at 75°C on Maximum MVA base at a nameplate tap			
18	Efficiency at 75^0C Winding Temperature at PF=0.9			
18.1	At 100% Load	%		
18.2	At 75% Load	%		
18.3	At 50% Load	%	Above 99%	

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)
ITEM NO. 3 : 132 /11 kV, 45 MVA Transformer

	DESCRIPTION	UNIT	Requirement	DATA to be Filled
19	Load in Percentage of Full Load and Power Factor at which maximum efficiency occurs.			
20	Regulation at full Load and at 75C			
20.1	At Unity Power Factor			
20.2	At 0.85 Power Factor Lagging			
21	No Load Current in Percentage of rated Current referred to HV and 50Hz.			
21.1	At 90% Rated Voltage	%		
21.2	At 100% Rated Voltage	%	<1	
21.3	At 110% Rated Voltage	%		
22	Clearances			
22.1	Minimum Clearances in air-HV/LV	mm		
22.2	Between Phases Between Phase and Earth	mm		
23	Insulation Level			
23.1	Power Frequency Withstand Voltage (1Min rms)			
23.1.1	Primary	kV	275	
23.1.2	Secondary	kV	28	
23.1.3	Tertiary (if provided)	kV		
23.2	Impulse Withstand Voltage			
23.2.1	Primary	kV	650(Crest)	
23.2.2	Secondary	kV	75 (Crest)	
23.2.2	Tertiary(if provided)	kV		
24	Details of Oil Preservation System			
24.1	Type		Conservator Type	
24.2	Details of Oil Preservation System			
24.3	If Conservator Type, Urethane Air Cell provided	Yes/No	Yes	
24.4	Volume of Conservator	Cu.m		
24.5	Volume of Oil Between the highest and	Liters		
	Lowest Levels			
25	Pressure Relief Device	Kg/cm^2		
	Min. pressure setting			
26	Details of Bushings HV / LV / Neutral			
26.1	Manufacturer / Type			
26.2	Voltage class	KV	145/12	
26.2	Creepage Distance	mm	25mm/kV	
26.3	Weight of Bushing	kg		
26.4	Standard Reference		IEC	
26.5	Power Frequency Withstand Voltage Dry	KV	305/30	
26.6	Power Frequency Withstand Voltage Wet	KV	275/28	
26.7	Impulse Withstand Voltage	KV	650/75	
27	Insulating Oil			
i	Manufacturer and Country of Origin			
ii	Manufacturer's type designation			

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)
ITEM NO. 3 : 132 /11 kV, 45 MVA Transformer

	DESCRIPTION	UNIT	Requirement	DATA to be Filled
iii	Type		Insulating Oil	
iv	Applicable standard		IEC	
v	Technical Specifications			
v.1	Dielectric Breakdown Strength (Min) at 2.5mm gap	kV	30	
v.2	Flash Point (Min)	°C	135	
v.3	Density at 20ºC (Max)	g/Cu.cm	0.895	
v.4	Viscosity at 40ºC (Max)	mm^2/s	12	
v.5	Viscosity at -30ºC (Max)	mm^2/s	1800	
v.6	Acidity Neutralization Value (Max)	Mg. KOH/g	0.01	
v.7	Sludge Value (Max)		0.10%	
v.8	Pour Point (Max)	°C	-40 C	
v.9	Corrosive Sulphur		Non-corrosive	
v.10	Water Content (Max)	ppm	40	
v.11	Dielectric Dissipation factor at 90 (Max)		0.005	
v.12	Appearance		clean free from sediment and suspended matter	
vi.	PCB Content		Not Detectable	
vii.	Approx. volume of Oil, ltrs			
Viii	Whether First filled of Oil with 5% excess provided	Yes/No	Yes	
28	Core Material			
28.1	Maximum flux density at rated voltage on principal tapping and rated frequency:			
	Transformer legs	T		
	Transformer yokes	T		
28.2	Maximum flux density at 110% voltage			
	Transformer legs	T	< 1.9	
	Transformer yokes	T	< 1.9	
28.3	Grade of core used	Prime Core		
	Type of Core	CRGO		
	Thickness of core lamination			
	Rated Loss per kg			
29.1	Maximum current density in windings at rated output:			
	Primary (HV)	A/mm^2		
	Secondary (LV)	A/mm^2		
	Weight of copper in windings:			
	Primary (HV)			
	Secondary (LV)			
30	Bushing Current Transformers			
30.2	Numbers of Cores			
	- HV	Nos	1 / phase	

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)
ITEM NO. 3 : 132 /11 kV, 45 MVA Transformer

	DESCRIPTION	UNIT	Requirement	DATA to be Filled
	- LV	Nos	1 / phase	
	- Neutral	Nos	1 / phase	
30.3	Accuracy class / Burden/Ratio			
	- HV			
	- LV			
	- HV / LV Neutral			
31	Lightning Arrestor mounted on			
	- HV	Yes/No	Yes	
	- LV	Yes/No	Yes	
32	RTCC Panel Details			
32.1	AVR make/Model		MR, Germany ABB, Sweden or equivalent	
32.2	Annunciator 12 Windows provided	Yes/No	Yes	
32.3	Indicating Voltmeter	Yes/No	Yes	
34.4	Facilities and Provision as per specification provided?	Yes/No	Yes	
33	Approximate Overall Dimension (L x W x H)			
34	Approximate Weights			
34.1	Core and Coil	Kg		
34.2	Tank and fittings	Kg		
34.3	Oil	Kg		
34.4	Total Weight	Kg		
35	Delivery of Equipment in Months, following the Award of Contract (Allowing the time for Drawing Approval)	Months		
36	Transformer Health Monitoring			
36.1	Is thermal monitoring provided as per the specification ?	Yes/No	Yes	
36.2	Is gas monitoring provided as per the specification ?	Yes/No	Yes	
36.3	Is vibration monitoring provided as per the specification ?	Yes/No	Yes	
36.4	Is water & moisture content measurement in OIL & PAPER provided as per the specification ?	Yes/No	Yes	
36.5	Is Partial discharge measurement provided as per the specification ?	Yes/No	Yes	
36.6	Is Transformer Life left forecast provided ?	Yes/No	Yes	
36.7	Is analytics provided for all the above data mentioned in clause no. 16.1 to 16.6 ?	Yes/No	Yes	
36.8	Whether 3 years subscription provided for online Transformer health data monitoring along with analytics ?	Yes/No	Yes	
37	Is manufacturer ISO 9001 holder?	Yes/No	Yes	

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)
ITEM NO. 3 : 132 /11 kV, 45 MVA Transformer

	DESCRIPTION	UNIT	Requirement	DATA to be Filled
38	Type test certificate submitted?	Yes/No	Yes	
39	Has manufacturer exported units?	Yes/No	Yes	
40	User's certificate submitted?	Yes/No	Yes	
41	Technical literature / drawings submitted?	Yes/No	Yes	

Signed _____
As representative for _____
Address_____
Date_____

4. LT TRANSFORMER

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 4 : 315 KVA 11/0.4 kV LT TRANSFORMER				
SN.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
1	Manufacturer			
1.1	Type		Outdoor	
1.2	Class			
2	Rated data and characteristics			
2.1	Rated power: - primary/secondary (Rated power at highest tap)	kVA	315	
2.2	Cooling method		ONAN	
2.3	Rated voltage			
	- HV winding	kV	11	
	- LV winding	kV	0.4	
2.4	Tap changer:			
	- manufacturer			
	- model			
	- type			
	- regulating range	%		
	- rating	A		
2.5	Frequency	Hz	50	
2.6	Connection of the three-phase windings (group of vectors IEC 60076)			
2.7	Rated current at ONAN rated power and rated voltage tap:			
	- HV winding	A		
	- LV winding	A		
2.8	No-load current through:			
	- HV winding	A		
	- LV winding	A		
2.9	Short circuit impedance			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 4 : 315 KVA 11/0.4 kV LT TRANSFORMER				
SN.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
2.9.1	Direct impedance at nominal voltage tap: - HV/LV	%		
2.9.2	Direct impedance at minimum voltage tap: - HV/LV	%		
2.9.3	Direct impedance at maximum voltage tap: - HV/LV	%		
2.9.4	Zero sequence impedance at nominal voltage tap: - HV / LV	%		
2.1	Tolerance to be applied to the short circuit impedance, in terms of % of the guaranteed value on:			
	- nominal voltage tap	%		
	- other taps	%		
2.11	Transformer capacity to withstand external short circuits:			
2.11.1	Short circuit duration	sec		
2.11.2	Symmetrical short circuit current withstand during the indicated period and asymmetrical short circuit withstand:			
	- HV winding	kA rms kA (peak)		
	- LV winding	kA rms kA (peak)		
	- pre-fault voltage	p.u.		
2.12	Guaranteed losses			
2.12.1	No-load losses at rated voltage and frequency, with rated voltage tap (design calculation sheet shall be submitted with the bid) corrected to 75 deg. C Wdg. Temp.	kW		
2.12.2	No-load losses at 110% of the rated voltage, at rated frequency and rated voltage tap corrected to 75 deg. C Wdg. Temp	kW		

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 4 : 315 KVA 11/0.4 kV LT TRANSFORMER				
SN.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
2.12.3	Tolerance to be applied to no-load losses (in % of the guaranteed value)	%	As per IEC	
2.12.4	Load losses at rated voltage and frequency, with rated voltage tap and ONAN rating corrected to 75 deg. C Wdg. Temp.	kW		
2.12.5	Auxiliary losses at rated voltage and frequency, with rated voltage tap and ONAN rating corrected to 75 deg. C Wdg. Temp (kW)	kW		
2.12.6	Tolerance to be applied to total losses (in %of the guaranteed value) for all the windings	%		
2.13	Highest voltage for equipment:			
	- HV winding	kV	12	
	- LV winding	kV	1.1	
2.14	Rated insulation level:			
2.14.1	Short time power frequency withstand:			
	- HV winding - line terminal	kV rms	28	
	- LV winding - line terminal	kV rms	3	
	- neutral	kV rms	3	
2.14.2	Basic impulse level:			
	- HV winding - line terminal	kV (peak)	75	
	- LV winding - line terminal	kV (peak)		
	- neutral point	kV (peak)		
2.15	Temperature rise limits at maximum power output ratings and at lowest voltage tap and corresponding voltage:			
	- average winding at ambient temperature	^{0}C		
	- top oil at ambient temperature	^{0}C		

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 4 : 315 KVA 11/0.4 kV LT TRANSFORMER				
SN.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
2.16	Permissible overload in emergency cases:			
	- permanent permissible overload based on highest winding temperature which exceeds by 5oC the guaranteed limit	kVA		
	- permanent permissible overvoltage based on the maximum top oil temperature which exceeds by 5oC the guaranteed limit at rated power (in % of the rated voltage)	%		
2.17	Audible noise level			
	- Voltage in percent of rated value	%		
	- ONAN rating	dB(A)		
2.18	Radio Interference Voltage at 0.5 MHz as per IEC 60694	uV		
2.19	Core:			
	- manufacturer			
	- grade and thickness of core steel	grade/mm		
	- standard			
	- data sheet attached			
2.2	Oil:			
	- manufacturer			
	- type			
	- standard			
	- data sheet attached			
2.21	Tank /corrugated wall and radiators			
2.21.1	Tank/corrugated wall :			
	- manufacturer			
	- thickness			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 4 : 315 KVA 11/0.4 kV LT TRANSFORMER				
SN.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
	- cover	mm		
	- side/corrugated wall	mm		
	- bottom	mm		
2.21.2	Radiator :			
	- manufacturer			
	- cooler tube thickness	mm		
	- pressed-sheet radiator thickness	mm		
2.21.3	Safe withstand vacuum at sea level	kPa		
2.22	Bushings			
2.22.1	HV bushings:			
	- class	kV	12	
	- manufacturer			
	- type designation			
	- rated current	A	100	
	- short circuit withstand	kA rms	31.5	
	- basic insulation level	kV (peak)		
	- power frequency withstand for 1 minute	kV rms		
	- terminal connector for conductor size	mm^2		
	- creepage distance	mm		
2.22.2	LV bushings:			
	- class	kV	1.1	
	- manufacturer			
	- type designation			
	- rated current	A	1000	
	- short circuit withstand	kA rms		
	- basic insulation level	kV (peak)		
	- power frequency withstand for 1 minute	kV rms		

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 4 : 315 KVA 11/0.4 kV LT TRANSFORMER				
SN.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
	- terminal connector for conductor size	mm^2		
	- creepage distance	mm		
2.22.3	Neutral bushings:			
	- class	kV		
	- manufacturer			
	- type designation			
	- rated current	A		
	- short circuit withstand	kA rms		
	- basic insulation level	kV (peak)		
	- power frequency withstand for 1 minute	kV rms		
	- terminal connector for conductor size	mm^2		
	- creepage distance	mm		
3	Design data:			
3.1	Core Design			
	- core type	core or shell		
	- number and length of limbs	no/mm		
	- core diameter	mm		
3.1.1	Core cross section area			
	- wound limbs	mm^2		
	- yoke	mm^2		
	- unwound limbs	mm^2		
3.1.2	Distance between core limb center	mm		
3.1.3	Maximum flux density in the wound limb at:			
	- rated voltage	tesla		
	- 110% of the rated voltage	tesla		
3.1.4	Maximum flux density in the yokes at:			
	- rated voltage	tesla		

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 4 : 315 KVA 11/0.4 kV LT TRANSFORMER				
SN.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
	- 110% of the rated voltage	tesla		
3.1.5	Voltage per turn at the above flux density			
	- rated voltage	V		
	- 110% of the rated voltage	V		
3.1.6	Magnetizing current, at rated frequency, on principal tapping, in percent of rated current at maximum HV rating	%		
	- at 90% of the rated voltage	%		
	- at 100% of the rated voltage	%		
	- at 110% of the rated voltage			
3.1.7	Specific loss of core at maximum flux density	W/kg		
3.1.8	Maximum current density in winding;			
	- HV	A/mm^2		
	- LV	A/mm^2		
3.2	Winding Design			
3.2.1	Winding resistance:			
	- HV winding	Ω		
	- winding conductor			
	- Inside diameter of winding coil	m		
	- Outside diameter of winding coil	m		
	- Number of winding turn at normal tap	turns		
	- Cross-section area of winding conductor	mm^2		
	- number and width of support spacers per turn			
	- total conductor mass	kg		
	- dry insulation mass	kg		
	- LV winding	Ω		

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 4 : 315 KVA 11/0.4 kV LT TRANSFORMER				
SN.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
	- winding conductor			
	- Inside diameter of winding coil	m		
	- Outside diameter of winding coil	m		
	- Number of winding turn at normal tap	turns		
	- Cross-section area of winding conductor	mm^2		
	- number and width of support spacers per turn			
	- total conductor mass	kg		
	- dry insulation mass	kg		
3.3	Voltage regulation at ONAN rating and rated voltage tap (in % of the rated voltage):			
	- with unity power factor:			
	- with 0.9 power factor (lagging):	%		
	- with 0.8 power factor (lagging):	%		
4	Weights and dimensions			
4.1	Total weight of transformer, equipped for service	kg		
4.2	Weight:			
	- oil	kg		
	- core and coil assembling	kg		
	- tank and accessories	kg		
	- net copper	kg		
	- net core steel	kg		
4.3	Outline dimensions:			
	- length	mm		
	- width	mm		
4.4	Layout drawing no.			
5	Standards			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 4 : 315 KVA 11/0.4 kV LT TRANSFORMER				
SN.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
5.1	Manufacturing			
5.2	Quality assurance			
5.3	Type test certification			
	(Shall be submitted with the bid for approval otherwise it will be assumed that no type tests for identical units are available)			

Signed _____
As representative for _____
Address _____
Date_____

5. LT SWITCHGEAR

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO 5: LT SWITCHGEAR				
S. No.	DESCRIPTION	UNIT	Requirement	Data to be filled
1	**General**			
1.1	Manufacturer			
1.2	Place of Manufacturer			
1.3	Standards			
1.4	Type			
1.5	Type tested	Yes/No		
1.6	Rated Voltage	V		
1.7	Maximum operating Voltage	V	400	
1.8	Rated Frequency	Hz	50	
1.9	Bus Bar Material			
1.10	Bus Bar Insulation Material			
1.11	Rated short time withstand Current(1s)	kA rms		
1.12	Rated peak withstand current	kA peak		
1.13	Rated power frequency withstand voltage	kV		
1.14	Protection Class	IP		
1.15	Thickness of sheet steel	mm		
	Dimensions of standard Cubicle:			
1.16	Width	mm		
1.17	Depth	mm		
1.18	Height	mm		
1.19	Mass per cubicle	kg approx		
2	**Circuit Breakers**			
2.1	(To be filled in for each type and size of circuit breaker)			
2.2	Manufacturer			
2.3	Type			
2.4	Designation			
2.5	Standards			

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)

ITEM NO 5: LT SWITCHGEAR

S. No.	DESCRIPTION	UNIT	Requirement	Data to be filled
2.6	Rated Voltage	V		
2.7	Rated Current	A		
2.8	Rated short circuit breaking current	kA		
2.9	Rated short circuit making current	kA		
2.10	Rated short time withstand Current(1s)	kA rms		
2.11	**Operating Mechanism:**			
	type(manual electromagnetic, electric motor)			
	Rated voltage	V		
	Power demand	W		
2.12	**Closing/Tripping Coil:**			
	Voltage	V		
	Power demand	VA		
2.13	**Releases: Overload/Overcurrent:**			
	Rated Current	A		
	operation current setting range of adjustment	A		
	operation time range of adjustment	ms		
	Full opening, closing time	ms		
	Number of auxiliary contacts	Nos		
	Mass	Kg		
2.14	**Motor Starters**			
	(To be filled in for each type and size of motor starter)			
	Manufacturer			
	Type			
	Designation			
	Standards			
	Category of main application			
	Rated current of main contacts	A		
	Rating of motors to be switched	kW		

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)

ITEM NO 5: LT SWITCHGEAR

S. No.	DESCRIPTION	UNIT	Requirement	Data to be filled
	Rated Current of auxiliary Contacts	A		
	Rated Voltage of auxiliary Contacts	V		
3	**Main Distribution Board**			
3.1	Number of cubicles	Nos		
3.2	Designation			
3.3	Type			
3.4	Standards			
3.5	Rating of main CB	A		
3.6	Busbar rating	A		
3.7	Rated short time withstand Current(1s)	kA rms		
3.8	Rated peak withstand current	kA peak		
3.9	**Dimensions:**			
	Length	mm		
	Width	mm		
	Height	mm		
	Total weight	kg		
4	**Sub Distribution Board**			
	Number of cubicles	Nos		
	Designation			
	Type			
	Standards			
	Rating of main CB	A		
	Busbar rating	A		
	Rated short time withstand Current(1s)	kA rms		
	Rated peak withstand current	kA peak		
	Dimensions:			
	Length	mm		
	Width	mm		

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) **ITEM NO 5: LT SWITCHGEAR**				
S. No.	DESCRIPTION	UNIT	Requirement	Data to be filled
	Height	mm		
	Total weight	kg		
5	**Information to be Submitted with the Tender**			
	Layout and dimension drawing for each distribution board			
	Technical leaflets for:			
	Switchgear and distribution boards			
	Circuit Breaker			
	Contactors			
	Protection relays and auxiliary devices			
	Typical single line diagrams			
6	**Informative Data**			
	Manufacturer			
	Place of manufacturing			
	Dimension (W x D x H)	mm		
	Weight	kg		
	Shipping Data			
	Weight of heaviest package	kg		
	Dimension of largest package (W x D x H)	mm		

Signed _____
As representative for

_____
Address

_____
Date_____

6. BATTERY AND BATTERY CHARGER

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO 6: BATTERIES AND BATTERY CHARGERS				
S. No.	**Description of Data**	**Unit**	**Requirement**	**Data to be filled**
A	**Batteries**			
1	General Data			
a)	Battery Type:			
	Grid alloy:			
	Pure lead(Pb),			
	lead calcium (Pb-Ca),lead antimony (Pb-Sb),			
	or lead selenium (Pb-Se) or other pl. specify			
	Cell type:			
	Absorbed glass mat or gel cell or other please specify			
	Seller's type number			
	Number of positive plates per cell			
b)	Does each battery and battery [rack]/ [cabinet] meet the seismic requirements	[Yes] [No]	yes	
c)	Manufacturer's Designed Life of Battery	Yrs	5	
d)	Recommended Battery Charger Data:			
	Floating voltage range	V	242	
	Boost charge	V	302	
	Current rating	Amps.	150	
	Recharge time	hr		
e)	Heat Released During:			
	Discharge duty cycle	Watt		
	Float charge	Watt		
	Boost Charge	Watt		
f)	Maximum Amount of Hydrogen Gas Evolved			
	During Battery-Boost Charge (2.33 V per cell) at Maximum Battery Temperature	(Litre /h)		

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO 6: BATTERIES AND BATTERY CHARGERS				
S. No.	**Description of Data**	**Unit**	**Requirement**	**Data to be filled**
	Hydrogen Gas Evolution at Float	(Litre /h)		
g)	Time Battery may be Stored Without a Freshening Charge	months		
h)	Temperature Compensation Provided			
	and its Details			
2	Physical Description.			
a)	Battery Cell:			
	Size (L x W x H)	mm		
	Weight	kg		
	Volume of electrolyte gal	L		
	Jar cover material			
	Jar container material			
	Separator material			
	Retainer material			
	Limiting-oxygen index (LOI)			
b)	Battery [Rack] [Cabinet]:			
	Outline or catalog number			
	Quantity of [racks][cabinets] for the battery			
	Description (tier or step type)			
c)	Total Net Weight of Battery Including [Racks] [Cabinets]	kg		
d)	Total Shipping Weight of Each Battery Jar and Associated Equipment	kg		
e)	Connectors:			
	Intercell:			
	Type			
	Material			
	No. per connection			
	Inter-[Tier] [Step]:			
	Type			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO 6: BATTERIES AND BATTERY CHARGERS				
S. No.	**Description of Data**	**Unit**	**Requirement**	**Data to be filled**
	Material			
	No. per connection			
	Terminal Detail:			
	Type			
	Material			
f)	Terminal Lugs for Power Cable:			
g)	Torque Data:			
	Intercell Connectors			
	Inter-[Tier] [Step]:			
3	Performance Data.			
	Battery String Designation No. [1] [ ]			
	Float Voltage Without Boost	V/cell		
	Float Voltage With Boost	V/cell		
	Boost Charge Voltage	V/cell		
	Recommended Frequency of Boost Charge			
	Recommended Duration of Boost Charge			
	Open-Circuit Voltage	V/cell		
	Short-Circuit Current at Battery Terminals at Float Voltage at (27°C):			
	Battery Discharge Characteristics	A or A /positive plate		
	Guaranteed Amp-Hour Capacity (at the 10-hr rate) to Specified Final Voltage	AH		
	One-minute	A/cell		
	Fifteen-minute	A/cell		
	One-hour	A/cell		
	Two-hour	A/cell		
	Three-hour	A/cell		

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO 6: BATTERIES AND BATTERY CHARGERS				
S. No.	**Description of Data**	**Unit**	**Requirement**	**Data to be filled**
	Eight-hour	A/cell		
	Ten-hour	A/cell		
4	Required operating environment.			
	Battery Room Ambient Temperature Range	(°C to °C)		
	Battery Room Ambient Design Temperature	°C		
	Battery Room Minimum/Maximum Design Temperature	(°C to °C)		
	Maximum temperature at which battery can be stored	°C		
B.	**BATTERY CHARGERS**			
1.0	Manufacturer's Name & address			
2.0	Confirm whether Manufactures have Manufactured, tested, supplied, installed and commissioned battery chargers of 10 KW capacity similar to the offered battery charger	Yes/No	YES	
3.0	Capacity of battery charger	AH		
4.0	Charger rate/output current			
5.0	Float charging mode (A)	A		
6.0	Boost charging mode (A)	A		
7.0	Ripple content in output voltage %	%	>3	
8.0	Confirm whether battery chargers are type tested as per specification			

Signed _____
As representative for
_____
Address
_____
Date_____

7. 11 KV INDOOR SWITCHGEAR

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 7: 11 kV VACUUM SWITCHGEAR PANEL				
	DESCRIPTION	**UNIT**	**Requirement**	**Data to be filled**
A	**SWITCHGEAR MANUFACTURER**			
1	**Manufacturer and Country of Origin**			
2	**Year of manufacturing experience**	Years	10	
3	**Manufacturing's Designation as per submitted catalogue**		To be Furnished	
4	**Applicable standard**			
B	**BUSBAR**			
1	Material			
	-Incomer		Copper	
	-Outgoing feeder		Aluminium(Satation Tr.)	
2	Size			
	a. Main bus	mm^2		
	b. Ground bus	mm^2		
3	Minimum Clearance			
	a. Phase to phase	mm		
	b. Phase to ground	mm		
4	Bus bar Rated Current			
	a. Continuous at 40 deg. C amb.	A	4000	
	b. Short time current for 3 sec	kA	31.5	
5	Rated Voltage	kV	12	
6	Bus Support Insulators			
	a. Manufacturer			
	b. Type			
	c. Impulse Withstand Voltage	kV	75	
	d. Power frequency withstand voltage (1min. rms)	kV	28	
C	**CIRCUIT BREAKER**			
1	Manufacturer			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 7: 11 kV VACUUM SWITCHGEAR PANEL				
2	Type		Vaccum with moving carriage in double tier arrangement	
3	Manufacturing's Designation as per submitted catalogue /Model No.		To be furnished	
4	Rated Voltage	kV	12	
5	Number of possible operation without maintenance			
	-Rated short circuit breaking current	No.	100	
	-Rated normal current	No.	10000	
	-For mechanism	No.	30000	
6	Frequency	Hz	50	
7	Rated current			
7.1	Continuous at 45 degree ambient			
	Incoming	A	3000	
	Outgoing	A	1250	
	Trunking	A	3000	
7.2	Short circuit current for 1 sec.	kA	31.5	
8	**Vacuum Interrupter**			
	a. Make			
	b. Rating			
9	Rated short circuit breaking current (rms sym.)	kA	31.5	
10	Interrupting time	ms	60	
11	Rated short circuit making current			
11.1	Peak	kA	63	
12	Closing time, max	mS	120	
13	**Insulation level**			
	a. Impulse Withstand Voltage	kV	75	
	b. Power frequency withstand Voltage	kV	28	
14	**Operating Mechanism**			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 7: 11 kV VACUUM SWITCHGEAR PANEL				
	a. Type		Spring with motor charging	
	b. Operating voltage range	% of rated voltage	85-110% 70-110%	
	-Closing			
	-Tripping			
	c. Closing and Tripping coils current	A		
	d. Duty cycle		0-0.3 sec-CO-3min-CO	
15	Spring charging motor			
	a. Type and Manufacturer			
	b. Voltage	**V**	220 V DC	
	c. Rating	kW		
	d. Time required by motor to charge	sec	<30	
	the spring completely			
16	Total no. of auxiliary contacts			
	a. Normally open	No.	8	
	b. Normally closed	No.	8	
	c. Contact ratings(make and			
	continuous current)			
	-AC at 230V	A	1	
	-DC inductive at 220 Volt	A	0.5	
17	Overall Dimension (L*W*H)	mm		
D	**CURRENT TRANSFORMER**			
1	Manufacturer			
2	Type			
3	Manufacturing's Designation as per			
	submitted catalogue /Model No.			
4	Frequency	Hz	50	
5	Voltage class	kV	12	

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 7: 11 kV VACUUM SWITCHGEAR PANEL				
6	Reference standard			
7.1	- For Incomer / Buscoupler		As specified in Specification/SLD	
	- Nos. of Core			
	- Ratio / Class / Burden			
	- Metering			
	- Protection			
	- Protection			
7.2	For Outgoing Feeders		As specified in Specification/SLD	
	- Nos. of Core			
	- Ratio / Class / Burden			
	- Metering			
	- Protection			
	- Protection			
8	Insulation level			
	a. Impulse Withstand Voltage	kV	78	
	b. Power frequency withstand Voltage	kV	28	
9	Continuous rated thermal current	A	1.5* In	
E	**VOLTAGE TRANSFORMER**			
1	Manufacturer			
2	Type		Incomer Cubical Mounted	
3	Manufacturing's Designation as per submitted catalogue /Model No.		To be furnished	
4	Frequency	Hz	50	
5	Voltage Class	kV	15	
6	Reference standard		IEC	
7	**Voltage Transformer for Incoming and Ring main Feeder**		As specified in Specification/SLD	
	- Ratio	kV		
	- Accuracy Class			
	- Burden	VA		
8	Insulation level			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 7: 11 kV VACUUM SWITCHGEAR PANEL				
	a. Impulse Withstand Voltage	kV	75	
	b. Power frequency withstand Voltage	kV	28	
9	Overall Dimension (L*W*H)	mm		
10	Weight	kg		
11	Fuses (HV/LV)			
	a) Type			
	b) Continuous ratings	A		
	c) Symmetrical fault rating	kV		
	METERING INSTRUMENT			
1	**KWh Meter for Incomer and Outgoing Feeders**			
i.	Manufacturer and Country of Origin			
ii.	Type		Digital, 3-phase 4 wire	
iii.	Applicable Standard		IEC	
iv.	Accuracy class		0.2	
v.	Import and Export meter provided	Yes/No	Yes	
vi.	Rated voltage	V	110	
vii.	Rated current	A	1	
viii.	Operating current range	A	0.7-1.2	
ix.	Operating Voltage range	V	0-480	
x.	VA Burden Current Coil Voltage Coil	VA	Yes	
xi.	Test Impulse output provided	Yes/No	Yes	
xii.	Programmable at Site	Yes/No	Yes	
xiii.	Software and optical probe provided as per Price schedule & BOQ	Yes/No	Yes	
xiv.	Load profile can be downloaded	Yes/No	Yes	
2	**Ammeter**			
i.	Manufacturer and Country of Origin			
ii.	Type		0.2	
iii.	Accuracy class			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 7: 11 kV VACUUM SWITCHGEAR PANEL				
v.	Scale			
	-Range of indication		As required	
	For Incomer / Bus coupler For Outgoing Feeder	A		
	-Overload range	%	150%	
vi.	VA Burden			
3	**Voltmeter for Incomer Only**			
i.	Manufacturer and Country of Origin			
ii.	Type		Digital	
iii.	Accuracy class		0.5	
iv.	**Scale**			
	-Range of indication	kV	0-15	
v.	VA Burden			
4	**Watt Meter (MW)**			
i.	Manufacturer and Country of Origin			
ii	Type			
iii	Rated voltage	kV	11/Sqt 3:0.11Sqt 3	
iv	Rated current	A		
vi	Accuracy class		0.2	
vii	Range of indication			
	- Incomer	MW		
	- Outgoing feeder	MW		
G	ANNUNCIATORS			
I	Manufacturer and Country of Origin			
ii.	Type			
vi.	Number of active points	No.	6	
ix.	Type of mounting		Flush	
x.	Replacement of individual inscription plates and lamps from	Yes/No		
xi.	Sequence of specification operation as per	Yes/No		
H	PROTECTIVE RELAYS			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 7: 11 kV VACUUM SWITCHGEAR PANEL				
1	Manufacturer & country of origin			
2	Years of manufacturing service	Years	10	
3	Reference standard		IEC	
4	Overcurrent Relays, (Non-Directional) for Outgoing Feeders			
i.	Manufacturer and Country of Origin			
ii.	Type		Numerical Non-Directional	
iii.	Manufacturer's type designation			
v.	No of Pole		Three	
vi.	Current setting range	% of rated current	20-250%	
vii.	Operating time at 10 times current	sec	0	
	setting			
viii.	Reset time	mS	0.3	
ix.	Characteristics		IDMT	
x.	Instantaneous unit provided	Yes/No		
	-Current setting range	% of current	200-2500%	
	-Operating range			
	-NO Contacts			
xi.	Insulating test according to IEC	Yes/No		
xii.	Indication			
	-Hand reset flags provided	Yes/No Yes/No		
	-Light emitting diode provided			
xiii.	Auxiliary DC Supply	V	220	
xvi.	Technical literature submitted	Yes/No	Yes	
5	Earth fault relays (non directional) for Outgoing Feeders			
i.	Manufacturer and Country of Origin			
ii.	Type			
iv.	Applicable standard			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 7: 11 kV VACUUM SWITCHGEAR PANEL				
vi.	Continuous overload capacity	x In		
vii.	Current setting range	%of In		
viii.	Operating time at 10 times current	sec	0	
	setting			
ix.	Characteristics		IDMT	
x.	Instantaneous unit provided	Yes/No		
	-Current setting range	%	50-500%	
	-Operating range	of In		
	-NO Contacts, Nos			
xi.	Insulating test according to IEC	Yes/No		
xii.	Indication			
	-Light emitting diode provided			
xiii.	Auxiliary DC Supply	V	220	
xiv.	Technical literature submitted	Yes/No	Yes	
xv	Type test certificate submitted	Yes/No	Yes	
6	Directional Phase Over current Relays for Incomer Panel			
i.	Manufacturer and Country of Origin			
ii.	Type		Numerical	
iii.	Manufacturer's type designation			
iv.	Applicable standard			
v.	Triple pole or single pole		Tripal	
vi.	Current setting range	% of rated current	50-200%	
vii.	Operating time at 10 times current	sec	0.3	
	setting			
viii.	Reset time	mS		
	Contact rating at 125V DC	A		
ix.	Characteristics		IDMT	
	Characteristic Angle		45°	

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 7: 11 kV VACUUM SWITCHGEAR PANEL				
x.	Instantaneous unit provided	Yes/No	Yes	
	-Current setting range	% of rated current	500-2000%	
	-Operating range			
	-NO Contacts			
xi.	Insulating test according to IEC	Yes/No		
xii.	Indication			
	-Hand reset flags provided	Yes/No Yes/No		
	-Light emitting diode provided			
xiii.	Auxiliary DC Supply	V		
7	DIRECTIONAL EARTH FAULT			
	RELAYS for Incomer Panel			
i.	Manufacturer and Country of Origin			
ii.	Type		Numerical	
iii.	Manufacturer's type designation			
iv.	Applicable standard			
v.	Triple pole or single pole		Tripal	
vi.	Continuous overload capacity	x In		
vii.	Current setting range	% of rated current	10-80%	
viii.	Operating time at 10 times current setting	sec	0.3	
ix.	Characteristics		IDMT	
x.	Instantaneous unit provided	Yes/No	Yes	
	-Operating range	mS	500-2000%	
	-NO Contacts, Nos			
xi.	Insulating test according to IEC	Yes/No		
xii.	Indication			
	-Hand reset flags provided	Yes/No Yes/No		
	-Light emitting diode provided			
xiii.	Auxilliary DC Supply	V	220	
xvii.	Technical literature/drawings submitted?	Yes/No	Yes	

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 7: 11 kV VACUUM SWITCHGEAR PANEL				
8	Auxiliary Tripping & Lockout Relays			
i.	Manufacturer and Country of Origin			
ii.	Type		Integrated	
iii.	Manufacturer's type designation			
v.	Operating time	mS	<15	
viii.	Contact rating at 125V DC	A		
I	EARTHING SWITCH			
	- Type			
	- Rating			
	- Interlocking	Yes/No	Yes	
J	SURGE ARRESTORS for			
	Incomer			
	Type rating	kA		
K	SWITCHGEAR ASSEMBLY			
1	Type of Switchgear			
2	Enclosure			
	a. Type			
	b. Thickness of metal sheet(min)	mm	2	
	c. Degree of protection provided by			
	the enclosure			
3	Breaker assembly			
	a. Breaker provided with service test	Yes/No	Yes	
	and withdrawn position			
	b. type of Indication provided for		LED	
	breaker position			
	c. Cubicle door can be closed with breaker in service or test position	Yes/No		
4	Space Heater			
	a. Thermostat controlled space heater	Yes/No	YES	
	furnished for each cubicle?			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 7: 11 kV VACUUM SWITCHGEAR PANEL				
	b. Ratings			
	-Voltage	V, AC	230	
	-Watts			
5	Overall Mechanical dimension	mm x mm x		
	(LXWXH)	mm		
6	Approximate weight (complete			
	panel)			
	complete panel			
8	Delivery of equipment in months following award of contract (Allowing time for approval of			
	drawing)			
9	Type test certificate submitted?	Yes/No	Yes	
10	Has manufacturer exported units?	Yes/No	Yes	
11	User's certificate submitted?	Yes/No	Yes	
12	Technical literature/drawings	Yes/No	Yes	
	submitted?		Yes	

Signed _____
As representative for _____
Address _____
Date_____

8. LV POWER AND CONTROL CABLE

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 8: 1.1 KV POWER AND CONTROL CABLES				
S. N.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
1	Manufacturer's name and address			
2	Manufacturer's type & designation			
3	Applicable standards		IEC	
4	Rated Voltage (Volts)	kV	1.1	
5	Suitable for earthed or unearthed system?			
6	Continuous current rating when laid in air in an ambient temp. of 50 deg.C and for maximum conductor temp. of 70 deg.C for PVC cable			
7	Short Circuit Capacity:			
i.	Short Circuit Current	kA rms		
ii.	Duration of short circuit	s	1	
iii.	Conductor temp. allowed for the short circuit duty (Deg. C)	^{0}C		
iv	Formula relating short circuit current (rms) and duration	s		
8	**Conductor (Circular)**			
i.	Material (Copper or aluminum)			
ii.	Grade			
iii.	Normal cross section area	mm^2		
iv	Approx. Number and diameter of wire before stranding	no./mm		
9	**Insulation**			
i.	Composition of insulation			
ii.	Nominal thickness of insulation	mm		
10	**Inner Sheath**			
i.	Material			
ii.	Calculated diameter over the laid up cores	mm		
iii.	Thickness of Sheath (minimum)	mm		
11	**Armour**			
i.	Type and material of armour (wire / strip)			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 8: 1.1 KV POWER AND CONTROL CABLES				
ii.	Calculated diameter under armour	mm		
iii.	Nominal diameter of round armour wire			
iv	Nominal size of strip			
v	Short circuit capacity armour along with formulae	kA		
vi	Maximum D.C. resistance at 20 deg. C	Ω		
S. N.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
i.	Material			
ii.	Calculated diameter under sheath			
13	Safe pulling force when pulled by pulling eye on the conductor (Kg)			
14	**Test Voltage**			
i	High Voltage test voltage	kV	2	
ii	Water immersion test voltage	kV		
15	Minimum bending radius permissible			
16	Whether the cables are type tested as per IEC			

Signed _____
As representative for _____
Address _____
Date_____

9. 11 KV XLPE POWER CABLE

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 9: 11 kV XLPE Cable				
	DESCRIPTION	**UNIT**	**Requirement**	**Data to be filled**
1	Manufacturer and Country of Origin			
2	Manufacturer's type designation			
3	Type		Armored	
4	Applicable standard			
5	Voltage rating a) Suitable for max. system voltage b) voltage grade of this cable	kV	12 12	
	c) Rated voltage between each conductor and screen	kV	11/Sqt.3	
	d) Rated voltage between two conductors	kV	11	
6	Conductor material	Copper		
7	Insulating material			
	Thickness			
8	Overall jacket material			
	Thickness			
9	Overall Cross -sectional Area of the cable, Copper	Sq.mm	800/240	
	Copper	Sq.mm		
10	Type of Cable	Copper	Single Core/ 3 core	
11	Continuous Current Rating at 45 Deg. C Ambient Temperature in Duct	A		
	Copper 800 sq.mm	A		
12	Short Circuit Current rating	kA	31.5	
13	Power Frequency Withstand Voltage		As per Technical Specification	
14	Impulse withstand voltage			
15	Maximum DC resistance at 20^0 C	Ohm		
16	No of Size of conductor strands	Nos.		
17	Over all Dimension (diameter)	cm		
18	Weight of cable per km	Kg/KM		
19	Minimum Bending Radius	cm		

20	Fire Retardive	Yes	Yes	
21	Moisture Resistant	Yes	Yes	
22	Technical Leaflets provided	Yes / No	Yes	
23	Delivery of equipment in months following award of contract (Allowing time for approval of drawing)	month		

Signed _____
As representative for _____
Address _____
Date_____

10. CONTROL AND RELAY PANEL

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 10: CONTROL AND RELAY PANEL				
SN.	**Description**	**Unit**	**Requirement**	**Data to be filled**
1	Name and address of Manufacturer of panels			
2	Manufacturer's type and designation			
3	Type of construction (Simplex/duplex)			
4	Thickness of sheet steel			
	(i)Front	mm		
	(ii)Back	mm		
	(iii)Sides	mm		
5	Degree of protection			
6	Name of the manufacturer of relays			
7	DC voltage of the relays			
8	Make and Model of static (0.2 accuracy class type) energy meters			
9	Confirm whether offered manufacturer of C&R panels and protective relays have tested commissioned & they are in successful operation for at least five years in 132 kV system			
I	**INTERCONNECTING DUCT PROTECTION**			
A	**Numerical Differential protection Scheme**			
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	Second harmonic restraint provided			
4	Whether three instantaneous units provided			
5	Operating Current setting range			
6	Bias setting range			
7	Operating time at 5X setting current			
8	Resetting time			
9	How ratio / phase angle corrections are being done (inter posing transformer/internal feature in the relay)			
B	**BACKUP DIRECTIONAL OVER CURRENT AND EARTH FAULT PROTECTION SCHEME**			
1	Name and address of Manufacturer			

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)

ITEM NO. 10: CONTROL AND RELAY PANEL

SN.	Description	Unit	Requirement	Data to be filled
2	Manufacturer's type and designation			
3	Three over current and one E/F elements Are whether independent or composite unit			
4	Type of relay (Electromechanical /static/Numerical)			
5	Directional sensitivity			
6	Whether characteristic conform to IEC 255-3			
7	Over current unit setting range inverse time			
8	Earth fault unit setting range inverse time			
C	**LINE OVER VOLTAGE PROTECTION RELAY**			
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	Type of relay (Electromechanical /static/Numerical)			
4	Operation indicator provided?			
5	Operating time			
6	Resetting time			
7	Whether monitors all three phases?			
8	Built in feature of Main1/Main 2 distance relay is offered. If so, which stage is offered as built in			
D	**DISTANCE TO FAULT LOCATOR (IF APPLICABLE)**			
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	Built in feature of Main1/Main 2 distance relay is offered			
4	Maximum registering time			
5	Whether direct display unit provided?			
6	Whether both phase to phase fault and phase to earth fault measuring units included?			
7	Whether "On-Line" type			
8	Accuracy for the typical conditions defined under technical specification			
F	**DISTURBANCE RECORDER**			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 10: CONTROL AND RELAY PANEL				
SN.	**Description**	**Unit**	**Requirement**	**Data to be filled**
	a. Acquisition unit			
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	No. of analogue channels			
4	No. of digital recording channels			
7	Built in feature of Main1/Main 2 distance relay is offered			
6	Pre-fault memory (milli seconds)			
7	Post fault memory(seconds)			
8	Total storage memory in seconds			
9	Sampling frequency			
10	Resolution of event channels			
11	Time displays present?			
12	Data output in comtrade is available?			
S. N.	**Description**	**Unit**	**Requirement**	**Data to be filled**
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	No of acquisition unit that can be connected to One evaluation unit			
4	Technical Parameters of evaluation unit			
	A Processor and speed			
	C Additional facilities			
	D Details of printer			
5	Details of power supply arrangement for Acquisition unit (including printer)			
G	**AUTO RECLOSE RELAY(IF APPLICABLE)**			
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	Electromechanical /static/numerical			

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)

ITEM NO. 10: CONTROL AND RELAY PANEL

SN.	Description	Unit	Requirement	Data to be filled
4	Auto reclose relay along with Dead line charging and check synchronizing relay (For 132 KV lines) offered as a part of distance relay			
5	Suitable for single and three phase?			
6	Single phase dead time setting Range			
7	Three phase dead time setting range			
8	Reclaim time setting range			
II	**TRANSFORMER PROTECTION**	-		
A	**Differential relay**			
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	Second harmonic restraint provided			
4	Whether three instantaneous units provided			
5	Operating Current setting range			
6	Bias setting range			
7	Operating time at 5X setting current			
8	Resetting time			
9	How ratio / phase angle corrections are being done (inter posing transformer/internal feature in the relay)			
B				
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	Operating time at 2 X setting			
C				
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	Whether inverse time operating characteristics			
4	Maximum operating time			
5	Accuracy of operating time			
S. N.	**Description**	**Unit**	**Requirement**	**Data to be filled**

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 10: CONTROL AND RELAY PANEL				
SN.	**Description**	**Unit**	**Requirement**	**Data to be filled**
6	Resetting time			
D	**Directional O/C and E/F relays**			
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	Whether Characteristic will confirm to IEC255-3			
4	Directional sensitivity			
5	Over current unit setting range			
	a) High time			
	b) High set			
6	Earth fault unit setting range			
	a) Inverse time			
	b) High set			
	GENERAL PROTECTION /MONITORING EQUIPMENT			
	Trip Circuit Supervision relay			
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	Whether pre-closing and post-closing supervision provided?			
4	Time delay			
	High Speed Trip Relays			
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	Contact ratings			
	a) Make and carry continuously			
	b) Make and carry for 0.5 sec.			
	c) Break			
	i). Resistive load			
	ii) Inductive load (With L/R=40milli sec.)			
4	Operating time at rated voltage(maximum)			

TECHNICAL DATA SHEET
(TO BE COMPLETED BY BIDDER)

ITEM NO. 10: CONTROL AND RELAY PANEL

SN.	Description	Unit	Requirement	Data to be filled
5	Resetting time			
6	Whether supervisory relays included			
E	**Local breaker back-up protection**			
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	Operating time			
4	Resetting time			
5	Setting ranges			
	a) Current			
	b) Time			
III	**Bus bar Protection**			
1	Name and address of Manufacturer			
2	Manufacturer's type and designation			
3	Type of relay (Electromechanical /static/Numerical)			
S. N.	**Description**	**Unit**	**Requirement**	**Data to be filled**
4	Principle of operation (Biased/High impedance)			
5	Operating time			
6	Resetting time			
7	Setting ranges			
	i)Current			
	ii)Time			
8	Whether will it cause tripping for the differential current below the load current of heavily loaded feeder (Bidder shall submit application check for the same)			

Note: Bidders shall provide the additional details of the offered equipment in line with Technical Specifications

Signed _____
As representative for _____
Address _____
Date_____

11. SUBSTATION AUTOMATION SYSTEM (SAS)

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM 11: SUBSTATION AUTOMATION SYSTEM				
SN.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
1	**Name of Manufacturer**			
	Type of unit Mounting			
	Manufacturer's type designation			
	Standards Applicable			
	Rated Auxiliary Voltage	V		
	No. of analogue variable (Specify Voltage & Current Separately)			
	Rated frequency	Hz		
	No. of binary inputs			
	No. of output			
	Language			
	Type of communication protocol supported by unit			
	No. & Type of communication ports			
	Operating temperature range			
	System response time			
	Exchange of display			
	Presentation of Binary Change			
	Presentation of Analogue Change			
	Order to process output			
	Order to update display			
	Report Generation			
2	**ETHERNET SWITCH**			
	Name & Address of the Manufacturer			
	Model			
	Type of switches			
	Mounting arrangement			
	Power consumtion			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM 11: SUBSTATION AUTOMATION SYSTEM				
	Protocol Supported			
3	**SERVER 1&2 (**As Applicable**)**			
	Make			
	Type/ Model			
	Construction			
	Operating system			
	Processor (Type /Make)			
	Processor speed			
	FSB			
	Chipsel			
	Memory capacity (RAM)			
	Hard disk			
	Ethernet Port			
	Power supply			
S. N.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
9	FIBRE OPTIC PATCH CABLE (As Applicable)			
	Name and address of the Manufacturer			
	Wavelength			
	Unarmoured/ Armoured type			
	Type of conectors used			
	Type of cable			
	Proper identification			
	Core diameter			
	Attenuation at 850 nm			
	Numerical aperture			
	No of cores per cable			
	Type of Material			
10	Armoured fibre optic cable (As Applicable)			
	Name and Address of Manufacturer			

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM 11: SUBSTATION AUTOMATION SYSTEM				
	Wavelength			
	Type of connectors used			
	Type of cable			
	Core diameter			
	Attenuation at 850nm			
	Numerical aperture			
	No. of cores per cable			
	No. of Spare cores			
	Type of Material			
11	**Substation Automation System Software (**As Applicable**)**			
	Make			
	Type			
12	**Substation Automation System erection & commissioning Agency**			
	Name and Address			
	Type of future Service in Nepal			

Note: Bidders shall provide the additional details of the offered equipment in line with Technical Specifications

Signed _____
As representative for _____
Address _____
Date_____

12. LIGHTING SYSTEM

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM 12: LIGHTING SYSTEM				
S. N.	**Parameters**	**Unit**	**Requirement**	**Data to be filled**
A.	**LIGHTING FIXTURES & ACCESSORIES**			
1.0	Manufacturer's Name & address			
	a) Fixtures b) Accessories			
2.0	Applicable Standards for			
	a) Fixtures b) Accessories			
4.0.	Maximum permissible supply voltage variation for satisfactory operation of			
	a) Fixtures			
	b) Accessories			
B.	**CONDUIT & ACCESSORIES (FOR EACH TYPE & SIZE)**			
1.0	Manufacture's Name & address			
2.0	Manufacturer's type, designation			
3.0	Applicable standard			
C.	**JUNCTION BOXES (FOR EACH TYPE & SIZE)**			
1.0	Manufacture's Name & address			
2.0	Manufacturer's type, designation			
3.0	Type of enclosure			
D.	**LIGHTING PANELS (FOR EACH TYPE & SIZE)**			
1.0	Manufacture's Name & address			
2.0	Type			
3.0	Degree of Protection			
E	**LIGHTING POLES**			
1.0	Manufacture's Name & address			
2.0	Type			
3.0	Dimension			
F	**LIGHTING WIRES**			
1.0	Manufacture's Name & address			

2.0	Voltage Grade			
3.0	Cross section of conductor			
4.0	Insulation Thickness			

Signed _____
As representative for _____
Address _____
Date_____

13. AIR CONDITIONING SYSTEM

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM 13: AIR CONDITIONING				
SN	**Description**	**Unit**	Requirement	Data to be filled
1	Manufacturer's Name & Model			
2	Star Rating			
3	Compressor Cooling capacity			
4	Rated current -cooling			
5	Rated Power input- cooling			
6	Rated EER			
7	Power Supply			
8	Air Flow Volume- Indoor			
9	Noise level - Indoor			
10	Operation			
11	Compressor type a) Compressor make b) Compressor sealed			
12	Refrigerant			
13	Indoor unit Dimension (WxHxD)			
14	Indoor unit Net/Gross weight			
15	Outdoor unit Dimension (WxHxD)			
16	Outdoor unit Net/Gross weight			
17	Connecting Pipe with Cable			
18	Length			
19	Connecting Box Dimension (WxHxD)			
20	No of Boxes			
	a) ODU			
	b)Connecting pipe			
	c)IDU			
21	Features			
	a)Filters			
	b)Coil			

	c)Copper tubes			
	d)IDU			
	e)Remote			

Signed _____
As representative for _____
Address _____
Date_____

14. UPS SYSTEM

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM 14: UPS SYSTEM				
SN	**Description**	**Unit**	**Requirement**	**Data to be filled**
1	Power (kVA)	kVA	10	
2	Power (kW)			
3	Input Voltage			
4	Input Voltage Range			
5	Input Frequency	Hz	50	
6	Input Frequency Range			
7	Input Power Factor	pf	0.85	
8	Output Power Factor			
10	Output Voltage			
11	Output Voltage Regulation			
12	Output Frequency			
13	Voltage Wave			
14	Total Harmonics Distortion	%	<3	
15	Cold Start			
16	Total Efficiency			
17	Crest Factor			
18	Transfer Time			
19	**MIMIC & Control Panel**			
19.1	Type			
19.2	LCD Display			
19.3	LED Display			
20	**Protection**			
20.1	Over Load Capacity			
20.2	Short Circuit			
20.3	Over Heat			
20.4	Battery Low Level			
21	**Alarms**			

21.1	Visual and Auditory			
22	**Computer Interface**			
22.1	Management			
22.2	Dry Contact Information			
22.3	HTTP / SNMP Harmony			
23	**General**			
23.1	Noise Level			
23.2	Operation Temperature / Humidity			
23.3	Cooliing			
23.4	Dimension WxHxD (mm)			
23.5	Weight			

Signed _____
As representative for _____
Address _____
Date_____

15. 132 KV CABLE

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM 15: 132 kV XLPE				
SN	**Description**	**Unit**	**Requirement**	**Data to be filled**
1	Description of Cable			
2	Highest system voltage	kV	145	
3	Voltage Grade	kV	132	
4	Voltage variation			
5	Frequency	Hz	50	
6	Frequency variation			
7	Power frequency withstand voltage	kV	As per Technical Specification	
8	Lightning impulse withstand voltage	kV	As per Technical Specification	
10	No of phase per Ckt	Nos	3	
11	Earthing system		Solidly Earthed	
12	Size of Cable	mm^2	400	
13	Max. in Conductor Temp.			
14	Fault level	kA	40	
15	Maximum permissible short ckt temperature.			
16	CABLE DETAILS: CONDUCTORS			
16.1	Conductor material		Copper	
16.2	Conductor Shape			
16.3	Conductor Screen			
16.4	Resistivity of the semiconducting screen			
16.5	Insulation			
	a) material			
	b) specified insulation resistance at 90^0C			
16.6	Insulation Screen: Type & Material			
16.7	Resistivity of the semiconducting compound			
16.8	Longitudinal water barrier Material			
16.9	Radial moisture barrier Material			

16.10	Overall sheath			
16.11	Coating of outer sheath			
17.	Approximate Length of cable in a drum			
18	Bending Radius			
19	TESTS Applicable standards			
19.1	Type Test a) whether previous test reports will be sufficient b) whether sample to be Type tested against this order.			
19.2	Routine Test			
19.3	Acceptance Test			
19.4	Whether test will be witnessed by purchaser or his representative			
20	Installation, termination and joints			
21	Ambient temperature Ground temperature Thermal resistivity of soil			
22	Laying Configuration			
23	Depth			
24	Termination			
25	Type			
26	Joints Required			
27	Earth Link Boxes Required			
28	Surge Suppressor Required			
29	Bonding Type			

Signed _____

As representative for _____

Address _____

Date_____

TECHNICAL DATA SHEET (TO BE COMPLETED BY BIDDER) ITEM NO. 16: 145 kV OUTDOOR CAPACITIVE VOLTAGE TRANSFORMER				
	DESCRIPTION	**UNIT**	**Requirement**	**Data to be filled**
1	Manufacturer and Country of Origin			
2	Year of manufacturing experience	Years		
3	Manufacturing's Designation as per submitted catalogue			
4	Applicable standard			
5	Type			
6	Rated Primary Voltage	kV	132	
7	Rated Secondary Voltage	kV	0.110	
8	Number of Secondary's	No	2	
9	Rated Frequency	Hz	50	
10	Rated output of each secondary winding (VA)	VA	As per technical Specification	
11	Rated Total Thermal Burden	VA	As per technical Specification	
12	Highest System Voltage	kV	145	
13	Rated voltage factor and corresponding rated time			
14	Accuracy class of each secondary winding			
15	Capacitance			
i)	of high voltage capacitance	pF		
ii)	of intermediate voltage capacitor	pF		
15	Carrier frequency coupling	pF		
16	Natural frequency of coupling	kHz		
17	Self-tuning frequency of CVT	kHz		
18	One minute power frequency test voltage of secondary winding	kV rms		
19	One minute power frequency test voltage of H.F terminal	kV rms		
20	One minute power frequency test voltage of capacitor (dry and Wet)	kV rms		
21	1.2/20 micro sec impulse withstand test voltage of capacitor	kVp		
22	Corona extinction voltage	kV rms		

Signed _____

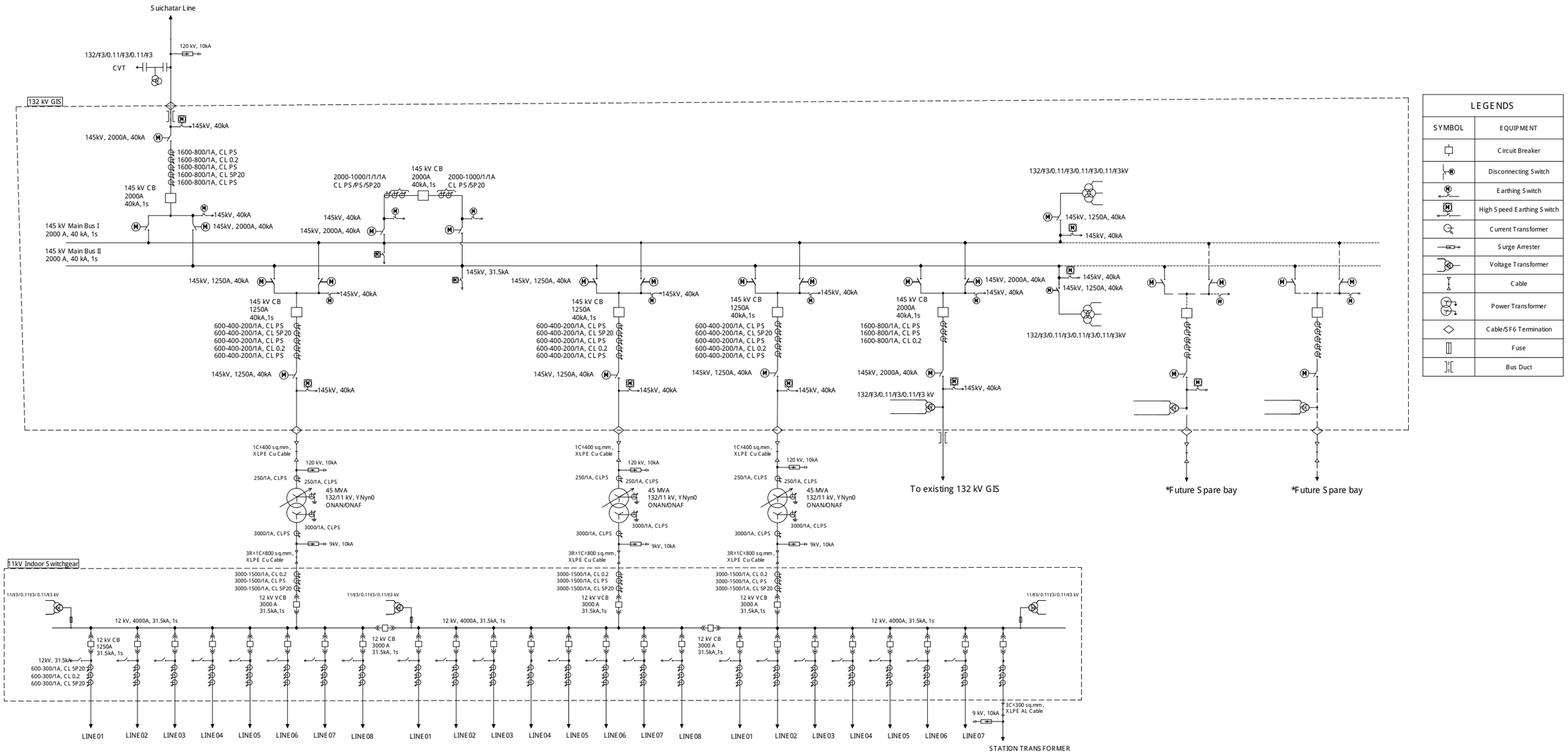
As representative for _____

Address _____

Date_____

CHAPTER 22

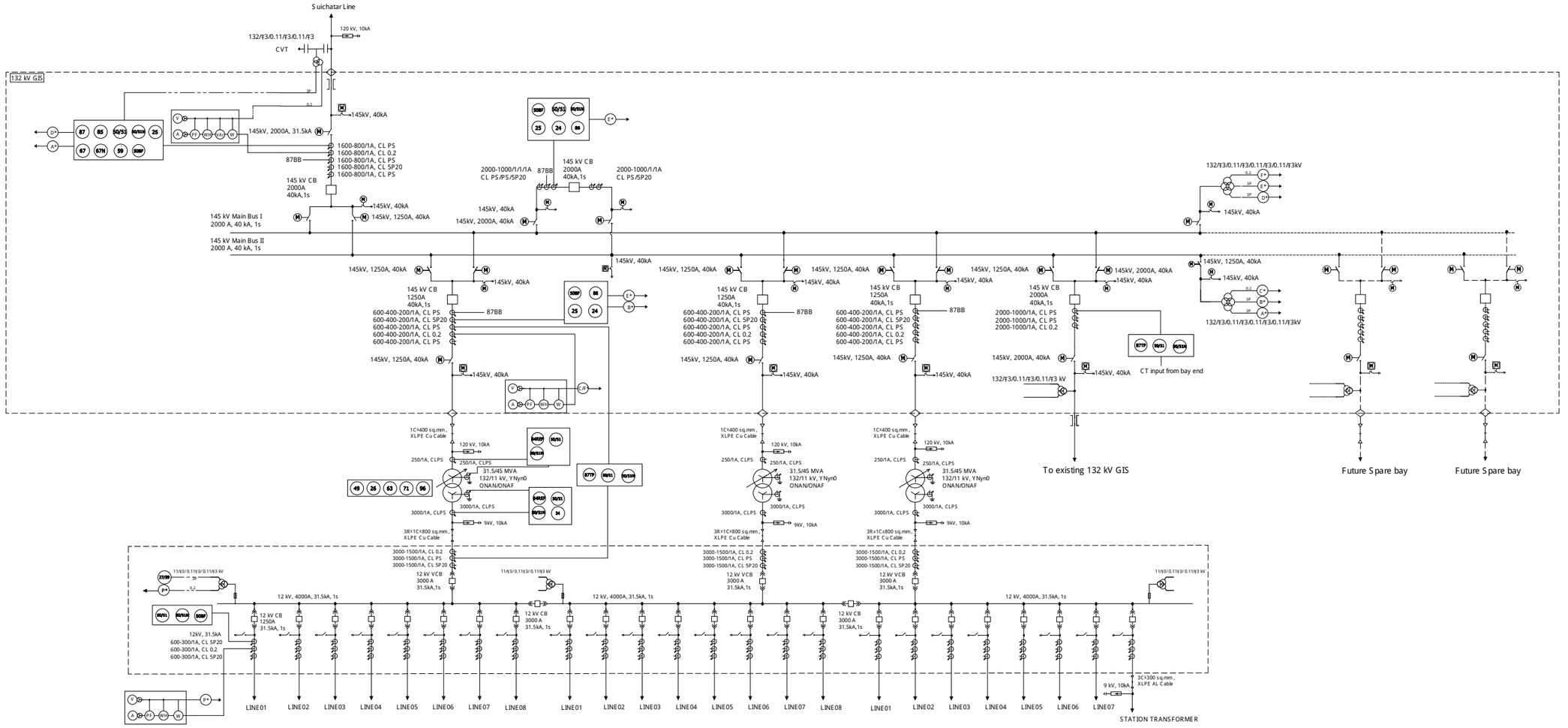
DRAWINGS



LEGENDS	
SYMBOL	EQUIPMENT
	Circuit Breaker
	Disconnecting Switch
	Earthing Switch
	High Speed Earthing Switch
	Current Transformer
	Surge Arrester
	Voltage Transformer
	Cable
	Power Transformer
	Cable/SF6 Termination
	Fuse
	Bus Duct

NOTE:
*-This is for future extension and not in present scope.Bus Bar length shall be of sufficient length to accommodate these bays in future with all complete arrangement.

CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT NEW BANESHWOR,KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT BALAJU SUBSTATION UPGRADATION PROJECT		DRAWN ST	DESIGNED ST
				DRAFTING CHECK ST	DESIGN CHECK ST
		ORIGINAL SIZE A3	REPORT STATUS	APPROVED ST	DRAWING NO. DWG-EE-01
		CONTRACT NUMBER:	REV 00	TITLE ELECTRICAL SINGLE LINE DIAGRAM	



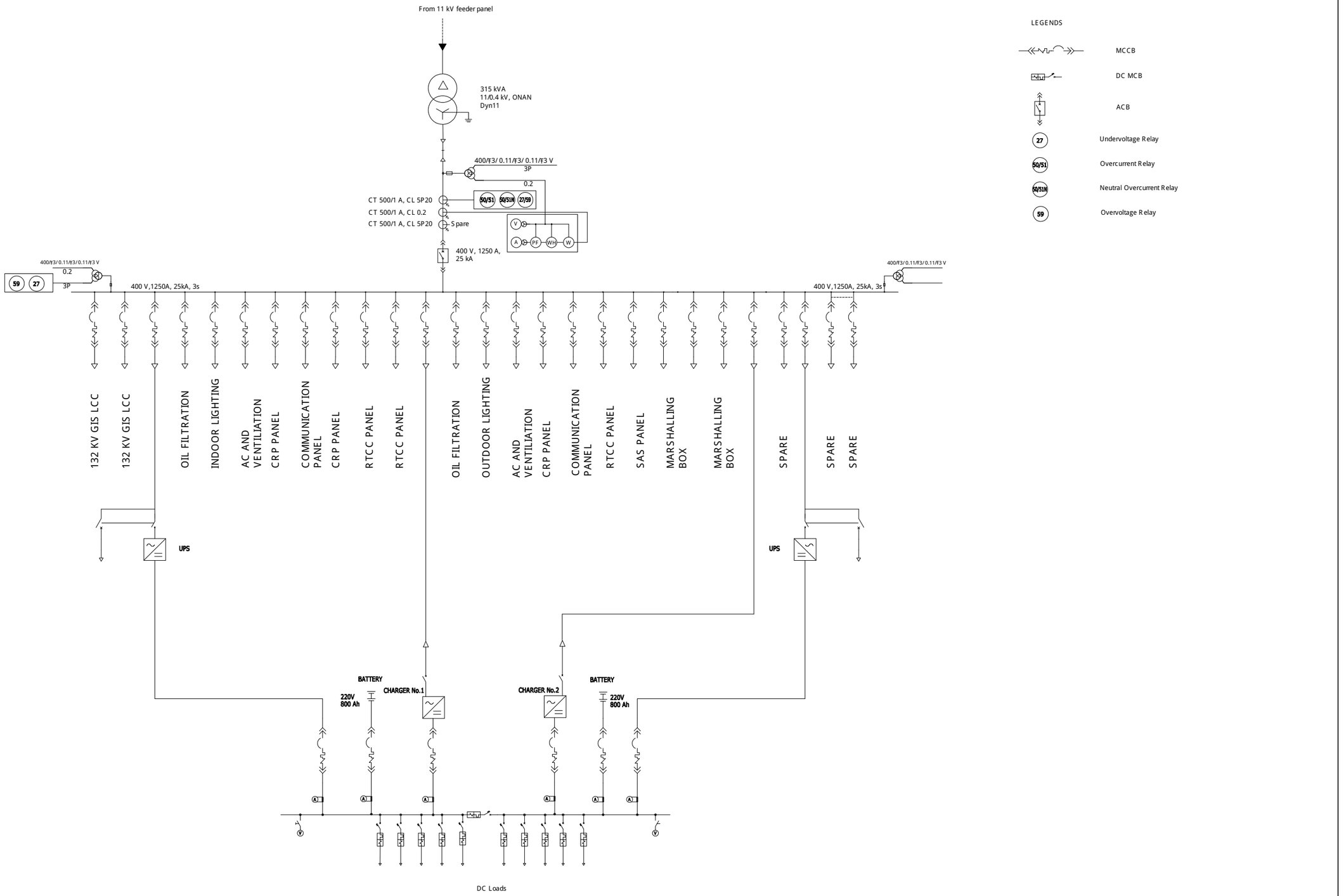
NOTES:
1. THIS DRAWING SHOWS TYPICAL PROTECTION OF 132 kV kV LINE AND TRANSFORMER.
2. ONLY THE MOST COMMON RELAY FUNCTIONS ARE SHOWN

LEGENDS	
SYMBOL	EQUIPMENT
	Circuit Breaker
	Disconnecting Switch
	Earthing Switch
	High Speed Earthing Switch
	Current Transformer
	Surge Arrester
	Voltage Transformer
	Cable
	Power Transformer
	Cable/SF6 Termination
	Fuse
	Bus Duct

RELAY SYMBOLS AND ABBREVIATION

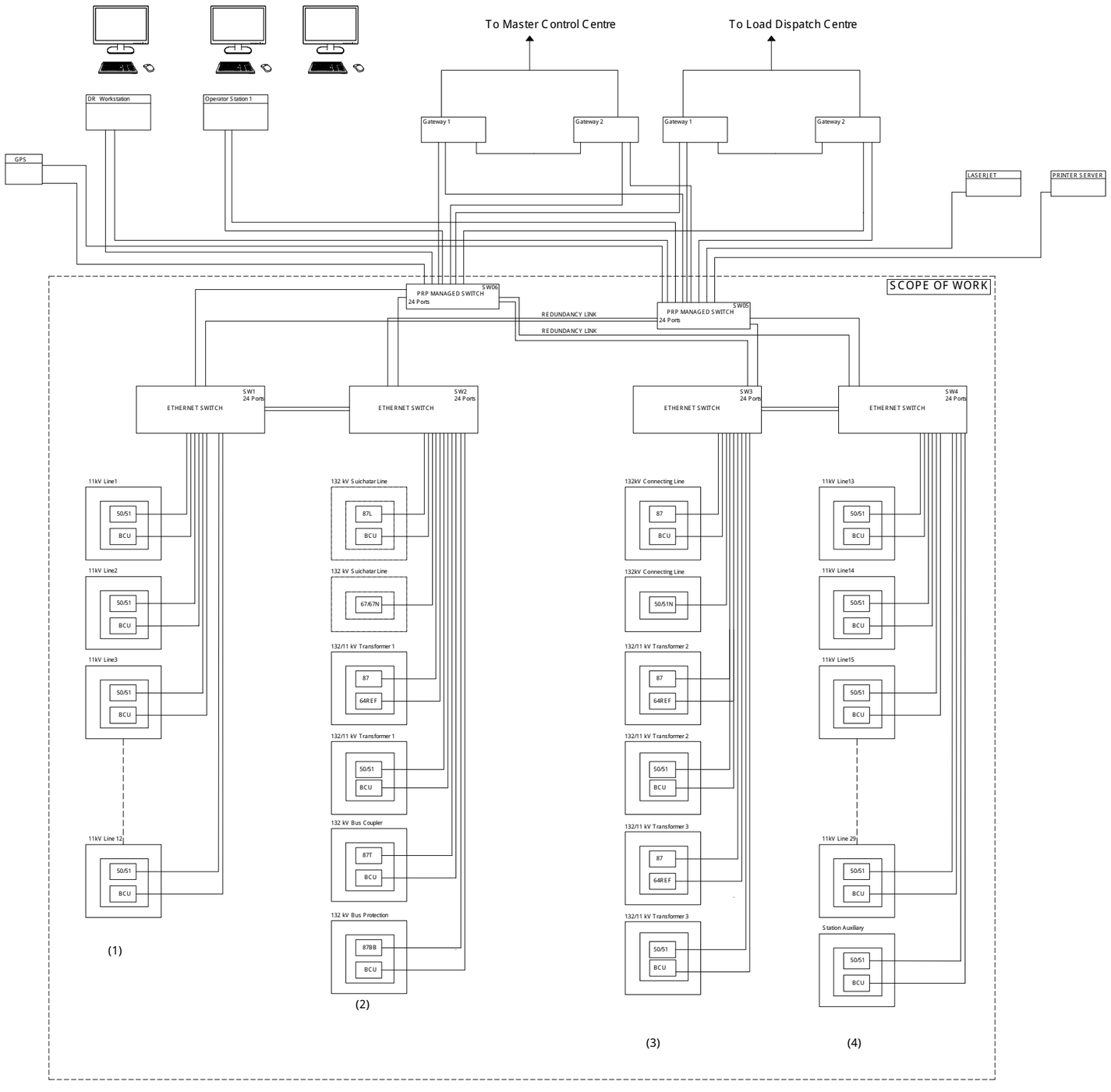
BB	BUSBAR
24	OVERFLUX RELAY
25	SYNCHRO CHECK RELAY
26	APPARATUS THERMAL DEVICE
49	THERMAL RELAY
63	SUDDEN PRESSURE RELAY
71	LIQUID LEVEL SWITCH
59	OVERVOLTAGE RELAY
79	AUTORECLOSING RELAY
85	CARRIER RECEIVER RELAY
21	LINE DISTANCE RELAY
87T	TRANSFORMER DIFFERENTIAL RELAY
50BF	BREAKER FAILURE RELAY
86	LOCKOUT RELAY
96	BUCHHOLZ RELAY
50/51	OVERCURRENT RELAY
50/51N	NEUTRAL TIME OVERCURRENT RELAY
24	OVERFLUXING PROTECTION RELAY
64REF	RESTRICTED EARTH FAULT RELAY

CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT NEW BANESHWOR,KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT BALAJU SUBSTATION UPGRADATION PROJECT	DRAWN ST	DESIGNED ST	TITLE ELECTRICAL PROTECTION DIAGRAM
		ORIGINAL SIZE A3	REPORT STATUS	DRAFTING CHECK ST	DESIGN CHECK ST	
		CONTRACT NUMBER:	REV 00	APPROVED ST	DRAWING NO. DWG-EE-02	



CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT NEW BANESHWOR,KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT BALAJU SUBSTATION UPGRADATION PROJECT		DRAWN ST	DESIGNED ST	TITLE LOW VOLTAGE AC/DC DIAGRAM
				DRAFTING CHECK ST	DESIGN CHECK ST	
		ORIGINAL SIZE A3	REPORT STATUS	APPROVED ST	DRAWING NO. DWG-EE-03	
		CONTRACT NUMBER:	REV 00			

132 kV SAS ARCHITECTURE



NOTES:

1. Typical connection are shown.
2. The upgraded substation shall be integrated to existing SAS system of Balaju Substation.
3. The upgraded substation shall be integrated to Master Control Centre at Baneshwor, Kathmandu .
4. The upgraded substation shall be integrated to Load Disptach Centre at Suichatar, Kathamandu.

LEGENDS:

DR Disturbance Recorder
SW Switch

CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT NEW BANESHWOR,KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT BALAJU SUBSTATION UPGRADATION PROJECT		DRAWN ST	DESIGNED ST
		ORIGINAL SIZE A3	REPORT STATUS	DRAFTING CHECK ST	DESIGN CHECK ST
		CONTRACT NUMBER:	REV 00	APPROVED ST	DRAWING NO. DWG-EE-04

TITLE
SUBSTATION AUTOMATION SYSTEM
SYSTEM ARCHITECTURE DRAWING

PRESENT SCOPE OF WORKS

Suichatar LIne

2000 A three- phase
SF6 bus duct

132 kV GIS (New)

145 kV CB
2000A
40kA,1s

145 kV Main Bus I
2000 A, 40 kA, 1s

145 kV Main Bus II
2000 A, 40 kA, 1s

145 kV CB
1250A
40kA,1s

145 kV CB
1250A
40kA,1s

145 kV CB
1250A
40kA,1s

145 kV CB
2000A
40kA,1s

45 MVA
132/11 kV, YNyn0
ONAN/ONAF

45 MVA
132/11 kV, YNyn0
ONAN/ONAF

45 MVA
132/11 kV, YNyn0
ONAN/ONAF

2000 A three- phase
SF6 bus duct

145kV, 2000A, 40kA

132 kV GIS (Existing GIS)

145 kV Bus
2000 A, 31.5 kA, 1s

145 kV CB
1250A
31.5kA,1s

145 kV CB
1250A
31.5kA,1s

145 kV CB
1250A
31.5kA,1s

145 kV CB
1250A
31.5kA,1s

Suichatar Line
(To be connected in new 132GIS)

Chapali Line1

Chapali Line2

15 X 3 MVA
132/66 kV, YNyn0
ONAN/ONAF

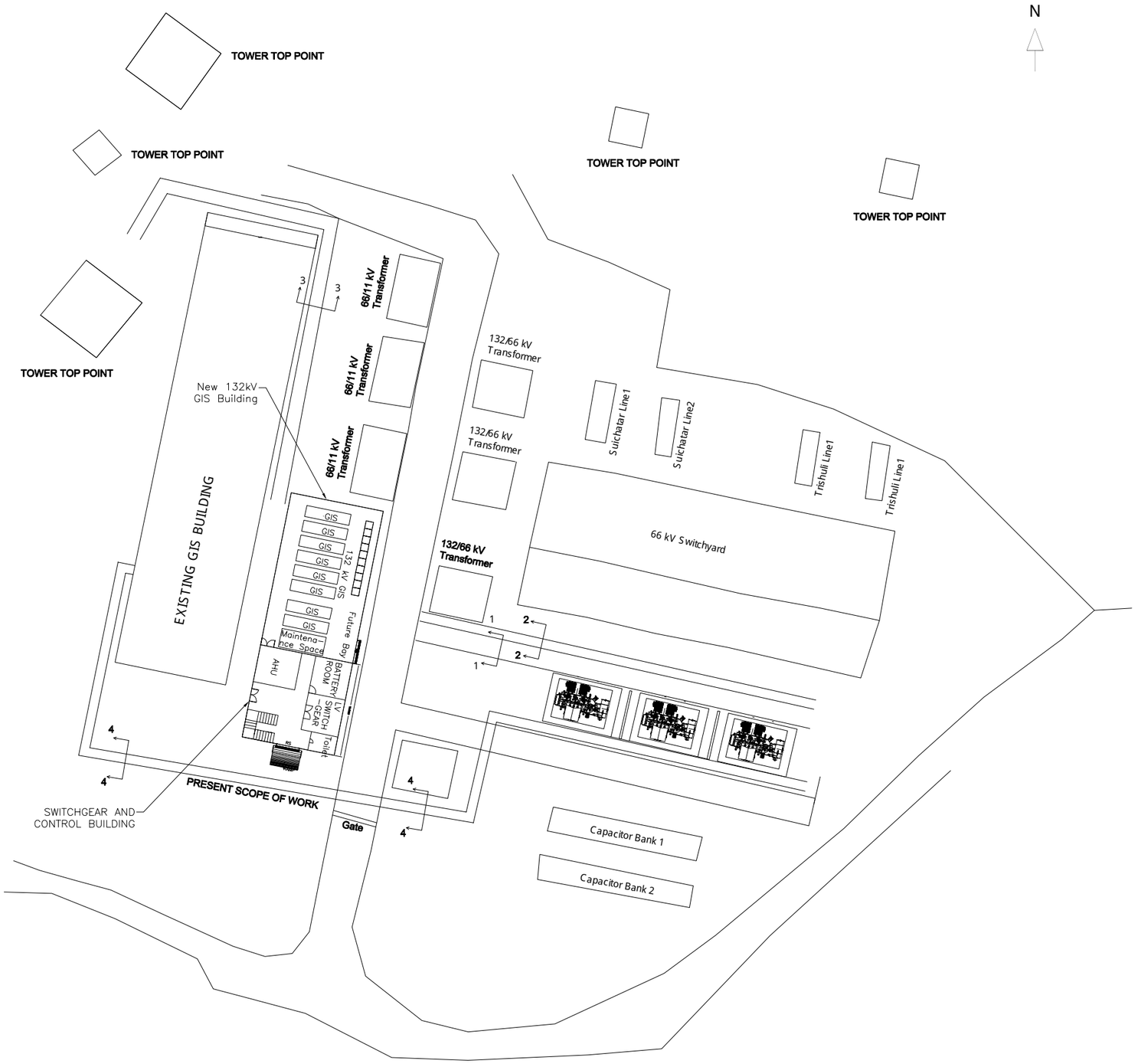
Note:
1.CT ratio of both CT
of interconnecting bay is same.

CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT NEW BANESHWOR,KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT BALAJU SUBSTATION UPGRADATION PROJECT		DRAWN ST	DESIGNED ST
				DRAFTING CHECK ST	DESIGN CHECK ST
		ORIGINAL SIZE A3	REPORT STATUS	APPROVED ST	DRAWING NO. DWG-EE-05
		CONTRACT NUMBER:	REV 00		

TITLE
CONNECTION TO EXISTING GIS

CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT NEW BANESHWOR,KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT BALAJU SUBSTATION UPGRADATION PROJECT		DRAWN ST	DESIGNED ST
				DRAFTING CHECK ST	DESIGN CHECK ST
		ORIGINAL SIZE A3	REPORT STATUS	APPROVED ST	DRAWING NO. DWG-EE-07
		CONTRACT NUMBER:	REV 00		

TITLE
LAYOUT OF SUBSTATION

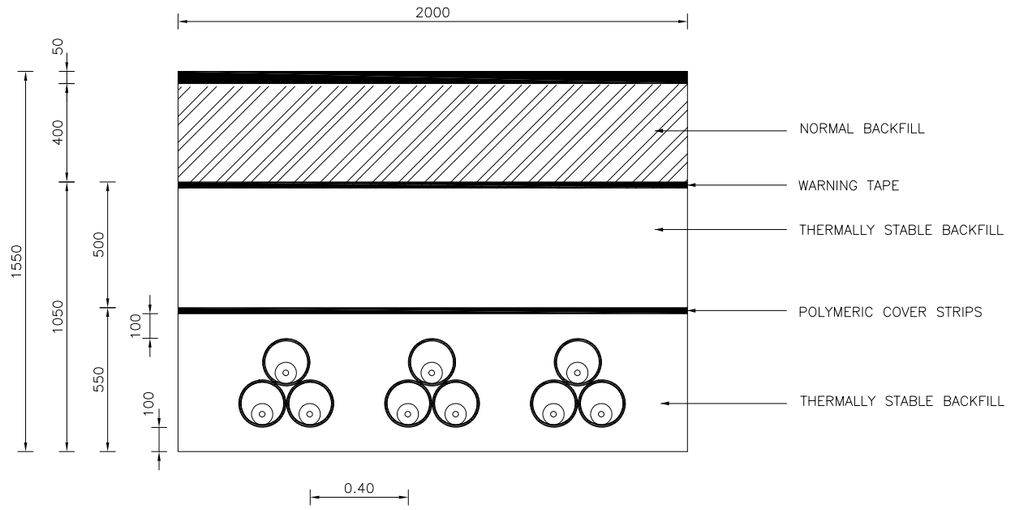


CABLE TRENCH LAYOUT

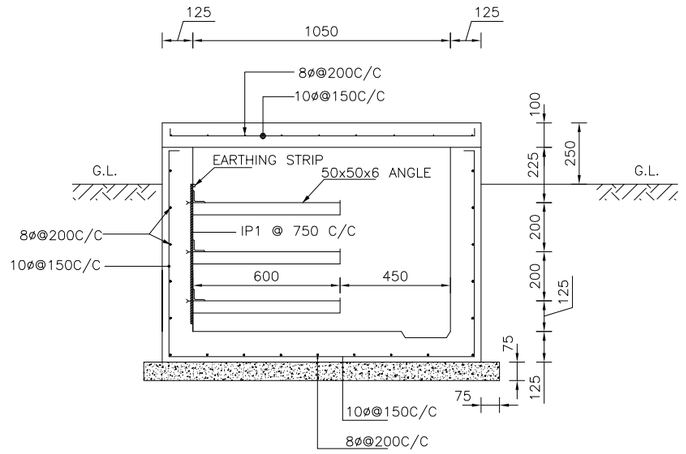
0 2500 5000 1000 1500 2000

SCALE 1:500

CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT BANESHWOR, KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT DETAIL ENGINEERING DESIGN OF BALAJU SUBSTATION UPGRADATION PROJECT SANKHUWASABHA, NEPAL	DRAWN NKC	DESIGNED NKC	TITLE BALAJU SUBSTAION UPGRADATION PROJECT UNDERGROUND CABLING TYPES CONNECTION PIT PLAN AND SECTIONS SHEET (1/2)
		ORIGINAL SIZE A3 / REPORT STATUS	DRAFTING CHECK GBT	DESIGN CHECK	
		REV 0	APPROVED	DRAWING NO. DWG-CT-1	



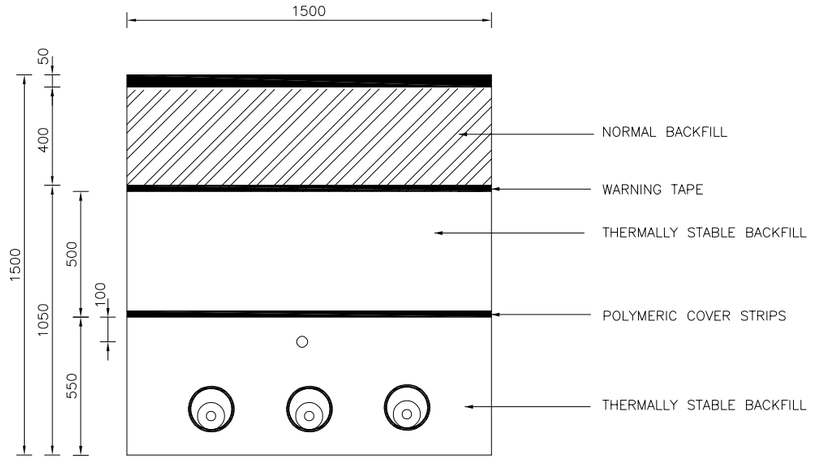
SECTION 1-1



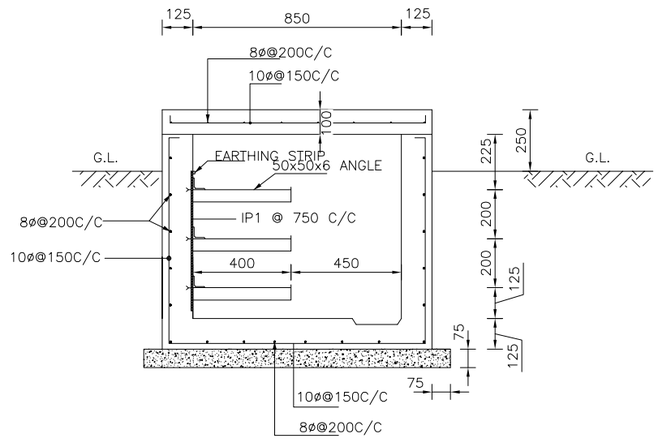
SECTION 2-2

NOTES:

1) ALL DIMENSIONS ARE IN MILLI-METERS UNLESS OTHERWISE SPECIFIED.



SECTION 3-3

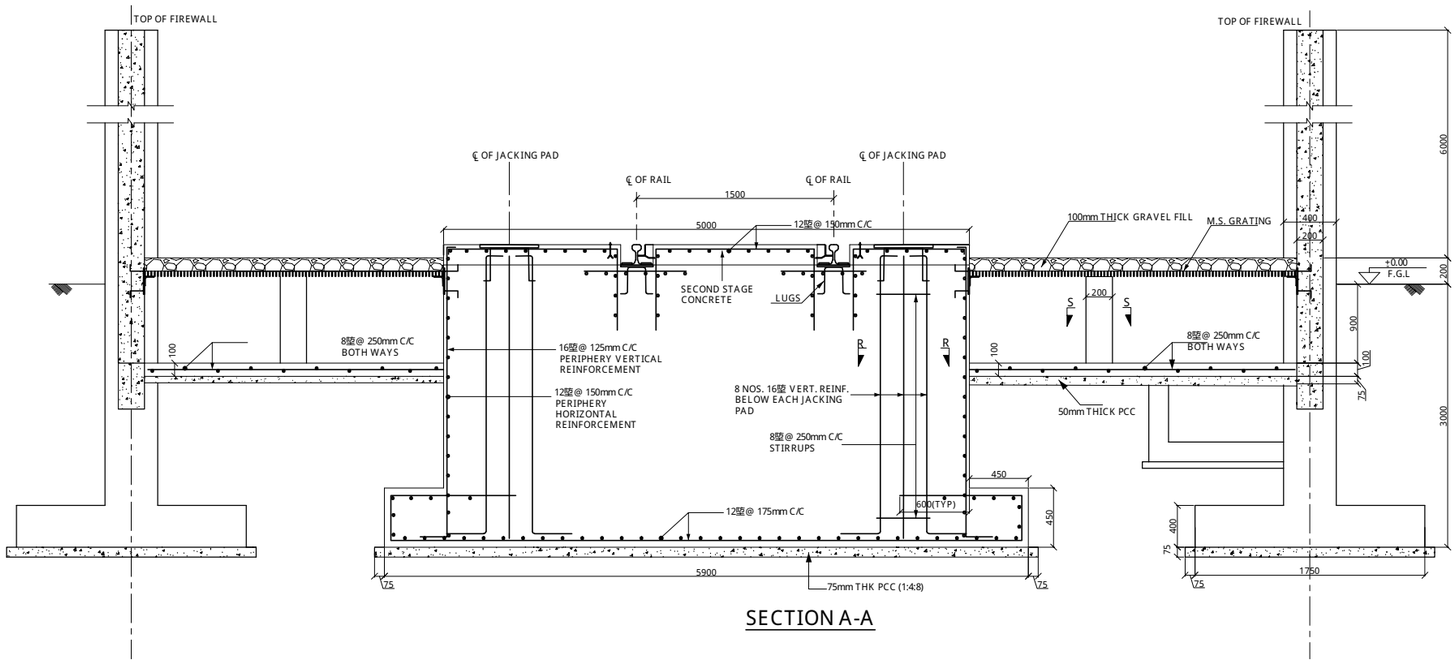


SECTION 4-4

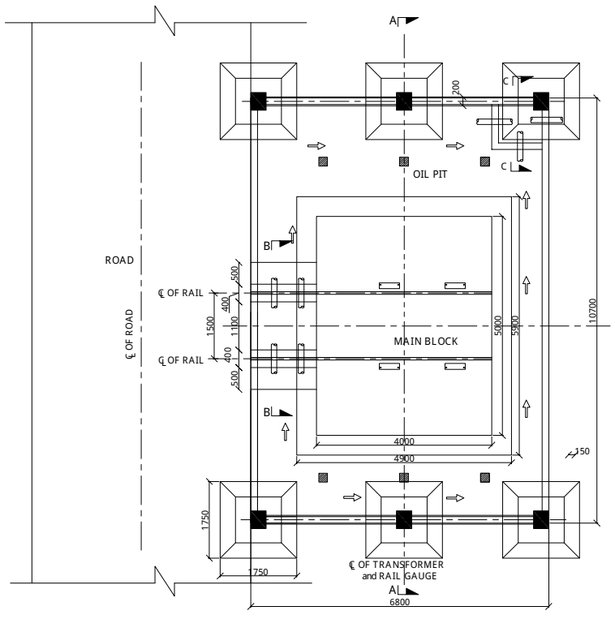
0 125 250 500 750 1000

SCALE 1:25

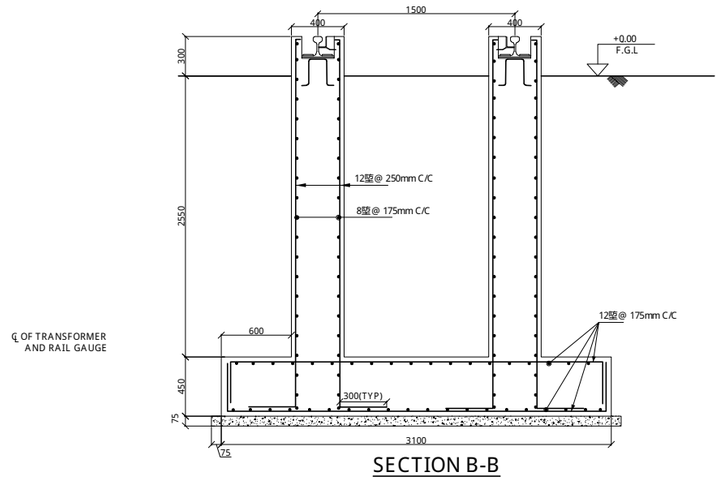
CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT BANESHWOR, KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT DETAIL ENGINEERING DESIGN OF BALAJU SUBSTATION UPGRADATION PROJECT SANKHUWASABHA, NEPAL ORIGINAL SIZE A3 / REPORT STATUS REV 0	DRAWN NKC DRAFTING CHECK GBT APPROVED	DESIGNED NKC DESIGN CHECK DRAWING NO. DWG-CV-4	TITLE BALAJU SUBSTAION UPGRADATION PROJECT UNDERGROUND CABLING TYPES CONNECTION PIT SECTIONS SHEET (2/2)



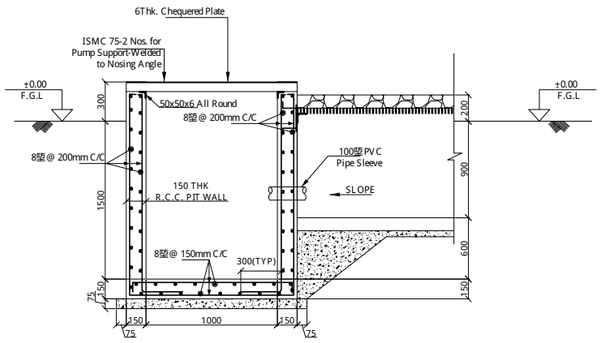
SECTION A-A



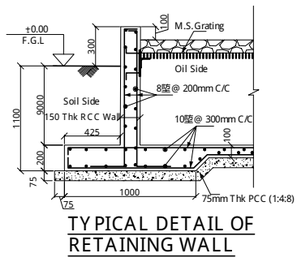
FOUNDATION PLAN



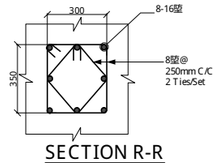
SECTION B-B



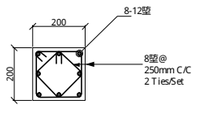
SECTION C-C



TYPICAL DETAIL OF RETAINING WALL



SECTION R-R

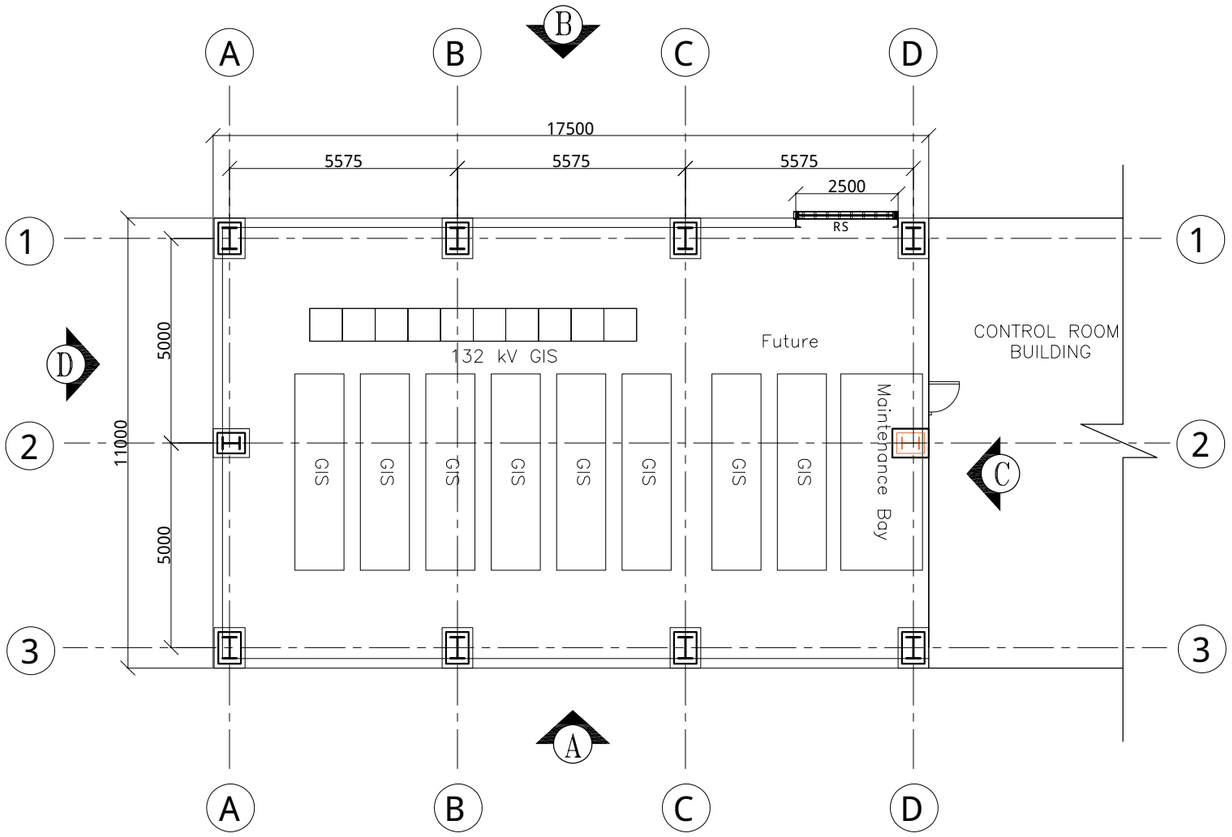


SECTION S-S

NOTES:-

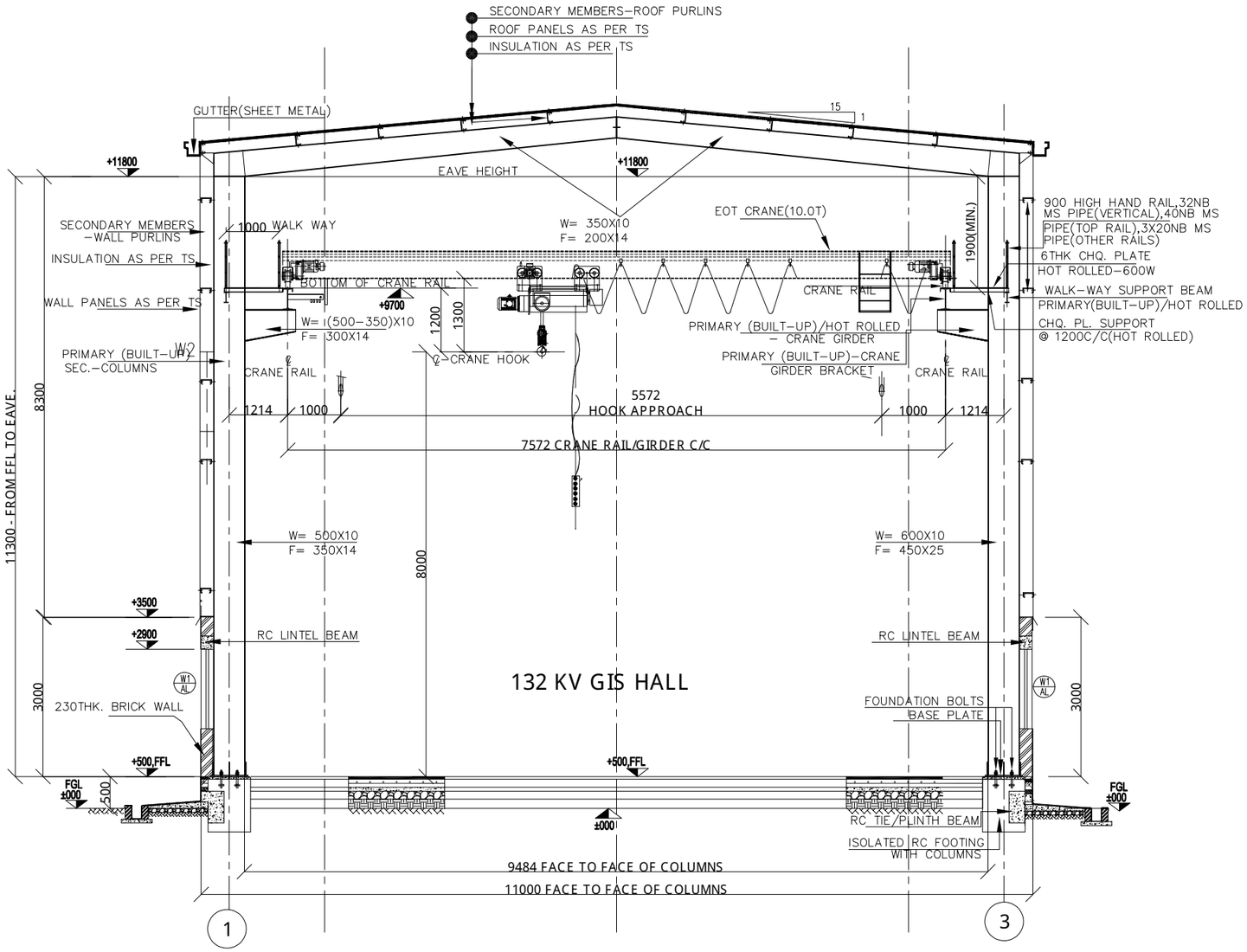
1. PL (PLINTH LEVEL) SHALL BE AT 300mm ABOVE FGL.
2. FGL DENOTES FINISHED GRADE LEVEL (BOTTOM OF GRAVEL)
3. R.C.C GRADE SHALL BE M25 CONFORMING TO IS:456.
4. LEAN CONCRETE MIX SHALL BE 1:3:6.
5. CLEAR COVER OF REINFORCEMENT SHALL BE AS BELOW,
   a) BOTTOM PAD - 50mm
   b) COLUMN - 50mm AT SIDES, 25mm AT TOP.
   c) WALL - 40mm AT SIDES, 25mm AT TOP.
6. LAP ANCHOR LENGTH FOR COLUMN VERTICAL REINFORCEMENT SHALL BE OF 50 TIMES THE DIAMETER OF THE BAR FROM THE PAD-COLUMN JUNCTION.
7. REINFORCEMENT USED SHALL BE HYSD BARS CONFORMING TO IS:1786-1987 (Fe-500)
8. FOUNDATION BOLTS SHALL BE PLACED IN POSITION DURING CONCRETING.
9. THE SOIL AROUND FOUNDATION SHALL BE WELL COMPACTED.
10. ALLOWABLE SAFE BEARING CAPACITY OF SOIL = 13 T/SQ.M AT FOUNDING LEVEL.
11. DO NOT SCALE DRAWINGS.

CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT BANESHWOR, KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT DETAIL ENGINEERING DESIGN OF BALAJU SUBSTATION UPGRADATION PROJECT SANKHUWASABHA, NEPAL		DRAWN NKC	DESIGNED NKC	TITLE BALAJU SUBSTAION UPGRADATION PROJECT 45MVA TRANSFORMER FOUNDATION TRANSFORMER FOUNDATION DETAILS SHEET (1/1)
		ORIGINAL SIZE A3	REPORT STATUS	DRAFTING CHECK GBT	DESIGN CHECK	
			REV 0	APPROVED	DRAWING NO. DWG-CIV-1	

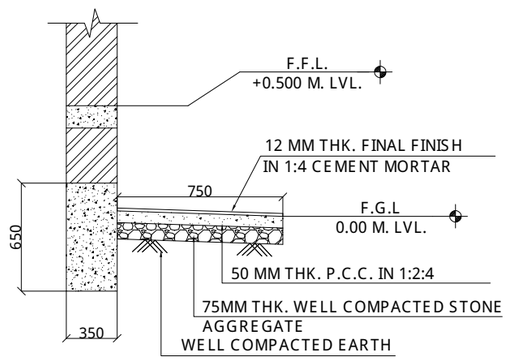


132KV GIS HALL - PEB BUILDING

CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT BANESHWOR, KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT DETAIL ENGINEERING DESIGN OF BALAJU SUBSTATION UPGRADATION PROJECT SANKHUWASABHA, NEPAL	DRAWN PRS	DESIGNED PRS	TITLE BALAJU SUBSTAION UPGRADATION PROJECT 132kV GIS BUILDING ARCHITECTURAL PLAN SHEET (1/4)
		ORIGINAL SIZE A3 / REPORT STATUS	DRAFTING CHECK GBT	DESIGN CHECK	
		REV 0	APPROVED	DRAWING NO. DWG-CIV-2	

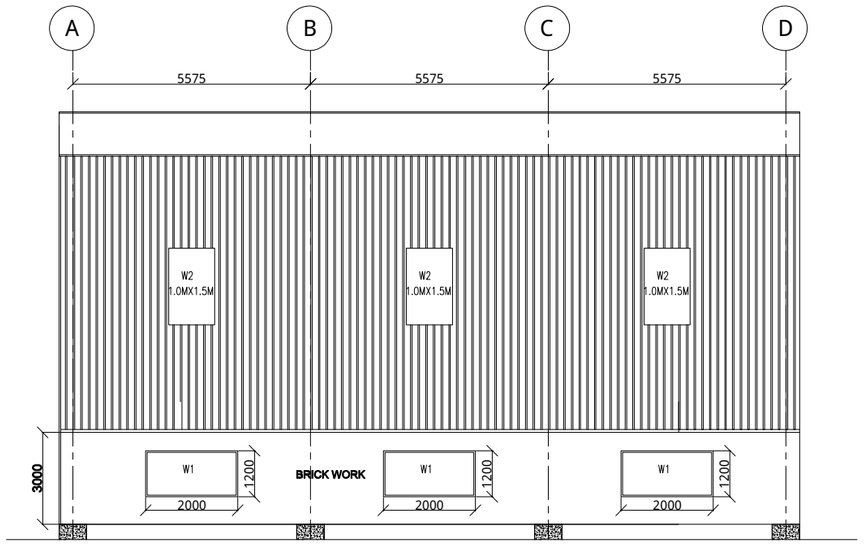


TYP. SECTIONAL DETAILS

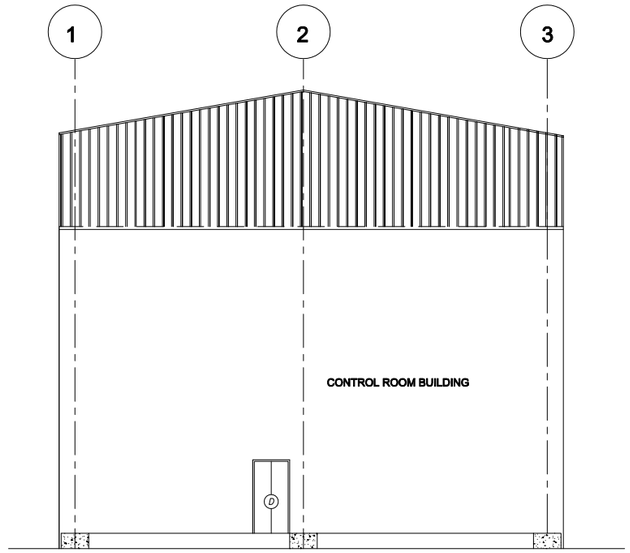


TYP. PLINTH PROTECTION DETAIL

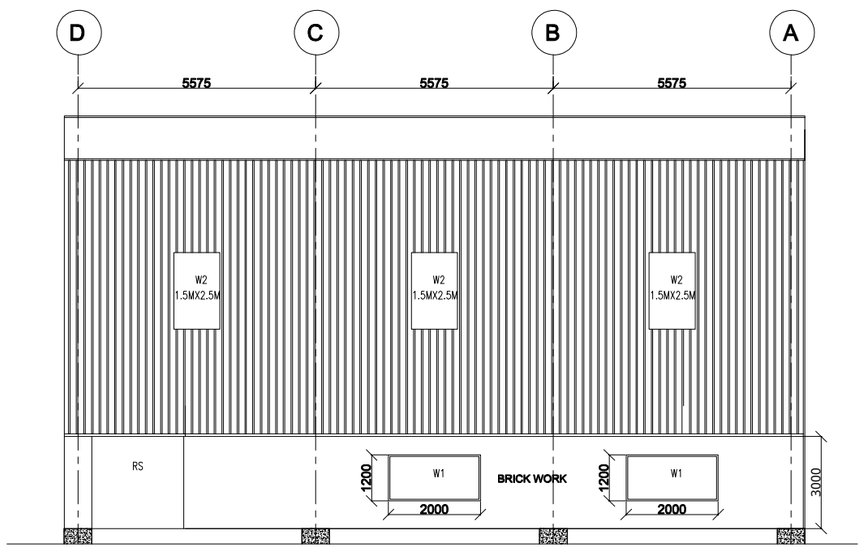
CLIENT: NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT BANESHWOR, KATHMANDU, NEPAL	CONSULTANT: NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT: DETAIL ENGINEERING DESIGN OF BALAJU SUBSTATION UPGRADATION PROJECT SANKHUWASABHA, NEPAL	DRAWN: PRS	DESIGNED: PRS	TITLE: BALAJU SUBSTAION UPGRADATION PROJECT 132kV GIS BUILDING SECTIONAL DETAILS SHEET (2/4)
		ORIGINAL SIZE: A3 / REPORT STATUS	DRAFTING CHECK: GBT	DESIGN CHECK	
		REV: 0	APPROVED	DRAWING NO.: DWG-CIV-2	



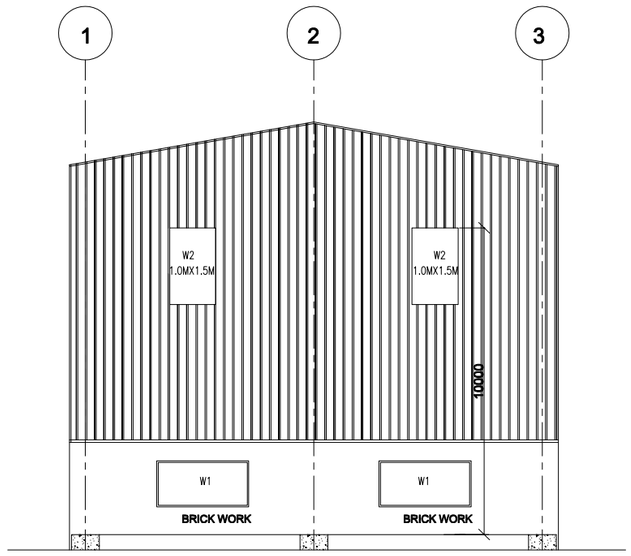
SIDEWALL ELEVATION A



SIDE WALL ELEVATION C

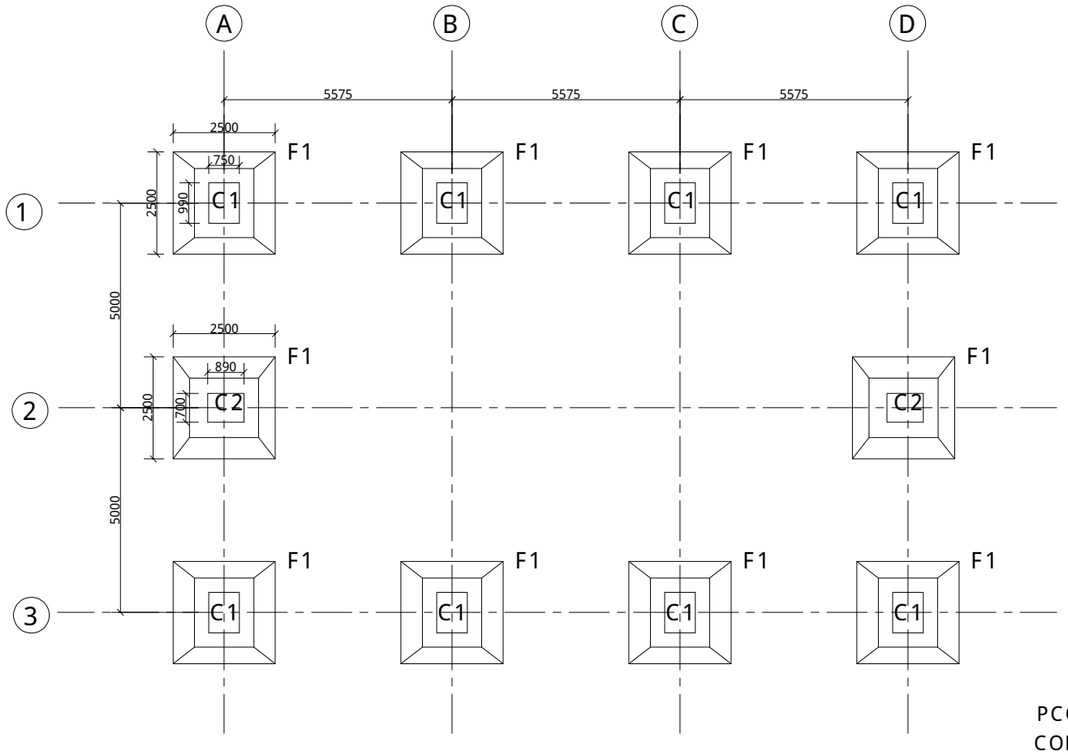


SIDEWALL ELEVATION B

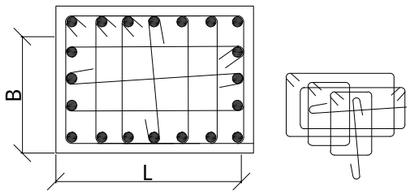


SIDE WALL ELEVATION D

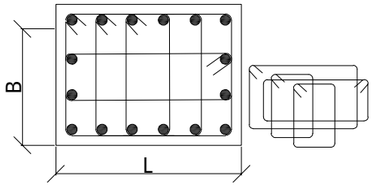
CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT BANESHWOR, KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT DETAIL ENGINEERING DESIGN OF BALAJU SUBSTATION UPGRADATION PROJECT SANKHUWASABHA, NEPAL	DRAWN PRS	DESIGNED PRS	TITLE BALAJU SUBSTAION UPGRADATION PROJECT 132kV GIS BUILDING ARCHITECTURAL ELEVATION SHEET (3/4)
		ORIGINAL SIZE A3 / REPORT STATUS	DRAFTING CHECK GBT	DESIGN CHECK	
		REV 0	APPROVED	DRAWING NO. DWG-CIV-2	



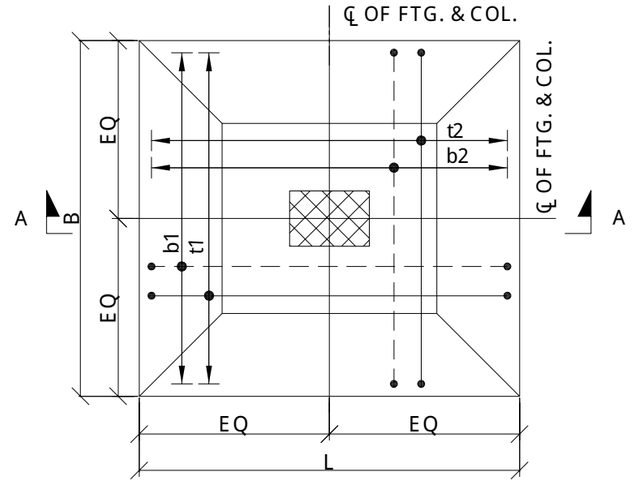
132KV GIS HALL FOUNDATION LAYOUT



TYPE I
(16 BARS)
(4 TIES/SET+2 SET LINK)



TYPE II
(16 BARS)
(4 TIES/SET)



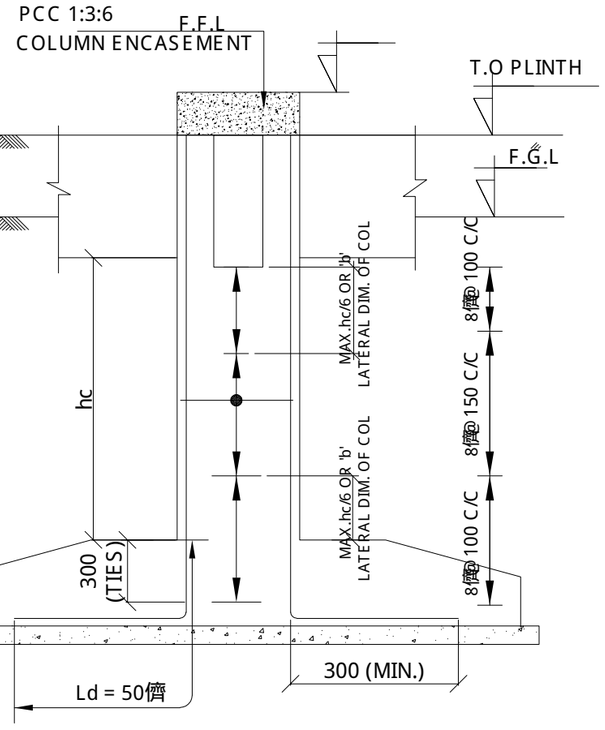
TYP. PLAN OF ISOLATED FDN
TYPE I

SCHEDULE OF COLUMNS

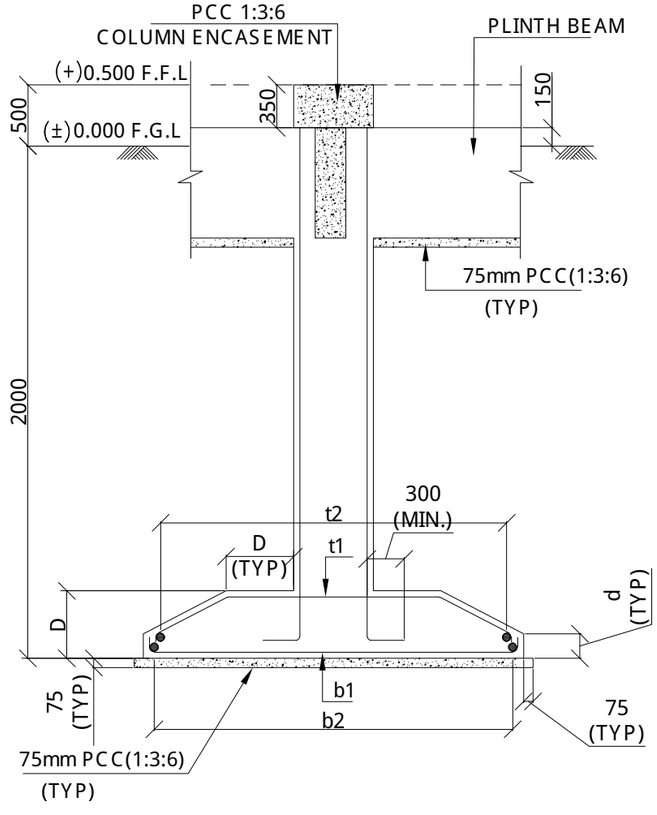
	COLUMN MARKS	C1	C2
FOUNDATION TO PLINTH LEVEL	COLUMN SIZE : L X B	750X990	700X890
	VERTICAL REINFORCEMENT	20-20ϕ	16-20ϕ
	TIES : FOR NON CONFINING ZONE	8ϕ@150 C/C	8ϕ@150 C/C
	CONCRETE MIX :	M25	M25
	COLUMN SECTION	TYPE I	TYPE II

SCHEDULE OF FOOTINGS

S.N.	FDN. MKD.	TYPE	SIZE				REINFORCEMENT (ϕ			
			L	B	D	d	b1	b2	t1	t2
1	F1	I	2500	2500	450	200	12ϕ@150	12ϕ@150	12ϕ@150	12ϕ@150

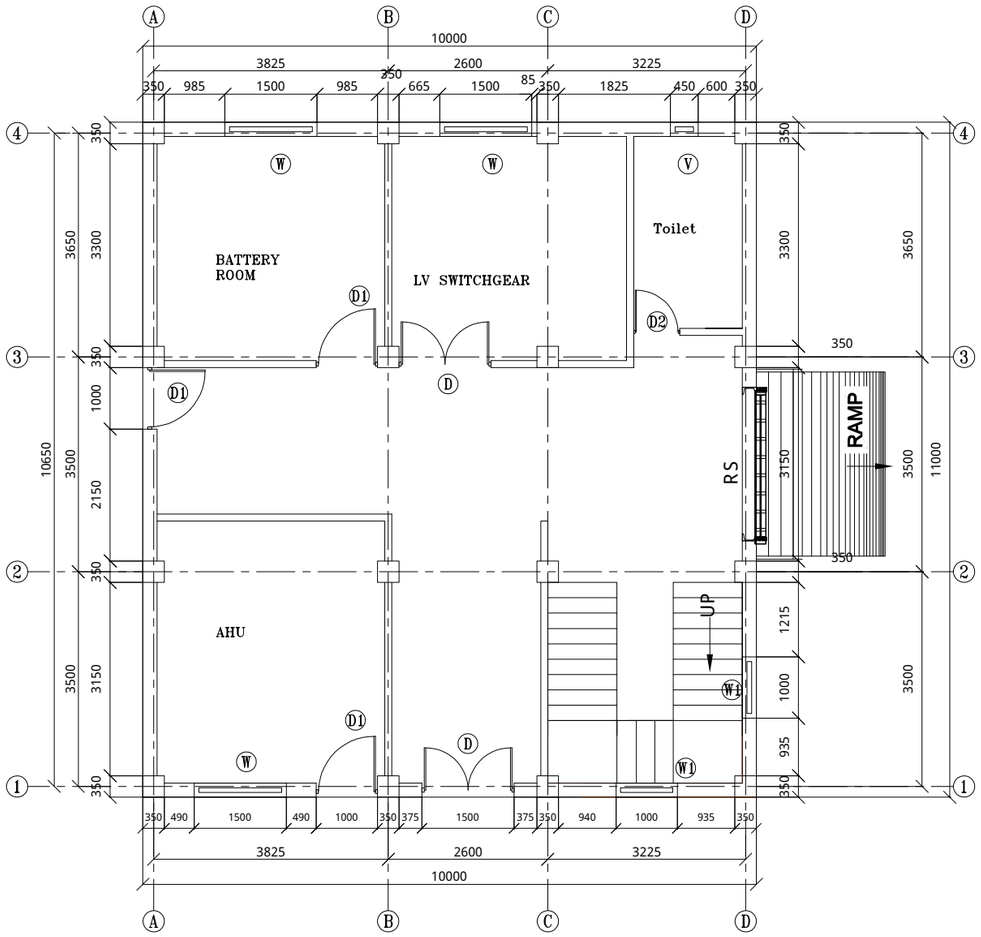


TYPICAL COLUMN ELEVATION
SHOWING LAP & TIES

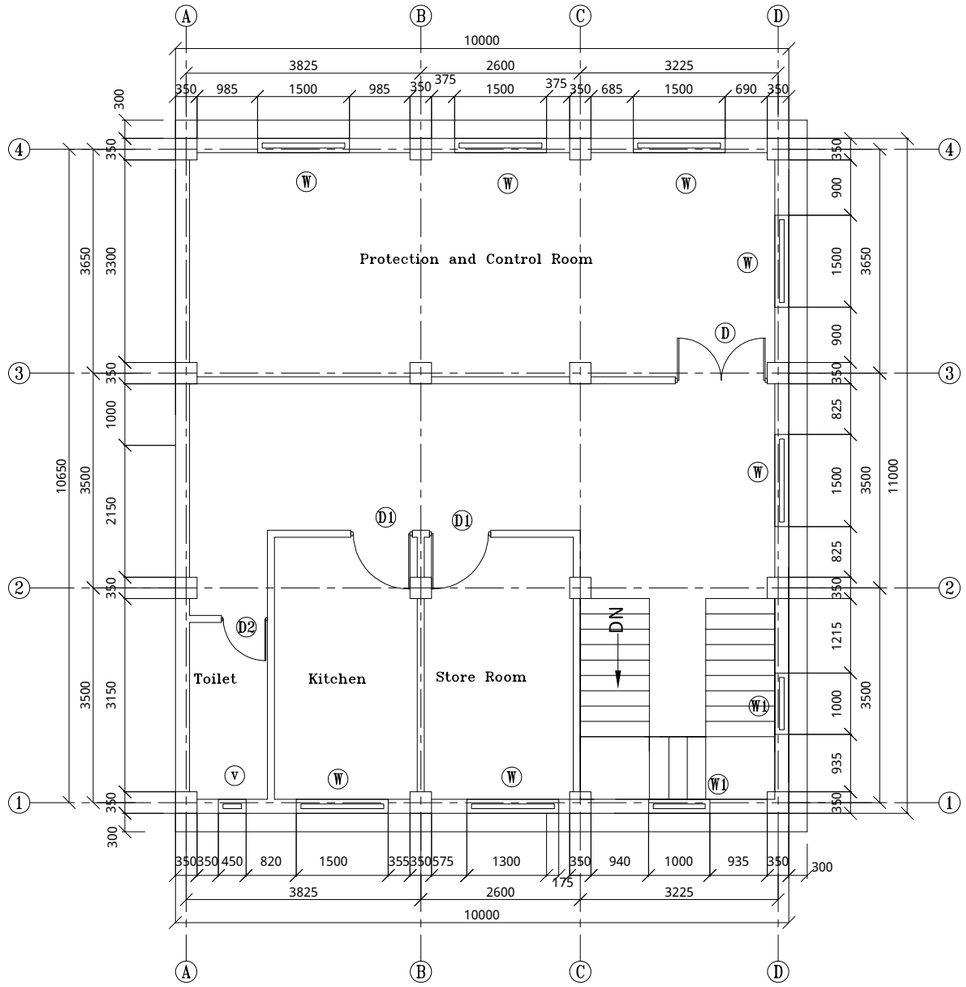


TYP.SECTION A-A OF ISOLATED FOUNDATION

CLIENT: NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT BANESHWOR, KATHMANDU, NEPAL	CONSULTANT: NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT: DETAIL ENGINEERING DESIGN OF BALAJU SUBSTATION UPGRADATION PROJECT SANKHUWASABHA, NEPAL	DRAWN: PRS DESIGNED: PRS DRAFTING CHECK: GBT DESIGN CHECK: APPROVED: DRAWING NO.: DWG-CIV-2
		ORIGINAL SIZE: A3 REPORT STATUS: REV: 0	TITLE: BALAJU SUBSTAION UPGRADATION PROJECT 132kV GIS BUILDING STRUCTURAL DETAILS SHEET (4/4)

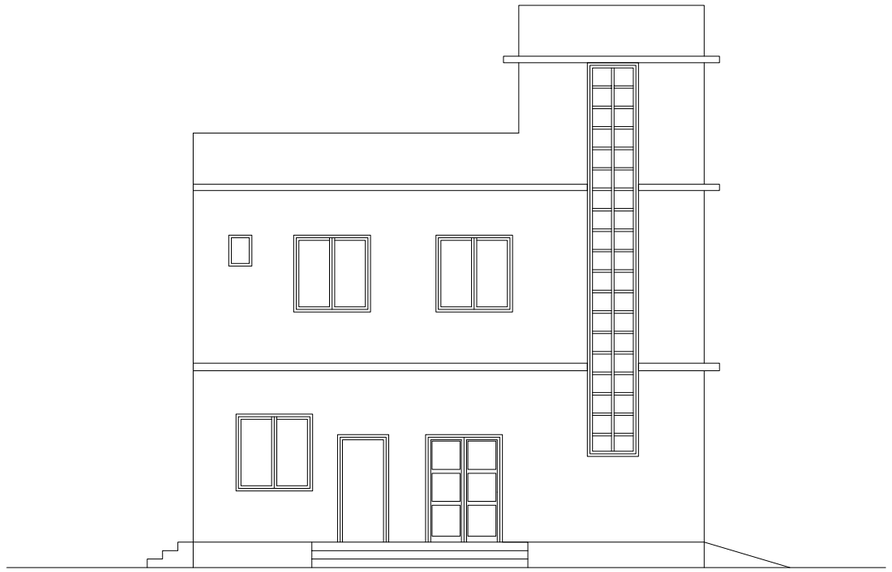


GROUND FLOOR PLAN (+)0.5m

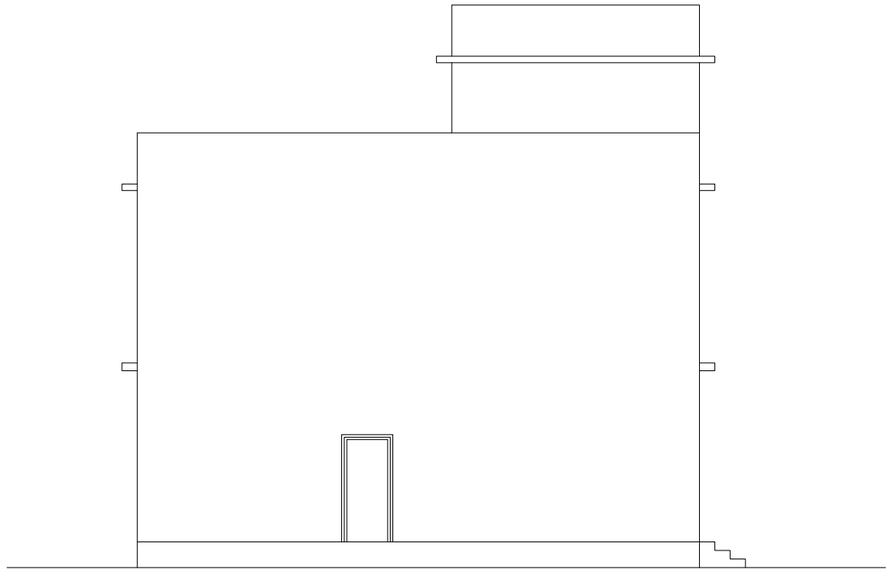


FIRST FLOOR PLAN (+) 4.0m

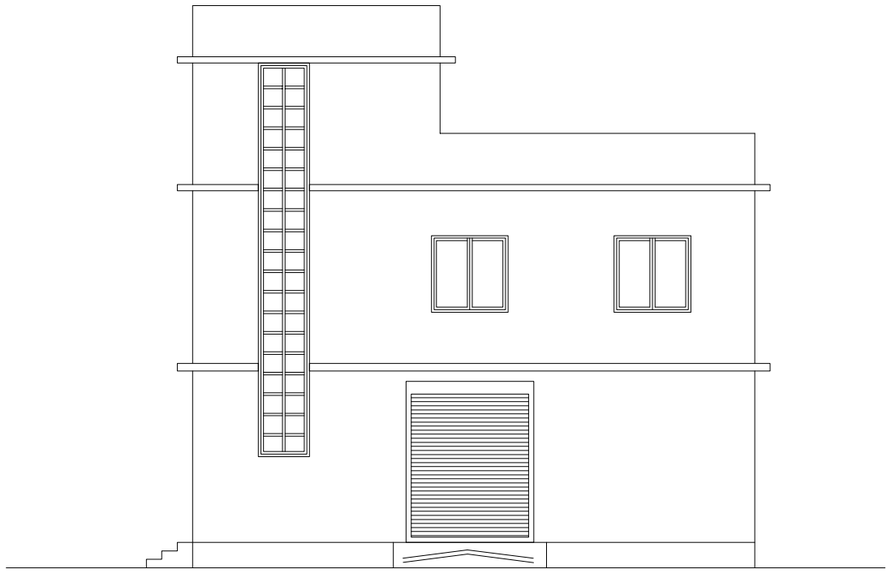
CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT BANESHWOR, KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT DETAIL ENGINEERING DESIGN OF BALAJU SUBSTATION UPGRADATION PROJECT SANKHUWASABHA, NEPAL	DRAWN PRS	DESIGNED PRS	TITLE BALAJU SUBSTAION UPGRADATION PROJECT 132kV CONTROL ROOM BUILDING ARCHITECTURAL PLAN
			DRAFTING CHECK GBT	DESIGN CHECK	
		ORIGINAL SIZE A3 / REPORT STATUS	APPROVED	DRAWING NO. DWG-CIV-3	
		REV 0			



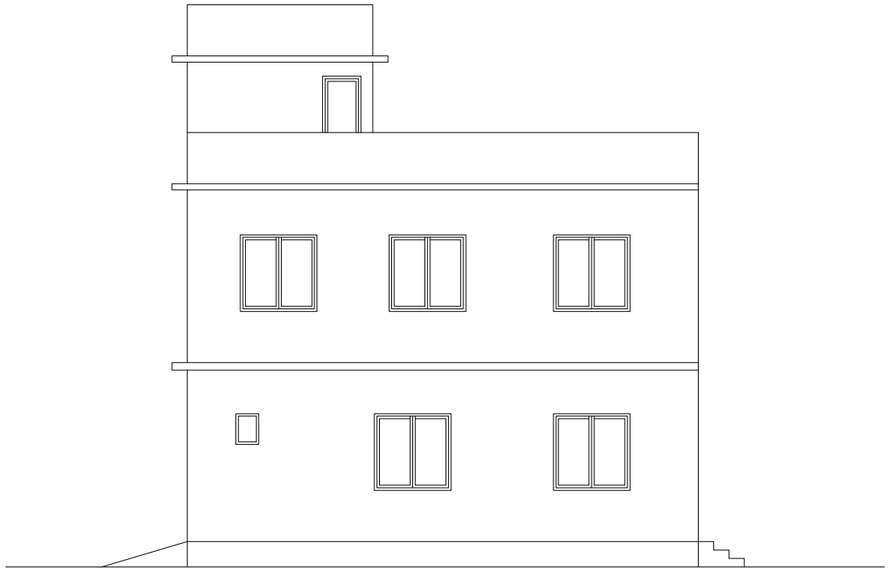
FRONT VIEW



LEFT SIDE VIEW

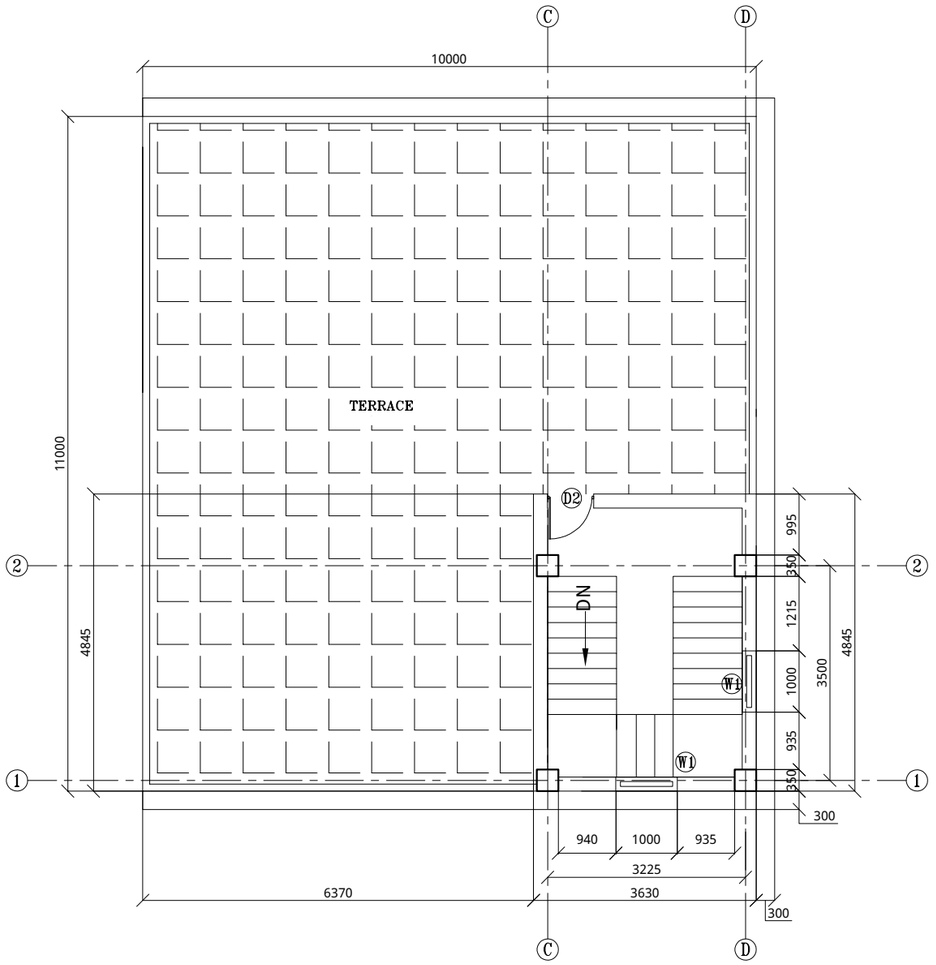


RIGHT SIDE VIEW

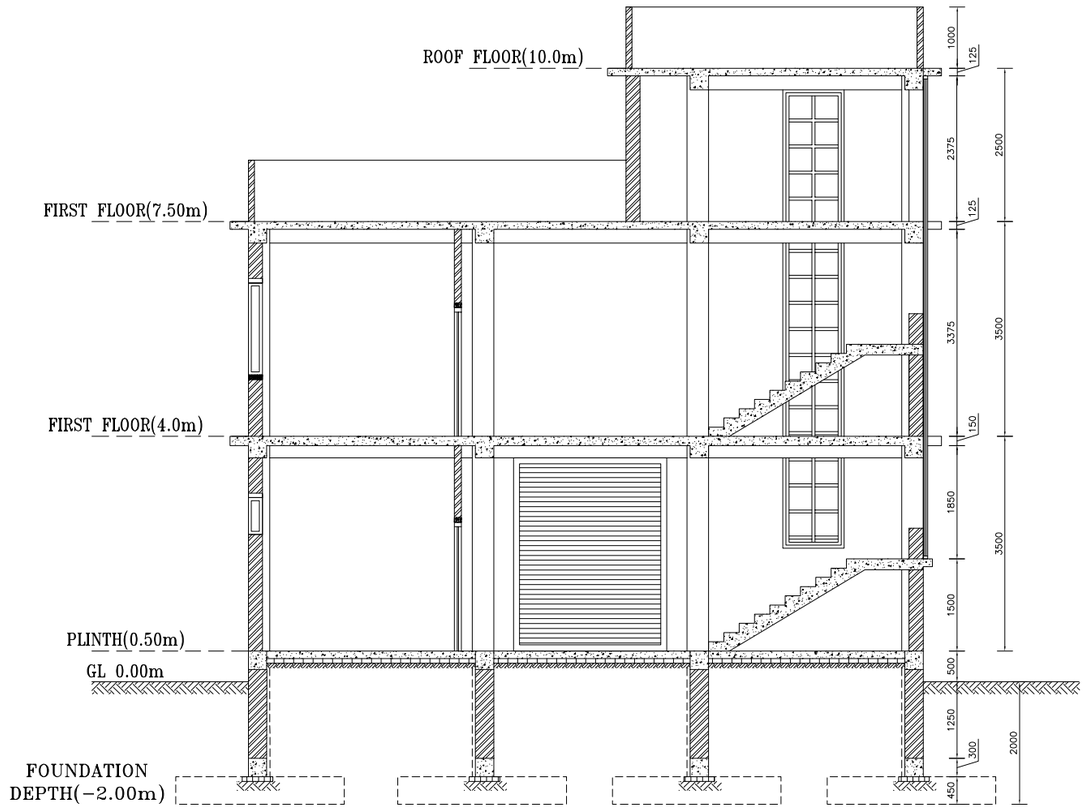


BACK VIEW

CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT BANESHWOR, KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT DETAIL ENGINEERING DESIGN OF BALAJU SUBSTATION UPGRADATION PROJECT SANKHUWASABHA, NEPAL		DRAWN PRS	DESIGNED PRS	TITLE BALAJU SUBSTAION UPGRADATION PROJECT 132kV CONTROL ROOM BUILDING ARCHITECTURAL ELEVATION
		ORIGINAL SIZE A3	REPORT STATUS	DRAFTING CHECK GBT	DESIGN CHECK	
			REV 0	APPROVED	DRAWING NO. DWG-CIV-3	



ROOF PLAN (+) 7.5m



SECTION AT A-A

CLIENT NEPAL ELECTRICITY AUTHORITY GRID OPERATION DEPARTMENT BANESHWOR, KATHMANDU, NEPAL	CONSULTANT NEA ENGINEERING COMPANY LTD. TRADE TOWER,THAPATHALI, KATHMANDU, NEPAL	PROJECT DETAIL ENGINEERING DESIGN OF BALAJU SUBSTATION UPGRADATION PROJECT SANKHUWASABHA, NEPAL	DRAWN PRS	DESIGNED PRS	TITLE BALAJU SUBSTAION UPGRADATION PROJECT 132kV CONTROL ROOM BUILDING ARCHITECTURAL PLAN AND SECTION
		ORIGINAL SIZE A3 / REPORT STATUS	DRAFTING CHECK GBT	DESIGN CHECK	
		REV 0	APPROVED	DRAWING NO. DWG-CIV-3	